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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Hook-up and move services for the occupancy phase of the National Institute of Standards and Technology (NIST) Advanced Measurement Laboratory (AML) project at Gaithersburg, MD, approximately 42,000 square meters, located north of South Drive and directly south of existing Buildings 220 and 221, will provide NIST with world class laboratories. Ever increasing demands for improved laboratory quality have brought about needs for these new generation labs. The emphasis for the project will be on outfitting labs which can meet the needs for cleanroom air quality, precise temperature control, vibration-free environments, and great flexibility to allow for science development over many coming years. Relocation of existing laboratory equipment and contents and associated office furniture, equipment and contents is also included.

The AML configuration features five major blocks of laboratories linked together by a circulation and service spine which also connects the new buildings with the present campus. The center point of the complex is Cleanroom Building 215, housing cleanroom laboratories for micro electronic science. Flanking the center lobby are two Instrument laboratory blocks, Buildings 216 and 217, each containing laboratory programs such as precision engineering, inorganic analysis, micro-analysis, atomic physics and ceramic science.

Below the courtyards adjacent to the existing buildings are two below grade Metrology laboratory blocks. The laboratories which are most sensitive to thermal variations or building vibration are located in these underground blocks. Metrology West, Building 219, houses laboratories for metrology and sensor systems. Metrology East, Building 218, includes facilities for electricity, surface metrology, mass analysis, spectroscopy, vacuum and electron physics.

Offices for scientists form the north and south edges of the Instrument laboratory blocks. Approximately 200 offices are located on two levels.

B. The Contractor shall be responsible for:
1. Laboratory hook-up (routing of services to final

location) necessary to tenant-specific laboratory needs. Hook-up consists of mechanical, plumbing, electrical, and related work.
2. Packing and crating of scientific, laboratory, and office equipment.
3. Physical relocation including moving, rigging, and equipment relocation. Relocation is from six existing buildings on the NIST Gaithersburg campus. These are 220-Metrology, 221-Physics, 222-Chemistry, 223-Materials, 225-Technology, and 233-Sound. Relocation is to any of five wings of the new Advance Measurement Laboratory.
4. Miscellaneous specialty work, vendor coordination, and user group activities coordination.
5. Detailed logistical planning for relocation and specialty equipment installation.
6. Trade and professional management.
7. Relocation of office furniture, equipment, and (packed) personal effects from above-listed buildings into the new AML.

C. The Government reserves the right to perform construction or operations related to the Project with the Government's own forces, and to award separate contracts in connection with other portions of the Project or other construction or operation on the site under Conditions of the Contract identical or substantially similar to these including those portions related to insurance and waiver of subrogation.
1. When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Government Contractor Agreement.
2. The Government shall provide for coordination of the activities of the Government's own forces and of each separate contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with other separate contractors and the Government in reviewing their construction schedules when directed to do so. The Contractor shall make any revisions to the construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, separate contractors and the Government until subsequently revised.
3. The Contractor shall afford the Government and separate contractors opportunity for introduction and storage of their materials and equipment and

performance of their activities and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

4. If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Government or a separate contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly report to the Government apparent discrepancies or defects in such other construction that would render it unsuitable for such proper execution and results. Failure of the Contractor to report shall constitute an acknowledgment that the Government or separate contractors' completed or partially completed construction is fit and proper to receive the Contractor's Work, except for defects that are not then reasonably discoverable.
5. Costs caused by delays or by improperly timed activities or defective construction shall be borne by the party responsible for the delays, improper timing or defects.
6. The Contractor shall promptly remedy damage wrongfully caused by the Contractor to completed or partially completed construction or to property of the Government.
7. If a dispute arises among the Contractor, separate contractors and the Government as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Government may clean up and allocate the cost among those responsible.
8. Separate contracts may include, but not limited to:
    a. Telecommunications.
    b. Equipment installation and connection.
    c. Maintenance.
    d. Signage.
    e. Fire alarm/security modification to installed systems.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01012

WORK BY OTHERS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Government may perform work with their staff or may award separate contracts for performance of certain construction operations at site. Operations may be scheduled to be performed during Work under this Contract.

B. Separate contracts include but are not limited to following:
   1. Telecommunications.
   2. Maintenance.
   3. Signage.
   4. Equipment and items indicated in documents as Government furnished (OFOI or GFGI).
   5. Owner furnished furnishing, such as, furniture, window coverings and art work.
   6. Security system installation in empty conduit.
   7. Asbestos Abatement or Abatement of other hazardous materials (if needed).
   8. Refer to Documents for additional miscellaneous items.

C. Contractors holding separate contracts with the Government to perform work for the Government may be non-union contractors. By executing this Contract, the General Contractor and all subcontractors acknowledge this and have no objection to it and agree that it will not have a negative impact on the Project.

D. Schedule activities to minimize interference with work of others and cooperate with other parties involved in concurrent Work. Cooperation by the Contractor shall not, in and of itself, be grounds for a claim of delay or additional cost.

END OF SECTION

SECTION 01016

CONTINUED OCCUPANCY OF EXISTING FACILITIES

PART 1 - GENERAL

1.01 NO INTERRUPTION OF OCCUPANCY

A. Work is required to be performed within existing Buildings. Contractor shall have access to areas in which this Work occurs, subject to the rights of the Government.

B. The Government will occupy and conduct highly sensitive and technologically advanced research in the existing adjacent buildings during life of this Contract. Contractor shall schedule all Work at such time and in such a manner to minimize interference and inconvenience to the Government.

1.02 DISRUPTION OF EXISTING SERVICES

A. No disruption to building-wide services is anticipated; however, if this becomes necessary perform all Work relating to disruption of existing services at such times as approved by COTR.

B. Limit duration of each such disruption of service to times approved in advance and in writing by COTR.

C. To the extent practical, schedule outages to coincide with regular full campus weekend outages provided twice each year, once in the Spring and once in the Fall.

D. Fabricate and install interconnecting portions of affected systems prior to shut down for final connections.

E. Maintain utilities or other services, indicated to be abandoned, in service or provide alternate means of service until Contractor provides, tests, and completes replacement facilities.

1.03 USE OF PREMISES

A. Use of site: Limit use and operation at site to "Limits of Construction" required to perform Work.
Portions of site beyond areas of required Work shall not be disturbed.
1. Keep existing roads, streets, drives, parking lots, entrances, ventilation air intakes and fire exit ways clear and available at all times for their intended use. Do not use these areas for parking, staging or

storage without written approval by the COTR.
2. Do not unreasonably encumber site with equipment, materials or vehicles.

B. Use of facilities:
1. Limit use and operation within existing facilities to areas indicated for Work and as required to perform the Work. Other areas within existing facilities shall not be disturbed or disrupted.
2. Perform Work so as to minimize interference with Government operations.
3. Maintain and keep clear all required fire exit ways throughout existing facilities within and in the vicinity of construction areas. Coordinate required temporary exits with COTR and the Government's Fire Marshal.
4. Do not load structure with weights that will endanger structure.
5. Prohibit smoking within Government facilities.
6. Submit documentation for audio devices and radios, including two-way radios needed for Contractor's operations, to COTR for approval prior to use. Limit use of two-way radios within occupied facilities, so not to disrupt occupants.
7. Use of toilet facilities within existing facility or occupied areas is not allowed.
8. Do not use elevators in existing or new facilities beyond posted maximum capacity.
9. Do not use cafeteria and dining areas in existing Government facilities.

1.04 WORK SEQUENCES AND PARTIAL OCCUPANCIES

A. Submit a detailed Work Sequence and Phasing Schedule to COTR for approval prior to commencement of any work. Partial closure of existing roads will be allowed when one lane of traffic can be accommodated in accordance with "Work Zone Traffic Controls" published by the Maryland Department of Transportation, and approved in writing by COTR. When the Work will not allow partial egress, submit a detailed traffic re-routing plan to COTR and comply with any alterations included by the COTR in the written approval.

1.05 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
   1. Work plan within 30 m of existing buildings.
   2. Work sequence and phasing schedule.
   3. Traffic re-routing plan.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01030
OPTIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION

A. Definitions:
1. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

B. Work specified under this section:
1. This Section includes administrative and procedural requirements for options.
2. Schedule: A Schedule of Options is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

1.03 PROCEDURES

A. Provide pricing good for 90 days minimum from NTP for each of the options in the following schedule.
1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

B. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
1. Include as part of each alternate, miscellaneous piping, mechanical and electrical devices, rigging, equipment, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

C. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if options have been accepted,

rejected, or deferred for later consideration. Include a complete description of negotiated modifications to options.

D. Execute accepted alternates under the same conditions as other work of the Contract.

E. Pricing Format:
   1. For each alternate provide a unit price that will be used for adding/deducting units to/from the entire scope of the alternate. Unit price shall include all miscellaneous items required for the installation of said unit. Furthermore, unit pricing shall be broken out in the format indicated next to the Unit Pricing column (example: by type, by location, etc.)
   2. For each alternate provide a total price that includes the entire scope of work and materials defined by the alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 SCHEDULE OF OPTIONS (See next page)

3.01 SCHEDULE OF OPTIONS

A. Option 1: Track lighting, task lighting and remote lighting per specification sections 16510 and 16512, and as indicated on the drawings.

B. Option 2: Overhead hoists and associated structural modifications, per specification section 14300 and as indicated on the drawings.

C. Option 3: Isolation pits, air springs, controls, and associated modifications to existing access floor, per specification sections 10270 and 13085, and as indicated on the drawings.

D. Option 4: Liquid Nitrogen tanks and associated piping, per specification sections 15487 and 15488.

E. Option 5: Shielded room and associated demolition and rebuilding of walls and doors per specification section 13095 and as indicated on drawing titled "Inner Shielded Room/Outer Shielded Room" and elsewhere on the drawings.

F. Option 6: Unit kitchens (UK) with connections to existing utilities per specification section 11460 and as indicated on the drawings, except for the following sub-options.
6a. Delete electric cooking surface units.
6b. Add wall cabinets as indicated on drawings.
6c. Add plastic laminate shelf as indicated on drawings.

END OF SECTION

SECTION 01044

CUTTING AND PATCHING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Perform Work as to preclude or minimize cutting and patching of new work by Contractor, Government or separate Contractors or existing improvements or services.

B. Execute cutting including excavation, fitting or patching of work, required to:
   1. Make several parts fit properly.
   2. Uncover work to provide for installation of ill timed work.
   3. Remove and replace defective work.
   4. Remove and replace non-conforming work.
   5. Remove samples of installed work for testing.
   6. Install specified work in existing construction.

C. Do not endanger any element that is part of, adjacent to or affected by the Project, by cutting, excavating, or otherwise altering any element, except with written consent of COTR.

D. Do not cut into or cut away any structural concrete or other structural elements, or any other concrete, and do not dig under any foundations or into walls or other parts, except with written consent of COTR.

E. Pay for repair of damage resulting from violation of these provisions.

F. Use only firms and individuals with minimum 5 years of previous applicable experience to perform work required under this Section.

1.02 SUBMITTALS

A. Shop Drawings: Not required for COTR review.

B. Product Data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project Information: Not required for COTR review.

E. Contract Closeout Information: Not required for COTR review.

1.03 JOB CONDITIONS

A. Perform preliminary and detailed investigations as required to ascertain extent of work.
   1. Conditions which would be apparent by such investigation will not be allowed as cause for claims.

B. Before start of work, obtain permits required by authorities having jurisdiction.
   1. Schedule utility outages as specified in Section 01016.

C. Obtain approval of COTR for work which affects existing exitways, exit stairs, means of egress, or access to or exit from areas.
   1. Review with and obtain written approval of COTR for any temporary construction which affects such areas.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide matching items for patching of work.

B. Comply with the applicable sections of the Specifications for type of work to be performed.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect existing conditions of work, including determination of elements subject to movement or damage during:
   1. Cutting and patching.
   2. Excavating and backfilling.

B. After uncovering existing conditions for work, inspect conditions affecting installation of new products or work.

3.02 PREPARATION PRIOR TO CUTTING

A. Provide shoring, bracing and support as required to maintain structural integrity of elements to be cut.

B. Provide protection for other portions of Project which may be affected.

C. Provide protection from weather.

3.03 CUTTING AND REMOVAL - GENERAL

A. Execute fitting and adjustments to provide finished installations complying with specified or indicated tolerances and finishes.

B. Execute cutting by methods which shall prevent damage to adjacent work and shall provide proper surfaces to receive installation of repairs or new work.

C. Perform backfilling as specified in applicable Sections of Specification.

D. Neatly cut and remove materials, and prepare all openings to receive new work.

E. Remove masonry or concrete in small sections.

F. Provide shoring, bracing, and other supports to prevent movement, settlement, or collapse of remaining or adjacent wall areas, structure, or facilities.

G. Arrange shoring, bracing, and supports to prevent overloading of structure.

H. Take all precautions to prevent damage to existing remaining work or to adjacent facilities.

I. Execute Work using methods which shall prevent interference with use of remaining and adjacent facilities by the Government.

J. Remove existing work indicated to be removed or as necessary for installation of new work.

K. Provide for cutting, fitting, repairing, patching and finishing of work disturbed by installation of new work.

L. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace damaged fireproofing.

M. Penetration of any fire rated partition in an existing structure or between an existing structure and a new work area shall be sealed and repaired as soon as practical and within a time frame acceptable to the COTR and the Government Authority Having Jurisdiction.

3.04 CUTTING IN CONCRETE CONSTRUCTION

A. Do not cut into or core drill openings or holes in beams, joists, and columns without prior written approval of COTR.
   1. When written approval is obtained, comply with requirements and instructions of COTR.

B. In elements other than beams, joists, and columns, where an opening larger than 250 mm in any dimension is required, or where the dimension between 2 openings is less than 2 times the maximum dimension of largest opening, and condition is not indicated on Drawings, obtain prior written approval of COTR.
   1. When written approval is obtained, comply with requirements and instructions of COTR.

3.05 CUTTING IN POST TENSIONED CONCRETE CONSTRUCTION

A. Do not cut into or core drill openings or holes in beams or joists.

B. Do not cut into or core drill openings or holes in slabs without prior written approval of COTR.
   1. When approval is obtained, comply with requirements and instructions of COTR.

C. Openings not greater than 150 mm in any dimension are permitted in flat slab portions of construction except that such openings shall not interfere with or disturb post tensioning strands.
   1. Do not place openings closer than 300 mm from any column face, or closer than 600 mm from any post tensioning strand anchor.

D. Do not install any trenched duct electrical systems.

3.06 CUTTING IN PRECAST PRESTRESSED CONCRETE CONSTRUCTION

A. Do not cut openings or core drill vertically nor horizontally through stems of members.

B. Openings not greater than 150 mm diameter in any dimension may be cut in flanges of units after obtaining prior written approval of COTR.
   1. When approval is obtained, comply with instructions and requirements of COTR.

3.07 CUTTING IN STEEL FRAME AND METAL DECK CONSTRUCTION

A. Do not cut or drill holes in webs and flanges of columns,

beams, purlins, and joists without prior written approval of COTR.
1. When approval is obtained, comply with requirements and instructions of COTR and provide reinforcing at such locations in accordance with applicable AISC standard details and recommendations, and as directed by COTR.

B. When openings are cut into metal decks having cast-in-place concrete slab over metal deck:
1. No reinforcing of holes is required for openings or sleeves having no dimension greater than 150 mm.
2. Reinforce openings greater than 150 mm in any dimension with steel plates and miscellaneous metal sections.
3. Obtain prior written approval of COTR for openings not indicated on Architectural or Structural Drawings.
a. Comply with requirements and instructions of COTR.

C. When openings are cut into metal roof decks that have no cast-in-place concrete (except lightweight insulating cementitious roof fill) over deck:
1. No reinforcing of holes is required for openings having no dimension greater than 150 mm.
2. Reinforce openings with one or more dimension between 150 mm and 300 mm, with 0.9 mm flat steel sheet 305 mm greater in dimension than opening; fusion weld to top surface of deck at each corner and on each side midway between corners.
3. Do not cut openings greater than 300 mm in any dimension without prior written approval of COTR.
a. Comply with requirements and instructions of COTR.

D. Where required, ensure proper quality of materials and workmanship to maintain appropriate fire ratings.

3.08 MATCHING AND PATCHING

A. Repair wall, ceiling, floor or partition disturbed by removal where items are removed from existing walls, ceilings, floors or partitions to remain.

B. Repair abutting walls, ceilings or floors disturbed by removal where walls, ceilings, floors or partitions are removed.

C. Patch and match existing disturbed construction where existing construction is cut, removed or otherwise disturbed to permit installation of new work.

D. Use methods and materials similar in appearance, and equal

in quality to areas or surfaces being repaired.

E. Restore work which has been cut or removed; install new products to provide completed work in accordance with requirements of Contract Documents.

F. Match existing work and adjacent surfaces with patch work.

G. Finish entire surfaces as necessary to provide an even finish.
   1. Continuous surfaces: Extend finish to nearest intersections.
   2. Assembly: Refinish entire assembly.

H. In existing areas remove and replace existing ceilings and finishes for installation of work, if not Indicated to be removed.

3.09 CLEAN UP

A. Remove all debris, rubbish, and materials resulting from cutting, demolition or patching operations, daily.

B. Transport materials and legally dispose of them off site.

END OF SECTION

SECTION 01094

DEFINITIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. General:
1. Basic definitions are included here to define terminology used throughout Specifications.
2. Definitions in this Section are in addition to terms defined in the Construction Contract Clauses.

1.02 ACCEPTANCE

A. "Acceptance" refers to the Government's written acknowledgment that the entirety of the work has been completed by Contractor.

1.03 ACCEPTABLE PERFORMANCE

A. A component or system being able to meet specified design parameters under actual load or operating conditions or both, as applicable.

1.04 ADDENDUM

A. "Addendum" shall have the same meaning as "amendment" defined in the Construction Contract Clauses.

1.05 APPROVE

A. Approve: The term "approved", where used in conjunction with the Government's action on the Contractor's submittals, applications, and requests, is limited to the duties and responsibilities of the Government's consultants as stated in Construction Contract Clauses. Such approval shall not release the Contractor from responsibility to fulfill Contract requirements unless otherwise provided in the Contract Documents.

1.06 ARCHITECT/ENGINEER (A/E)

A. The professional services firm responsible for design of the Project. The A/E may perform post construction award services during the Construction Phase for the Government.

1.07 CERTIFY

A. The word "certify" and any derivative thereof refers to a signed written declaration vouching for a subject in writing and/or formally attesting to the quality or worth of a portion of the work. Business letter format may be form of certification. Contractor shall cause certificates from subcontractors, vendors, manufacturers and other such entities to be signed by a duly authorized officer of such entities. Provide only original signed certificates.

1.08 CONSTRUCTION MANAGER (CM)

A. The Government has retained non-government CM firm(s) on this Project to assist the COTR in the administration of this Construction Contract.

1.09 CONTRACT PRICE

A. "Contract Price" refers to the amount set out in the executed solicitation, offer and award document as full compensation to the Contractor for performance of the work.

1.10 CONTRACT SCHEDULE/CPM SCHEDULE

A. The terms "Contract Schedule" and "CPM Schedule" are referenced in various locations within the Contract Documents. These terms are defined further in the Associated General Contractors of America (AGC) publication; "Construction Planning and Scheduling, a Manual for General Contractors and the Construction Industry", referenced in Section 01310. Contractor shall use the terms referenced in this publication for all scheduling requirements on this project.

1.11 CONTRACT TIME/PERIOD OF PERFORMANCE

A. "Contract Time" refers to the "Contract Period of Performance", that period of time in which Contractor must perform the entirety of the work. Contract Time is initiated by Contractor's receipt of Government's written notice to Contractor that Contractor is to proceed with the work (i.e., "Notice to Proceed"). All references to "Contract Time" means "Period of Performance".

1.12 CONTRACTOR

A. The Contractor is the entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The term "Contractor" means the Contractor or the Contractor's authorized

representative.

1.13 THE CONTRACTOR SHALL

A. In interest of conciseness and an imperative writing style, any sentences, statements, and clauses used may exclude any form of verb "shall" normally expressed in verb phrase with verbs such as "furnish", "install", "provide", "perform", "construct", "erect", "comply", "apply", "submit", etc. Any such sentences, statements, and clauses are to be interpreted to include applicable form of phrase "the Contractor shall" and requirements described therein interpreted as mandatory elements of Contract.

1.14 DAY

A. "Day" shall mean calendar day, unless otherwise stated.

1.15 DIRECTED

A. Terms such as "directed", "requested", "authorized", "selected", "approved", "required", and "permitted" mean "directed by the Government", "requested by the Government", and similar phrases. However, no implied meaning shall be interpreted to extend the Government's responsibility into the Contractor's area of construction supervision or means and methods of construction.

1.16 THE DRAWINGS

A. The Drawings are the graphic and pictorial portions of the Contract Documents, indicating the design, location and dimensions of the work. The Drawings generally include plans, elevations, sections, details, schedules, sketches, and diagrams.

1.17 DRAWINGS SYMBOLS

A. Graphic symbols: Where not otherwise noted, symbols are defined by "Architectural Graphic Standards", published by John Wiley & Sons, Inc., ninth edition.

B. Mechanical/Electrical Drawings: Graphic symbols used on Mechanical and Electrical Drawings are generally symbols recommended by ASHRAE. Where appropriate, more specific symbols recommended by technical associations including ASME, ASPE, IEEE and similar organizations are used. Refer instances of uncertainty to the COTR for clarification before proceeding.

1.18 FURNISH

A. Unless specifically limited in context, "furnish" means; furnishing the specified item to the Project site and includes manufacturing and fabrication, packaging, shipping, unloading, storing, protecting, unpacking, relocating and assembling for installation.

1.19 GENERAL CONDITIONS

A. "General Conditions" refer to the Construction Contract Clauses and other Contract provisions referenced in the Agreement, and any other requirements pertinent to the Contract.

1.20 INDICATED AND SHOWN

A. "Indicated" or "shown" refers to graphic representations, notes or schedules on the Drawings, or other Paragraphs or Schedules in Specifications, and similar requirements in Contract Documents. Where terms such as "indicated", "noted", "scheduled", and "specified", are used, it is to help locate the reference; no limitation on location is intended except as specifically noted.

1.21 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference. Individual Sections Indicate certain codes and standards.

B. Publication Dates: Where the date of issue of a referenced code or standard is not specified, comply with the standard or code including amendments and modifications, in effect as of the date of the Contract Documents.
   1. Updated Standards and Codes: At the request of Government, or authority having jurisdiction, the Contractor shall submit a Change Order proposal where an applicable standard or code has been revised and reissued after the date of the Contract Documents and before performance of work affected. The Contracting Officer will decide whether to issue a Change Order to proceed with the updated standard or code.

C. Conflicting Requirements: Where compliance with two or more standards or codes are specified, and these establish

different or conflicting requirements for minimum quantities or quality levels, satisfy the most stringent requirement unless the Contract Documents expressly indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent, to the COTR for a decision before proceeding.

1. Minimum Quantity or Quality Levels: Comply exactly, within specified tolerances, with the minimum quantity and quality levels specified or indicated, or exceed minimum quantity or quality within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the COTR for a decision before proceeding.

D. Copies of Standards and Codes: Contractor is required to be familiar with industry standards applicable to the work. Copies of applicable standards and codes are not bound with the Contract Documents.

1. Where copies of standards and codes are needed for performance of a required construction activity, obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards and codes are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations", published by Gale Research Co.

F. Permits, licenses, and Certificates: For the Government's records, submit copies of permits, licenses, Certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the work.

1.22 INSPECTION

A. As used in these documents "inspection" means the type of observation that a reasonably prudent Government representative, in the exercise of ordinary care, would make to determine if the work is in general compliance with the Contract Documents but are not inspections as

would necessarily disclose a defect.

1.23 INSTALL

A. "Install" means incorporating the specified item into the work and includes all necessary labor, materials, equipment and connections to complete the installation as indicated and protection after installation until Acceptance.

1.24 OBSERVATION

A. "Observe" or "Observation" means to become generally familiar with the process and quality of the work and to determine if the work is proceeding in general accordance with the Contract Documents based on what is plainly visible at the construction site, without the removal of materials or other construction that is in place.

1.25 THE PROJECT

A. The Project is the total construction of which the work performed under the Contract Documents may be the whole or a part and which may include construction by the Government or by separate contractors.

1.26 THE PROJECT MANUAL

A. The Project Manual is the volume or volumes usually assembled for the work which may include the offering requirements, sample forms, Conditions of the Contract and Specifications.

B. Project Manual is formatted based on guidelines established by the Construction Specifications Institute.
   1. Division: Standard category of construction information. Divisions form basic framework of Project Specification. Division titles appear in table of contents of Project Manual.
   2. Section: Portion of Project Specifications covering one portion of total work or requirements. Individual Sections dealing with related items are grouped together under 17 Divisions. Sections are included in Project Manual as needed to meet requirements.
      a. Sections of Division 1 include general requirements for administration, procedures, and temporary facilities. Sections in Division 2 through Division 17 include specific requirements for units of work.
   3. Part: Organizational device to divide Specification Section into three distinct groupings of related

information.
a. PART 1 - GENERAL: Defines specific administrative and procedural requirements unique to the Section.
b. PART 2 - PRODUCTS: Describes, in detail, quality of items that are required for incorporation into Project under the Section.
c. PART 3 - EXECUTION: Describes, in detail, preparatory actions and how products are to be incorporated into Project.

4. Article: Major subject consisting of related paragraphs within a part of a Specification Section.
5. Paragraph: One or more sentences, dealing with particular item or point, separated from preceding text by beginning on new line. Groups of paragraphs of related information constitute an article.

C. Specification Language:
1. Basic grammatical moods of sentences can be used to clearly and concisely convey specification requirements.
2. The simple imperative mood is method for instructions covering installation of products and equipment. The verb which clearly defines action becomes first word in the sentence. The imperative sentence is concise and readily understandable. Example: "a. Spread adhesive with notched trowel."
3. Streamlining is used to list products, materials, reference standard, and other itemized specifications. This technique places subject first and hence provides key words for quick reference. Example: "a. Sealant: Silicone."
4. These Specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" shall be included by inference where colon (:) is used within sentences or phrases.
5. In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an", but the fact that a modifier or an article is absent from one statement and appears in another shall not affect the interpretation of either statement.

1.27 PROVIDE

A. "Provide" means Furnish and Install, and is inclusive of all work required for the specified item.

1.28 REGULATION

A. "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the work, whether lawfully imposed by authorities having jurisdiction or not.

1.29 AS REQUIRED

A. In the interest of conciseness, where the phrase "As Required" is used without an object, it should be interpreted to mean, "as required to perform the work".

1.30 SEE

A. In interest of conciseness, references to specification sections and details are often preceded by word "See". Any such references are to be interpreted to include applicable form of phrase ", and comply with,".

1.31 THE SPECIFICATIONS

A. The Specifications, in addition to the definition elsewhere in the Contract Documents, are that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards and workmanship for the work, and performance of related services. The Specifications include the requirements defined in Construction Specification Institute Masterformat Divisions 0 through 17 inclusive of the Project Manual. Specifications are organized by "Sections" with such Sections represented by unique 5 digit numbers and titles.

1.32 SUBCONTRACTOR

A. A Subcontractor is an entity who has a direct contract with the Contractor to perform a portion of the work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a separate contractor or subcontractors of a separate contractor.

1.33 SUB-SUBCONTRACTOR

A. A Sub-subcontractor is an entity who has a direct or indirect contract with a Subcontractor to perform a portion of the work at the site. The term "Sub-subcontractor" is referred to throughout the Contract

Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

1.34 TESTING LABORATORIES

A. A testing laboratory is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.35 THE WORK

A. The term "work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all labor, materials, equipment and services to be provided by the Contractor to fulfill the Contractor's obligations. The work may constitute the whole or a part of the Project.

B. Work includes coordination of work of other trades.

C. Although not indicated, work includes providing supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01100

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION - GENERAL

A. Work included:
1. Coordinate with other on-site operations:
a. Contractor shall coordinate site use with the on-going NIST site operations to ensure no disruption of NIST campus activities. Prior to the commencement of Work, the Contractor shall attend a meeting with the COTR and other Government representatives to coordinate Contractor's Work with NIST operations, including timing of Work, control of Contractor vehicles, noise and vibration control, security requirements, temporary utility requirements, emergency and safety procedures, dust control, and location of erosion control structures. Contractor shall perform the Work in accordance with the Government's directions received at the meeting, as indicated in Government-issued minutes of meeting.
2. Cleanup and dust control:
a. At a minimum, Contractor shall provide daily clean-up and dust control in conformance with the Contract Documents. Use water to protect all on-site and potentially affected off-site operations from construction dust generated from performing the Work and from use of on and off-site roads. The Contractor shall ensure protection from dust and worker trespass of NIST campus areas outside of the Work area and all neighboring properties during construction.
b. Continuously clean on-site roads and affected off-site roads. The Contractor's use of roads in the vicinity of the Project shall not adversely impact on or off-site operations and facilities. Wet all loads of soils imported to or exported from the Work area at the source and cover with a tarpaulin to minimize the amount of dust deposited during transportation to the unloading location.
c. The Contractor shall furnish all labor, equipment and material required and shall carry out effective measures wherever and as often as necessary to prevent its operation from producing dust in amounts damaging to property, vegetation, or causing a nuisance to persons or property in

the vicinity of the Work. The Contractor shall be accountable for any damage resulting from any dust originating from its operations. Continue dust control measures until Acceptance of the Work.

3. Existing structures and devices on Project site:
   a. The approximate location of existing on-site structures and devices within the vicinity of the Work are indicated on the Drawings. The Contractor shall establish their exact location and shall protect the existing on-site structures and devices during construction.
4. Scrap building materials disposal:
   a. In order to reduce disposal volumes of clean scrap wood-based building materials taken to landfill dump, segregate such materials and dispose of the materials using one or a combination of the following methods: 1) arrange for recycling of materials or 2) sell to companies that purchase wood for disposal in biomass-to-energy facilities.
   b. Store recyclable waste in separate clearly marked containers. Arrange and pay for collection by a licensed recycling contractor. Recyclable items include wood, glass, aluminum, steel, gypsum, paper, cardboard and plastics.
   c. Segregate remaining construction debris (that Contractor cannot feasibly recycle or reuse in some way) and give such materials, if feasible, to companies which recycle inert materials.
5. Government-furnished forms:
   a. Use forms provided in the latest version of PRIMAVERA EXPEDITION software as referenced in Section 01340.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
   1. Water control plan.
   2. Certificate of MDE compliance.

E. Contract closeout information: Not required for COTR review.

1.03 USE OF EQUIPMENT BY GOVERNMENT

A. The Government may take over and operate, with Government

employees, such equipment as is necessary for heating or cooling such areas of the building as require the service, as soon as the installation is sufficiently complete.

B. The Contracting Officer will advise the Contractor by letter, prior to the use of equipment, which items of equipment will be operated, and the date and time such operation will begin.

C. Government operation of equipment will not relieve the Contractor of the guarantee on materials and workmanship elsewhere provided for in this Contract.

1.04 CEREMONIES

A. Subject to mutually satisfactory agreements between the parties of the contract, the Government may enter the premises during the term of the Contract to conduct ceremonies, such as laying the cornerstone or dedication ceremonies, and to occupy temporarily such portions of the premises as may be necessary.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01110

CHANGE ORDER PROCEDURES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The provisions of the Construction Contract Clause entitled "Changes", are supplemented as follows:

1.02 DEFINITIONS

A. Change Order:
   1. A written order directing changes in the work within the general scope of the Contract, including changes:
      a. In the specifications or to the drawings;
      b. In the method or manner of performance of the work;
      c. In Government furnished facilities, equipment, materials, services or site; or
      d. Directing acceleration in the performance of the work.
   2. If any change causes an increase or decrease in the Contractor's cost or time required, the Contracting Officer will make an equitable adjustment and modify the Contract in writing.

B. Basis for Establishing Costs:
   1. General: The cost or credit to Government resulting from Change Orders shall be determined in one or more of the following ways: (1) by the Contract parties' mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit Government evaluation; or (2) by unit prices stated in the Contract Documents or subsequently agreed upon; or (3) by Force Account.
   2. Mark-ups: Apply only allowable mark-ups to Contractor-proposed estimates of the direct cost of labor, materials, equipment and other approved categories of costs Contractor proposes to incur in the execution of work under Change Orders. Allowable overhead and profit percentage mark-ups are set out in this section. These percentages include full and final compensation to Contractor for the cost of bonding, architecture, design and engineering, estimating, field supervision above the level of working foremen including superintendents, assistant superintendents and general foremen, field engineers, accountants, timekeepers, office managers, and other

on-site staff, office supplies, drinking water, temporary heat, light and power, safety equipment, general clean-up, small tools, field offices, tool trailers, field toilets, personnel vehicles including pick-up trucks, minor consumables, and other cost of labor, materials, equipment and incidental overhead or profit not incorporated in Work or Change Order work and directly or indirectly associated with Work or Change Order work, including home office costs, overhead costs of all sorts including general, administrative, corporate and legal overhead costs, preparation of cost proposals and schedule analyses connected with Change Orders (whether such Change Orders are contemplated or implemented), liability, property damage and other insurances, executives, managers, administrators, office managers, supervisors, assistants and other home office staff or staff not located on the Project site. The following percentages shall be added to the net increases (or deducted from net credits) to the Contractor's costs and shall constitute the markup for overhead and profits. The percentages for overhead and profit to be allowed by Government on Contractor's self-performed Change Order work may vary according to the nature, extent, and complexity of work involved, but in no case shall exceed the following:

Overhead:. 10%
Profits: 10%

3. Combined Increases and Decreases: On proposals involving both increases and decreases in the Contract Price, the overhead and profit mark-ups will be allowed on the net increases only. On net decreases, deduct corresponding overhead and profit.
4. Limit of Mark-Up on Subcontracted Change Order Work: Contractor may apply a mark-up fee of up to 5% on the approved cost of subcontracted Change Order work, however this percentage shall apply to the first Subcontractor tier only. Mark-up on multi-tier subcontracted work shall be subject to the following limitations. The aggregate arithmetic total of percentage mark-ups for overhead and profit and fee applied to the whole or any portion of subcontracted work at all tiers in the Contractor's Change Order proposals may not exceed a total of 25% based on the following formula: Contractor's mark-up on Subcontractors' proposals equals "a", Subcontractors' mark-up equals "b", and Sub-Subcontractors' mark-ups equal "c" through "n" a + b + (c through n) shall be less than or equal to 25% for increased cost portions

of Change Order proposals and equal to 25% for reduced cost (credit to Government) portions of Change Order proposals. The Government shall not be responsible to allocate percentages between Contractor, Subcontractors and/or Sub-Subcontractors at any tier.

5. Allowable costs: Comply with the following requirements for proposals and record keeping for Change Order work, including under Force Account.
   a. Labor: Report cost of Change Order labor by itemizing each craft involved, and indicating hourly rate for each and hours required, excluding premium pay, paid to employees proposed by Contractor to be directly engaged in Change Order work. The costs of labor will be the cost for wages prevailing for each craft or types of workers performing the work under Change Order at the time the Change Order is done or contemplated to be performed, plus employer payments of all applicable burdens including payroll taxes, Social Security, unemployment insurances, workers compensation insurance, health and welfare, pension, FICA, FUTA, and other direct costs resulting from Federal, State or local laws, as well as assessments or benefits such as union dues, apprenticeship funds, subsistence and/or mileage, required by lawful collective bargaining agreements. The use of a labor classification which would increase the Change Order cost will not be permitted unless the Contractor establishes the necessity for such additional costs to the satisfaction of the Government. Labor productivity assumed by Contractor in its lump sum Change Order cost proposals shall be the same as that assumed by Contractor for similar work included in the Contract Price as of execution of the Contract. Propose productivity factors which are applicable to the work under the contemplated lump sum Change Order and provide data supporting their derivation and reasonableness to the Government for its review and consideration. Report labor costs for equipment operators and helpers only when such costs are not included in invoices for equipment rental, if applicable. The labor cost for working foremen shall be apportioned to all of their assigned work and only that portion applicable to Change Order work shall be paid. In no case will a ratio higher than one foreman per six workers be allowed for Change Order work. In the event the Government directs the Contractor to perform work on a basis which will result in costs for premium time, the premium

portion of applicable wages for Change Order work which the Contractor was directed by Government to be performed during other than normal working hours may be allowed by Government, including social security taxes, unemployment insurance, and union fringe benefits if required by lawful union agreements, but overhead and profit mark-ups shall not be applied to such premium time costs.

b. Materials: The cost of materials reported shall be at invoice or lowest current price at which such materials are locally available (whichever yields the lowest cost to Government) and delivered to the job site in the quantities involved, plus sales tax, freight and delivery. Reduce proposal in proportion to any pertinent tax rebates which shall inure to Contractor's benefit. The Government reserves the right to approve materials and sources of supply, or to supply materials to the Contractor if necessary for the progress of the Work. No markup shall be applied to any material provided by the Government.

c. Equipment (Including Tools): No payment will be made to Contractor for the use of equipment or tools which have a replacement value of $500 or less. Regardless of ownership, the rates (including mark-up, if any) to be used in determining equipment rental costs shall not exceed rates listed in "Construction Equipment Ownership and Operating Expense Schedule", Region II, latest edition, published by Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. The rental rates paid shall include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs and maintenance of any kind, depreciation, storage, insurance, and all incidentals. Necessary loading and transportation costs for equipment used on the Change Order work may be included in Contractor Change Order proposals. If equipment is used intermittently and, when not in use, could be returned to its rental source at less expense to the Government than holding it at the work site, it shall be returned, unless the Contractor elects to keep it at the work site at no expense to the Government. All equipment shall be acceptable to the Government, in good working condition, and suitable for the purpose for which it is to be used. Manufacturer's ratings and manufacturer's approved modifications shall be used to classify equipment and it shall be powered by a unit of at least the minimum rating recommended by the

manufacturer. The reported rental time for equipment already at the job site shall be the duration of its use on the Change in the Work, commencing at the time it is first put into actual operation on the Change in the Work, plus the time required to move it from its previous site and back or to a closer site.

d. Other Items and Expenditures: The Government may authorize other items which may be required on the Change Order work. Such items include labor, services, material and equipment which are different in their nature from those required for the Work specified in the Contract and which are of a type not ordinarily available from the Contractor or any of Subcontractors at any tier. Proposals or invoices covering all such items in detail shall be submitted with Contractor's Change Order proposals.

C. Methods Used In Determining Adjustments To Contract Time:

1. Adjustments to the Contract Schedule which may or may not result in adjustments to Contract Time flowing from Change Orders shall comply with the provisions in Specification Section 01310.
2. Extended overhead are costs which may be incurred by Contractor as a result of an extension of the Contract Time. The applicability of extended overhead costs for time extensions are governed by the requirements of Section 01310. Extended overhead costs, if allowed in accordance with the stipulations set out in Section 01310, may only include costs incurred on the Project site and shall exclude all cost categories included in overhead and profit mark-ups as set out in this Section.
3. Bad weather (rain days) shall be determined by the average for the period of time using the U.S. Weather Service (NOAA) records. Extreme weather is non-compensatable; only time is extended.
4. Request for Proposal: Request for Proposal (RFP) defines proposed changes in the Work which are contemplated by Government and which may or may not result in Change Order(s), and is prepared and given to Contractor by Government.
5. Notice of Potential Impact: Upon receipt of a request for proposal (RFP), Contractor shall immediately review and evaluate the scope of such RFP's. Make an immediate determination of any potential impact on the Work. In the event any potential impact is determined, notify Government immediately, but in no case more than 3 business days after Contractor's receipt of RFP. Government may direct Contractor to

stop work in the area affected by the change to minimize the cost impact, or may direct Contractor to proceed with the change described in the RFP or some modification thereof, as the Government deems fit.

6. Timing of Proposal Submission: Submit proposals and breakdown as promptly as possible, but no later than 35 calendar days following Contractor's receipt of Government's RFP.
7. Content and Format of Proposal: Submit all proposals for contemplated Change Orders in the form of a lump sum fixed price proposal, unless otherwise requested by the Government. Furnish the summaries and details of Change Order proposals in the format and on forms required by Government. With each proposal for a change involving an increase or decrease in the Contract Price, submit an itemized breakdown that includes the following, and any other information requested by the Government:
   a. Labor costs (separated into trades), including all payroll burdens.
   b. Material quantities and unit prices. (Separated into trades).

D. Construction Equipment shall be priced as described above to include the following:
   1. Subcontractor costs.
   2. Other approved items and expenditures.
   3. Mark-ups for overhead, profit and other costs as defined above.
   4. Proposal Review:
      a. In considering proposals for changes in the Work involving added work, reduced or deleted work, or any combination thereof, Contractor proposals will be checked in detail by the Government, utilizing unit prices where specified or agreed upon, with the objective of arriving at equitable adjustments.
      b. Change Order Issuance: Change Order will be prepared by Government if Contractor's proposal, or amended version thereof, is acceptable and agreed upon by Government. Contractor is authorized to proceed after Government issues notice to proceed with work in Change Order.
      c. Procedure In Event of Non-Agreement: When the necessity to proceed with a change does not allow sufficient time to properly check a proposal, or the cost of the Change Order work cannot be agreed upon using lump sum, unit prices or other pricing method satisfactory to Government, or because of failure to reach an agreement, or for other reason deemed by Government to be in Government's

interest, Government may, at its sole discretion, order the Contractor to proceed on the basis of price to be determined at the earliest practicable date (PDL Change Order). Upon such written direction, perform the work directed and record all applicable costs separate from the base contract work.

5. Miscellaneous Requirements:
   a. Obligations of Surety Under Change Orders: Changes in the Work, or extensions of time, made pursuant to the Contract, shall in no way release the Contractor or Surety from their obligations.
   b. Change Orders, supplemental agreements and Government-approved revisions to Plans and Specifications will take precedence over the pertinent elements of the Contract Documents which are thereby amended or deleted.
   c. No change in Work, whether by way of alteration, addition, clarification or interpretation, shall be the basis of adjustment to Contract Price or Contract Time unless and until authorized by Government in a Change Order, executed in accordance with requirements of Contract Documents.
   d. Failure of Contractor and COTR to agree on an adjustment of Contract Sum or Contract Time shall not excuse Contractor from proceeding with prosecution and performance of Work not affected by Change Orders. Ensure that Contractor and Subcontractors, Sub-subcontractors and Suppliers handle all disputes in a manner which will permit Work to proceed on schedule while any matter in dispute is being resolved.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01152

PARTIAL AND FINAL PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION

A. General:
1. Requirements included:
a. Government shall use Contractor's approved schedule of values, derived from Contractor's approved and updated cost-loaded construction schedule which was developed in PRIMAVERA PROJECT PLANNER (P3) software per Section 01310, as the basis of determining progress payments, and the actual Contractor's schedule of values shall equal in total the Contract Price.
b. Government will independently determine the approximate measurement of payable Contractor progress as of the monthly payment closure date.
c. Government will independently review the Contractor's application for payment and process payment to Contractor in the amount the Government deems appropriate.
d. Contractor shall submit, for the record, monthly invoices to the Contracting Officer in the amount calculated by cost-loaded CPM schedule.
e. Contractor shall submit application for payment in accordance with the Construction Contract Clauses' requirements for invoicing.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. General:
1. Requirements include:
a. On a periodic basis, during construction, during normal business hours, Contractor's Project Manager, Superintendent and Subcontractor representative shall attend meetings upon request of Government. Government may invite Government representatives and other parties as Government deems appropriate. Government will chair the meetings. Government will prepare minutes of the meetings, and may tape-record or video-record the meetings, at its sole discretion. Contractor shall sign the minutes indicating its agreement therewith within 10 calendar days of its receipt thereof or return same signed with suggested amendments. Project meetings shall include:
(1) Progress review meetings: Held on a periodic basis, usually weekly, to review work in progress, schedule status, issues that are current as of meeting and other matters raised by Government or Contractor. Contractor shall be prepared, at such meetings, to propose and commit Contractor to corrective actions and associated timetables for remediation of Contractor-accountability deviations from Contract requirements, if applicable.
(2) Coordination meetings: Held on a periodic basis, as deemed necessary by Government, to review issues relevant for proper coordination of the Work with the Project as a whole, including work by Government and separate contractors. Such meetings shall not be used by Contractor to replace the Contractor's ongoing coordination work required by the Contract and such meetings shall not be construed to transfer to Government the Contractor's coordination duties under the Contract.
(3) Miscellaneous meetings: Held on an as needed basis, as deemed necessary by Government or as proposed by Contractor and accepted by Government.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01310

SCHEDULING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Summary of Work:
   1. Ensure timely execution of the work using a critical path method construction schedule, and using the latest version of PRIMAVERA PROJECT PLANNER (P3) software.
   2. Provide computer generated cost reports, schedule reports and graphics.
   3. Satisfy procedural requirements in support of Contractor's effective use of schedules.
   4. Allow Government to monitor Contractor's Contract Schedule continuously and cooperate such that Government may audit Contractor's management of the Contract Schedule via comparison by Government to a copy of the approved Contract Schedule under Government's control.
   5. Use the approved Contract Schedule for management of the entire work and make no change, modification, or updating of logic and/or durations in the Contract Schedule without written concurrence from Government.

B. Purpose of this Section:
   1. Assure adequate planning, scheduling, and reporting during execution of the work so it may be executed in an orderly and expeditious manner within the specified time constraints.
   2. Assure coordination of Contractor's self-performed work with work of all of the elements of Contractor's organization, including subcontractors, and between such subcontractors and vendors at all tiers.
   3. Assist in processing of payments to Contractor.
   4. Assist Contractor and Government in monitoring the progress of the work.
   5. Assist Contractor and Government in evaluating impact of proposed changes to the work, if any.
   6. Assist in detecting problems for the purpose of taking timely and effective corrective actions, to provide a mechanism for monitoring the effect of such corrective actions and to make adjustments in such corrective actions as necessary to ensure timely execution of the work.

1.02 DEFINITIONS

A. Completion Time and Milestones: All work shall be completed within 158 calendar days after the date of the Notice To Proceed (NTP). Within this period, the Contract Schedule shall establish milestone dates where each wing (building) shall in turn be sufficiently complete to allow equipment installations by a separate follow-on fit-up contractor.

B. Contract Schedule: The Contract Schedule is the document that controls Contractor's timely execution of the work. It is initially defined by the number of calendar days listed in the Contract Documents for completion of the work, until the Government approves the Preliminary Network Activity Schedule (PNAS). Upon acceptance by Government of the PNAS, the PNAS becomes the Contract Schedule. Upon acceptance by Government of the Detailed CPM Schedule (DCS), the DCS becomes the Contract Schedule. Upon approval by Government of mutually agreed change orders which amend the DCS, the most current such approved amended version of the DCS becomes the Contract Schedule. The proposed construction activities shall include:
   1. Activity durations in units of calendar days, limited to a maximum of 20 calendar days.
   2. Cost-loading of activities, coded by Construction Specification Institute (CSI) division number.

C. Calendar Days: The Contractor shall use calendar days as the base for all schedules.

D. Holidays: The federal holidays are New Years Day, Martin Luther King's Birthday, President's Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day.

E. Data Date: The date that the Contractor completes updating of the CPM schedule, in accordance with schedule update requirements of this section.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
   1. Resume of Scheduler.
   2. Scheduling documents as specified in this section.

E. Contract closeout information: Not required for COTR

review.

PART 2 - PRODUCTS

2.01 CPM METHODOLOGY

A. Plan, schedule, execute and report on the work using the critical path method (hereinafter referred to as CPM). The principles used herein shall be as set forth in the Associated General Contractors of America (AGC) publication, "Construction Planning and Scheduling, a Manual for General Contractors and the Construction Industry" (latest edition), except that in case of conflict, the provisions of the Contract Documents shall take precedence.

2.02 SCHEDULER

A. Provide the services of a Scheduling Consultant, fully qualified and experienced in construction CPM scheduling, utilizing the specified CPM scheduling software, for the duration of the Contract. The Contractor shall submit the resume of the Certified P3 Scheduler on the Contractor's staff who will be responsible for all scheduling requirements. The full-time Scheduler shall be available for questions and to attend meetings, as required, on a daily basis with the Government. Scheduler shall cooperate with Government and shall be on the site when required or directed by Government for the purpose of creating and thereafter continuously monitoring, modifying or updating the elements of the Contract Schedule. Scheduler shall have complete authority to act on behalf of Contractor in fulfilling the time requirements of the Contract.

2.03 SUBMISSION FORMAT

A. All submittals from the Contractor pertaining to schedule and/or cost data shall include all Contract Schedule data, (network, calendar, code files and any other resource files necessary for a complete and operable Contract Schedule) on 90 mm computer MS-DOS diskettes.

2.04 CODING REQUIREMENTS

A. Provide a minimum of eight Government designated codes per activity, for Government use, as directed by Government. Such codes include Government resource, phasing, site, cost allocation, Subprojects and other Government-designated categories of activity coding.

PART 3 - EXECUTION

3.01 PRECONSTRUCTION SCHEDULING CONFERENCE

A. Within 21 calendar days following NTP, attend a preconstruction scheduling conference, including:
   1. Contractor's project manager, Scheduler, and superintendent.
   2. Other Contractor key personnel, representatives of major subcontractors, and major supplier representatives designated by the Contractor or requested by the COTR.
   3. Government representatives.

B. The following procedures will be reviewed at or during subject conference:
   1. Contractor's proposed sequence of operations for the work.
   2. Activity numbering and coding structure to be followed by the Contractor.
   3. Development of preliminary list of key procurement items.
   4. Updating of and revisions to the Contract Schedule.
   5. Distribution of contract price to schedule activities.
   6. Resource leveling.
   7. P3 Master Project/Subproject format.
   8. Milestone requirements for each Subproject.
   9. Other items at Government's discretion.

3.02 PRELIMINARY NETWORK ACTIVITY SCHEDULE (PNAS)

A. Along with the submission of the solicitation, submit for review one reproducible and four prints of proposed PNAS, drawn time scaled on either ISO (International Standards Organization) "A0" (1189 x 841 mm) or "A1" (841 x 594 mm) metric-sized sheets with suitable notation relating the interface points among sheets. Also submit two PNAS's on 90 mm floppy disk or CD. Ensure that proposed PNAS submission covers the following elements:
   1. Narrative of Contractor's proposed construction methodology, including a proposed general sequencing plan including pre-determined milestones.
   2. Proposed procurement activities.
   3. Proposed construction activities to be accomplished during the first 45 calendar days following NTP.
   4. Summary activities not included above which are necessary to properly indicate:
      a. The approach to scheduling the work areas or phases of the work after the first 45 calendar

days following NTP. The work for each phase or area must be represented by at least one summary activity such that the PNAS indicates the entire work.

b. Cost-loading of the Contract Price and CSI division numbers for summary activities in the PNAS. Indicate the cost and duration for each summary activity on the PNAS.

5. Resource leveling analysis. Ensure that such analysis indicates that there are no severe troughs or peaks in resource usage in Contractor's proposed PNAS.

B. Within 14 calendar days of receipt by Government of the PNAS, Government shall provide Contractor a written list of any incomplete and deficient items discovered by Government in its review of PNAS. Promptly provide a written response to subject list, if any, and provide an amended PNAS. Obtain Government acceptance of amended PNAS, meeting specified requirements. Resubmit a complete PNAS package as many times as is necessary to obtain such approval.

C. The PNAS shall be the basis for the first progress payment while the DCS is being developed by Contractor and reviewed by Government.

3.03 DETAILED CPM SCHEDULE (DCS)

A. Submit to Government within 30 calendar days following NTP, detailed time-scaled precedence format network graphics, including all Subprojects, of proposed DCS containing the following:

1. Narrative of Contractor's proposed construction methodology, including a proposed general sequencing plan.
2. The description, duration and total float for all non-critical activities.
3. Sequence of operations for the work and the order relationships and interdependencies of work activities between all Subprojects. Indicate the major points of interface or interrelation of such activities with the activities of Government and/or other contractors.
4. Conformance with and identification of the Milestone durations or dates specified for each Subproject.
5. Delivery of Government-furnished material and/or equipment, if applicable.
6. Critical path (or paths).

B. Special constraints: Clearly identify and explain proposed special constraints including:

1. Finish-to-finish, start-to-start, start-to-finish, and

finish-to-start leads and lags.
2. Starts-on, starts-no-earlier, finishes-on and finishes-no-earlier date constraints.
3. Resource caps.

C. Duration and cost limits: Ensure that the level of detail of the Contractor's DCS is a function of the complexity of the work involved. Ensure that all activities have a duration less than 20 calendar days. Government will take into account special attributes of the work, such as long -lead equipment with extended engineering, fabrication and delivery schedules.

D. Key items procurement report: For all "key" (major equipment and materials and long-lead (over 16 weeks, from order placement to delivery)) items fabricated or supplied for the work, include in the DCS submittal Subproject SUQC including items to be procured, indicating:
1. Preparation of submittals, including shop drawings and samples. Submittal activities included within P3 shall be connected to submittal requirements in EXPEDITION CONTRACT CONTROL software, as specified in Section 01340.
2. Review of submittals. Indicate Government's review time of no less than 21 calendar days for any individual submittal. Adjust logic and/or duration of submittal activities as directed by Government in event Government determines that Contractor's proposed submittal schedule assumes an overly concentrated period of Government review and approval. Include the following activities for all key Contractor-purchased items, which require submittals:
   a. Development and delivery of submittal by Contractor.
   b. Review and approval period of submittal by Government.
   c. Manufacture or fabrication.
   d. In-plant testing.
   e. Erection or installation.
   f. Testing and inspection.
   g. Commissioning.
   h. Final inspection of installed equipment and materials.
3. Pertinent activity numbers for successor activities.
4. All submittals shall be linked via predecessor and successor relationships.

E. Schedule reports indicating the following:
1. Activity numbers and appropriate description.
2. Estimated duration time for each activity in calendar days.

3. Early start, early finish, late start and late finish dates for each activity.
4. Total and free float for all non-critical activities.
5. Identification of all critical path activities.
6. The responsibility code for the Contractor (or subcontractors, if any) or other organization performing each activity.

F. Cost reports including the following activity information, sorted by labor category, including construction trades:
1. Activity number and appropriate description.
2. Total cost proposed for each activity, divided into each of labor, material, equipment, plant and general.
3. Computer-produced cash-flow analysis and graphics generated by both early start and late start activity dates, compared to an industry standard such as the "Miller" curve.

G. Labor and equipment allocation report: A narrative report indicating anticipated allocation of labor and equipment resources and work shifts to be utilized on the work.

H. Activity details: Incorporate the following elements and requirements in proposed DCS:
1. Use clear and concise activity descriptions. The beginning and end of each activity shall be readily observable and verifiable during execution of the work.
2. Restrict each activity to a single performing organization. Such organizations shall include Contractor self-performed work organization, subcontractors (if any), manufacturers, fabricators, and time-sensitive suppliers. Involve all such organizations in the development of the Contract Schedule and secure their individual and collective express commitment to satisfy the requirements of the Contract Schedule proposed by Contractor to Government. Cause this commitment to be represented in the form of a signed acceptance by all such parties, included with the DCS submittal.
3. Code activities in the DCS that are Government responsibility, such as submittal reviews, to execute as Government responsibility activities.
4. In addition to identification of responsible organization, each activity shall have codes identifying area or building, location. Ensure that buildings are planned and scheduled in the DCS in manageable area increments. Code such increments and indicate the codes for each activity.
5. Distribute the contract price over activities (hereinafter "cost loading"). Mobilization, bond and

insurance costs may be indicated separately; however, prorate other general requirement costs, such as overhead and profit, throughout all activities. Divide each activity's cost loading into each of labor, material, and equipment where Contractor desires to receive payment for material delivered to the site separate from labor and/or equipment expenditure on the activities concerned.

6. Permits, notices, tests and inspections.
7. Include sequential activities for:
   a. Contractor preparation for pre-final inspections by area.
   b. Contractor request for pre-final inspections by area.
   c. Government pre-final inspections by area (allow a minimum of 15 work days from time of Contractor request to time of Government issue of written pre-final incomplete and/or deficient work (IDW) lists).
   d. Contractor correction of pre-final IDW lists by area.
   e. Contractor notice of readiness for final inspection by area or for the work.
   f. Contractor preparation for final inspections by area or for the work.
   g. Contractor notice of readiness for final inspection by area or for the work.
   h. Government final inspection by area or for the work (allow a minimum of 10 work days from time of Contractor request to time of Government issue of final IDW lists).
   i. Contractor correction of final IDW lists by area or for the work.
   j. Contractor notice of final completion for the work.
   k. Government Acceptance of the work.
8. Submittals, in coordination with the level of detail indicated in the key items procurement report.
9. Enter all activity starts and finishes, with the exception of Milestones successors and start-of-work predecessor, into the schedule by activity-to-activity finish-to-start logic ties.
10. Proposed durations assigned to each activity shall be the Contractor's best estimate of time required to complete the activity considering the scope and resources planned by Contractor for each activity.
11. Consider and include additional time as appropriate for potential weather conditions in the planning and scheduling of all work influenced by high or low ambient temperatures and/or precipitation and/or other environmental conditions in the Project region, to

ensure completion of the work within specified time constraints.

12. Availability of labor in all categories in the vicinity of the work.

I. Resource Analyses:

1. Prepare a manpower leveling analysis, derived directly from the proposed DCS. Submit subject analysis with proposed DCS, in graphic format depicting manpower by principal trades. Analysis shall span the entire work duration and shall include separate graphs for each of a) manpower by trade per work day, and b) man-hour usage by trade in the form of a cumulative "S" curve. Subject manpower leveling analysis shall include trade-by-trade manpower leveling using Contractor-imposed caps for each labor category, which coordinate with Milestone requirements. Through the use of such resource caps, identify and correct any peaks or troughs in each trade manpower usage distribution. Present evidence of the leveling iterations to the Government with DCS submission.

2. Assign all major limited quantity construction equipment and any other limited key resources to be utilized by Contractor and sub-contractors at all tiers in prosecuting the work, to applicable activities of the DCS. Similar pieces of key equipment shall be separately identified by the use of unique identifying numbers for each piece of equipment. Present evidence that Contractor's proposed DCS shall not be controlled by the limitations in the quantities such resources or propose a plan for management by Contractor of each resources type which may control the critical path or paths at any time during execution of the work. Resources analyzed may include crane use and special testing equipment.

3.04 REVIEW, REVISION, RESUBMISSION AND ACCEPTANCE OF DCS

A. Within 14 calendar days after Contractor's submission of proposed DCS, in proper form and content, Government shall respond in writing with any questions and/or requests for amendment to Contractor's proposed activities, logic, durations, manpower, cost or equipment loading.

B. Within 7 calendar days of receipt of Government's questions and/or requests, submit a revision to or justification for the schedule element(s) concerned, for review by the Government.

C. If Government does not request justification or amendment,

Government and Contractor shall meet within fourteen calendar days of receipt of the Contractor's proposed DCS for joint review, correction and adjustment thereof. Revise any areas which, in opinion of Government, conflict with timely completion of the work and/or the project.

D. Within 7 calendar days after the joint review between Contractor and Government, submit revised DCS in accordance with agreements reached during subject review and submit per requirements of paragraph 3.03:
   1. One vellum reproducible (printed in color) of the revised DCS logic diagrams.
   2. Computer-produced schedules and cost reports for all Subprojects.
   3. A computer-produced cash-flow analysis and graphics generated P3 by both early start and late start activity dates, compared to an industry standard such as the "Miller" curve for all Subprojects.
   4. DCNs on 3.5 floppy disk or CD.

E. Review and acceptance of revised DCS by Government will be granted within 7 calendar days, provided Contractor's revised DCS submission fully complies with Government requested amendments, if any.

F. Government's acceptance of the Contractor's DCS is a condition precedent to any progress payments after the first 30 calendar days following NTP.

G. Upon Government's acceptance of the cost-loaded values, such values will be used as a basis for determining progress payments.

H. Government's acceptance of proposed DCS signifies only that Government's summary review of the DCS leads Government to believe that Contractor has met the general requirements of this Section pertaining to DCS format and content. Acceptance by Government of the DCS does not relieve Contractor of any of its responsibility whatsoever for the accuracy or feasibility of Contractor's plan for execution of the work, or to perform the work within specified time constraints. Such acceptance does not expressly or impliedly warrant, acknowledge or admit the reasonableness of the activities, logic, durations, manpower, cost or equipment loading of the Contractor's proposed or accepted Contract Schedule.

I. Government's acceptance in no way makes Government or its representatives insurers of success of Contractor's time performance or liable for time or cost overruns flowing from the shortcomings of Contractor-authored Contract

Schedule. Government disclaims and Contractor waives any Government obligation or liability by reason of Government's acceptance of or acquiescence to Contractor's schedule submissions.

J. Should Contractor fail to define any element of work, activity or logic and Government review does not detect this omission or error, such omission or error, when discovered by Contractor or Government, shall be corrected by Contractor before the next monthly schedule update and shall not be cause for delay of completion of the work within the specified time constraints. Contractor acknowledges that Government is not required or otherwise obligated to discover errors or omissions in Contractor's proposed Contract Schedule. Government's acceptance of DCS does not relieve Contractor of its responsibility of the Contract Schedule.

3.05 FLOAT TIME

A. Float is not for the exclusive benefit of either Contractor or Government. Manage work according to early start dates, by commencing activities on the early start date (calculated by the latest approved Contract Schedule) or earlier if possible, unless constrained by a bonafide resource limitation. Government may reserve and apportion float time according to the needs of the Project. Actual or projected Government-caused delays that do not exceed available float time shall not have any effect upon Contractor's adherence to specified time constraints and shall not be a basis for any time extension.

B. Contractor acknowledges that a) activity delays shall not automatically result in adjustment of specified time constraints, b) a Change Order or other Government action or inaction may not affect existing critical activities or cause non-critical activities to become critical, c) a Change Order or delay may result in only absorbing a part of the available total float that may exist within an activity chain of the network, thereby not causing any effect on specified time constraints.

C. Pursuant to the above float sharing requirements, use of float released by elimination of float suppression techniques such as preferential sequencing, special lead/lag logic restraints, unreasonably extended activity durations, or imposed dates shall be distributed by Government to the benefit of Government and Contractor.

D. In the event the Contractor wishes to complete the work earlier than the time specified therefor:

1. Continue to calculate float based on the work completion date specified as of Contract execution, by maintaining the specified work completion date as a "finish-no-later-than" constraint.
2. The completion time for the work shall not be amended by Government's approval of, acceptance of or acquiescence to Contractor's proposed earlier completion date.
3. Contractor shall not, under any circumstances, receive additional compensation for indirect, general, administrative or other forms of overhead costs, for the period between the time of earlier completion proposed by Contractor and the completion time for the work specified as of NTP.

3.06 UPDATES

A. On a working day approximately five working days preceding time designated for monthly payment, meet with Government for the purpose of reviewing Contractor's report of actual progress. Submit Contractor's up-to-date and accurate progress data as of Data Date.

B. Submit computer reports and network graphics which reflect the progress of the work with respect to both cost and time, in accordance with the requirements of the initial Contractor- proposed DCS. Submit an updated cash flow graphic indicating a) approval baseline schedule early start (ES) and late start (LS) curves, b) actual curve as of update and c) forecast ES and LS curves to complete work. Adjust the selection and sort sequence, format and content of reports as directed by Government. In addition to the graphics and reports.

C. Contractor acknowledges that updating the Contract Schedule to reflect actual progress made as of the date of update is not a modification to the Contract Schedule's Milestone requirements.

D. Submit progress report indicating the activities, or portions of activities completed during the reporting period for each Subproject, the actual start dates for those activities currently in progress, the actual finish dates for those activities which were completed since the last update, and the progress along and deviations from the critical path for each Subproject in terms of days ahead or days behind specific Milestone dates.

E. Submit a narrative report which shall include a description of the status of the overall Master Schedule progress and individual Subprojects, problem areas if any,

and an explanation of corrective actions taken.

F. Submit a list of major construction equipment used on the work during the reporting period and any construction equipment idle during the reporting period.

G. Submit list of number of personnel (or man-hours) by trade by working day by activity actually engaged on the work during the reporting period, with such total stated separately as to on- site office, administrative management personnel, on-site supervisory personnel (superintendents and foremen), and each trade of on-site direct labor.

H. Submit procurement list, per paragraph 3.03, indicating anticipated Project site delivery dates for all key items in each Subproject.

I. Submit two updated copies of the network. The first copy shall be an updated version of the Contract Schedule, excluding Contractor-proposed changes. The second copy shall be an updated version of the Contract Schedule, including Contractor-proposed changes. Submit with the second copy a list of proposed modifications, additions, deletions and changes in activity logic and/or durations to approved Contract Schedule, including time-recovery steps and actions set out in "Responsibility for Completion" provisions of this Section. Include a written justification for each such proposal.

J. If, as a result of the monthly update, it appears the Contract Schedule no longer represents the actual prosecution and progress of the work, submit a revision to the Contract Schedule. Include proposed adjustments in activity durations, logic changes, resource usage or cost loading. Any negative float indicated in Contractor's proposed updates must be presented to Government by Contractor with a bona bonafide Contractor-authored plan for elimination of such negative float.

K. Government will respond in writing to each schedule update. Government's response may include questions and/or requests for revisions. Respond in writing within 5 work days, either agreeing with Government's proposed revisions and submitting a modified update, or setting forth justification why such revisions should not be implemented. If Contractor's justification for not implementing the revision is acceptable, in Government's sole judgment, such revision will be waived. If the Contractor's justification is not accepted by Government, the Government-directed revisions shall be incorporated

into the Contract Schedule. Contractor's failure to respond in writing within 5 work days shall constitute Contractor acceptance of the Government-directed revisions, and such revisions shall be incorporated by Contractor into the Contract Schedule, with final and binding Contractor waiver of any potential Contractor requests for time extension or additional compensation.

3.07 PROGRESS PAYMENTS

A. Contractor's submission and acceptance by Government of monthly progress updates and the reports calculating the value of work done for any given pay period for each activity based on the percentage complete for that activity less the amount previously paid for past percentages complete and percent of retainage (if applicable) shall precede Government's processing of payment to Contractor. Contractor shall be entitled to progress payments only as determined from cost reports directly derived from Contractor's updated Contract Schedule, approved by Government in form and content. If, in the judgment of Government, Contractor fails to provide full and complete Contract Schedule update as specified herein, Contractor shall be deemed to have not provided the required information upon which progress payments may be made.

B. Monthly progress payments shall be based upon information developed at the monthly schedule update. A computer-produced cost report, derived from an updated DCS, will be utilized by Government for calculation of the amounts due Contractor. The DCS resources pertaining to payment for materials shall govern payment of materials fully incorporated into the work. In the event Contractor wishes to be paid for material stored on the site but not incorporated in the work, or for material stored offsite, comply with procedures for such payment established by the Government.

3.08 SHORT INTERVAL SCHEDULE

A. Each Monday morning (or following day if a holiday), submit to Government, a short interval schedule (SIS) for each Subproject listing the activities completed and in progress for the previous week and the activities scheduled for the succeeding 2 weeks. Incorporate in the SIS a bar chart directly derived from the current updated approved Contract Schedule updated as of the week submitted. Identify all activities in the SIS by the same activity numbers and descriptions as in current updated approved Contract Schedule. SIS shall indicate percent

complete, actual start and finish dates and float for all displayed activities. The SIS shall serve as a basis for discussion at the progress review meeting between Contractor and Government.

3.09 WEEKLY SCHEDULE MEETING

A. Once each week, on a day mutually agreed to by Government and Contractor, a progress review meeting will be held to review work achieved by Contractor during previous work week and Contractor's proposed plans to stay on schedule.

3.10 REQUESTED TIME ADJUSTMENT SCHEDULE (RTAS)

A. The updated Contract Schedule submitted by Contractor shall not indicate a completion date later than the specified time constraints, subject to time extensions approved by Government. If Contractor believes it is entitled to a time extension, submit to Government, within the deadlines set out herein and with each contemporaneous monthly update, a separate schedule analysis entitled Requested Time Adjustment Schedule (RTAS). Indicate Subproject being affected, in said analysis, in addition to requirements of the General Conditions, proposed adjustments in the Contract Schedule which, in the opinion of Contractor, should be made due to changes, delays or conditions occurring during the past month or previously, or which are expected or contended by Contractor. Said analysis shall be time-scaled utilizing a computer generated and computer drawn network. This paragraph shall not relieve Contractor of its obligation to provide proper and timely separate written notice of impacts to schedule. Contractor acknowledges that its preparation of RTAS's is not extra work to the Contract and that, therefore, preparation by Contractor of RTAS's shall not be cause for Contractor to receive any additional time for performance of the work or additional compensation.

B. Include, in subject analysis, schedule forecasts that predict the Contractor's bona bonafide expectation of each completion date for each Milestone.

C. In the event any time extension requests are pending Government's approval at the time of any update of the Contract Schedule, also update and submit proposed but unapproved RTAS's. Such presentations shall define and explain any adjustments proposed by Contractor in the logic or duration of any activities in the Contract Schedule, or any time extensions previously granted by Government, and reflect actual or expected progress, in order that the presentations shall accurately reflect

Contractor's proposed plan for actual execution of the work and proposed time adjustments as of the latest approved Contract Schedule update.

D. The RTAS shall demonstrate time impacts based on information available as of the date the pertinent Government-issued directive or information is given to Contractor or the date the delay occurred (whichever is later); the status of construction at that point in time; and the computation of impact on all affected activities. The durations and float used in the RTAS shall be those included in the latest approved update of the Contract Schedule.

E. Subject to float sharing requirements defined herein, time extensions will be granted only to the extent equitable and mutually acceptable time adjustments to the activity or activities affected by the Change Order(s), or delays the critical activity (or path) and extends Milestone dates, using the approved update of the Contract Schedule that is current as of the issue of Government's written request for Contractor proposal connected with a potential Change Order or other Government-accountability potential schedule effect.

F. Submit RTAS within twenty calendar days after the initiation of the thing(s) or event(s) which Contractor contends may lead to a potential Government-accountability delay in the performance of the work, or from the time of Government's issuance of a written request for Contractor proposal connected with a potential change order (or documents of like effect), even if such issuance precedes notice to proceed for change order(s) concerned, whichever is later. Other Government-caused potential impacts of any category shall be considered to have been initiated upon written initial Government advice connected therewith, including notice provided through required meeting minutes.

G. In the event all potentially relevant facts bearing the RTAS are not available within the foregoing 20 calendar days, make reasonable assumptions regarding such facts and include the list of assumptions in the RTAS submission documentation.

H. Should Contractor not submit a RTAS (meeting the above requirements) within twenty calendar days following the initiation of potential Government-caused schedule impacts (including continuing impacts), Contractor shall have waived its right to thereafter request or be granted any time extension or additional compensation connected with

such impacts.

I. Within 14 calendar days following submittal by Contractor to Government of RTAS, in the proper format and including all specified contents, Government will meet with Contractor to review the submittal. Revise and resubmit RTAS within 3 working days of such meeting, adjusting RTAS to consider issues raised by Government in above meeting. Government will respond with written decision within 7 calendar days following Contractor resubmittal of RTAS. Upon approval, if approved, a copy of the RTAS signed by Government shall be returned to Contractor and thereafter incorporated into the Contract via Change Order. Incorporate the results of each approved RTAS in the update of the Contract Schedule that immediately follows such approval.

J. Contractor waives its right to submit requests for time extension and to receive a time extension unless it meets the above requirements for RTAS's. Contractor waives any claim for acceleration due to refusal by Government to grant time extensions should Contractor fail to comply with the submission and justification requirements described herein for RTAS's. Contractor's submission of RTAS's shall not constitute a basis for adjustment in specified time constraints unless and until approved by Government. Actively pursue timely completion of all activities pending such approval.

K. Contractor shall not be compensated for any form of Extended Overhead Cost of any sort unless all five of the following conditions are satisfied:
   1. Government grants Contractor duly executed change order(s), incorporating a time extension.
   2. Such change order(s) extend(s) the specified completion time for the entire work beyond the time set out for same as of the NTP.
   3. There is a portion of the extended period wherein Government-accountability action or inaction is the sole and controlling cause of the delay.
   4. Government agrees that Government-accountability action or inaction is the sole and controlling cause of the delay leading to said extended overhead costs for the portion of time set out in item 3 above.
   5. Government agrees that Contractor employed all reasonable means to avoid and mitigate any and all causes of delay in performance of the work.

L. The method used for calculation of extended overhead costs, if any, will take into account the specific attributes and conditions of the work as of the time of

the period of extension, such that only those actual costs directly connected to the period of extension may be cause for additional compensation to Contractor. Only those costs approved by Government as normal and necessary may be considered by Contractor in its calculation of extended overhead, if any.

3.11 COORDINATION

A. Coordinate work including subcontractors (if any) and cooperate fully with Government in maintaining orderly progress toward completion of the entire Project. Failure of Contractor and/or its subcontractors (if any) and/or suppliers to properly coordinate their respective portions of the work shall not be justification for any adjustment in specified time constraints. Government's decisions regarding priority between the work and work of other contractors at the Project site shall be final and shall not be cause for extra compensation or extension of time.

B. Keep Contractor's organization, including Contractor's own personnel, and its subcontractors, advised at all times during the course of the work regarding the progress of construction work being performed, and ensure that said organization takes all actions necessary to ensure timely completion of the work, in accordance with the most current iteration of Government-approved Contract Schedule.

3.12 PERFORMANCE MONITORING

A. Government will, throughout or at any time during Contractor's execution of the work, record the number of workers and construction equipment working on each schedule activity in each area of the work and will give a copy of this log to the Contractor who shall be responsible for advising Government, without additional cost to Government, of any specific error in this work history, in writing, within five work days of Contractor's receipt of same. This information will be used by Government in its evaluation of the adequacy of the Contractor's performance and on-site manpower staffing, as well as in the evaluation of any Contractor authored RTAS. Government will also use video, photographs, inspector reports, certified payroll records, and other documentation in evaluation of Contractor's time extension requests.

3.13 RESPONSIBILITY FOR COMPLETION

A. Furnish sufficient forces, offices, materials, facilities,

plant and equipment, to ensure the prosecution of the work in accordance with the most current approved Contract Schedule update. If Government advises that Contractor has fallen behind in meeting Milestones as presented in such approved update, take such steps as may be necessary to improve progress. Upon Government's written advice that Contractor is behind schedule, as a result of inexcusable causes, immediately remediate such loss by increasing the hours of work, the number of shifts, overtime operations and/or the amount of construction plant and equipment without additional cost to Government. Contractor acknowledges that such remedial action on Contractor's part is not compensable acceleration of the performance of the work. The provisions of this paragraph shall not be construed as prohibiting work on Saturdays, Sundays, and holidays, if the Contractor so elects and gives written notice to Government at least 5 working days in advance of same.

END OF SECTION

SECTION 01340

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Contractor or Subcontractors may require additional submittals for coordination purposes even if not required by COTR for review.

B. Product options and substitutions after execution of Contract: See Section 01641.

C. Contractor shall use the latest version of PRIMAVERA EXPEDITION CONTRACT CONTROL software for all submittal and RFI procedures and other requirements included in this section.

D. Contractor shall provide all licenses for PRIMAVERA EXPEDITION CONTRACT CONTROL software necessary for own staff use on this Project.

E. Contractor shall be required to develop and input all submittal and Quality Control submittal requirements into the EXPEDITION software database.

F. The Contractor shall utilize other aspects of the EXPEDITION software, including:
1. Transmittals to COTR and Subcontractors.
2. Requests for Information (RFI) process.
3. Contractor's daily reports.
4. Submittal requirements linked to CPM Schedule specified in Section 01310.
5. Other functions as required by the COTR.

1.02 DEFINITIONS

A. Shop Drawing submittals are drawings, diagrams, schedules, product data and other data specially prepared for work by Contractor or Subcontractor, manufacturer, supplier or distributor to illustrate some portion of work.

B. Product Data submittals are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, test data and other information furnished by Contractor to illustrate material, product or system for some portion of work.

C. Sample submittals are physical examples which illustrate

materials, equipment or workmanship and establish standards by which work will be judged.
1. Samples also include job site mockups.

D. Project Information submittals are items pertaining to quality control and COTR information which do not require review or response by COTR and are to be retained for project file only.
1. Examples:
a. Product performance and construction test reports.
b. Certifications.
c. Design calculations.

E. Contract Closeout Information submittals are items pertaining to quality control and COTR information, which are required at Acceptance and do not require review or response by COTR before Commencement of Construction.
1. Examples:
a. Preoccupancy test reports.
b. Warranties.
c. Instruction, training, demonstration, and commissioning reports.
d. Operation and maintenance manuals.
e. Record Documents.
f. As-Built Drawings in MICROSTATION format issued to the Government on CDs.

F. Shop Drawings, Product Data, Samples and information submittals are not Contract Documents.
1. Purpose of submittal is to demonstrate for those portions of work, for which submittals are required, the way Contractor proposes to conform to information given and design concept expressed in Contract Documents.

G. "Base" manufacturer:
1. The term "base manufacturer" as used in the Specifications refers to a manufacturer of equipment, material, articles, or patented processes, designated by trade name, make or catalog number, that have been used as the basis of design.
2. Base manufacturer's products shall be regarded as establishing a standard of quality and shall not be construed as limiting competition.

H. "Optional" manufacturer:
1. Subject to the limitations set out in Sections 01640 and 01641, the term "optional manufacturer" as used in the Specifications refers to a manufacturer of equipment, material, articles or patented processes that may provide the same functions and meet the same

performance standards as the base manufacturer's product, but may require different structural support or different utility hookups or other adjustments. Optional manufacturers' products are acceptable for performance but the Contractor is responsible for the costs for any dimensional, operational, structural, or utility adjustments to make the products fit the Project. If the Contractor intends to supply an optional manufacturer's product, the "or equal" terms and conditions of Construction Contract Clauses titled "Materials and Workmanship" shall apply, except as otherwise specifically provided in Sections 01640 and 01641.

2. Listing of an optional manufacturer indicates acceptance of that manufacturer as a supplier of the product, but only if the optional manufacturer's product complies or can be successfully made to comply with the specified requirements, including the salient qualities provided by the base manufacturer's product. Salient qualities include but are not necessarily limited to the following:
   a. Purpose and function.
   b. Material and finish.
   c. Strength, durability and other applicable physical properties.
   d. Compatibility and performance attributes for the indicated application.
   e. Capacity and operating characteristics, where applicable.
   f. Size and configuration to the extent required for fit with adjoining and adjacent conditions and within spatial limitations.
   g. Appearance, including exposed dimensions, profile, texture, pattern and color, where visible to personnel in finished spaces or from the exterior.

1.03 TRANSMITTAL - GENERAL

A. Submit items to General Contractor for transmittal to COTR using EXPEDITION CONTRACT CONTROL software.

B. Contractor is responsible for making submissions.
   1. Submit to COTR, unless otherwise instructed by the COTR.
   2. Transmittal to include items from one Specification Section only.
   3. Transmit items with EXPEDITION furnished Submittal Transmittal Form.

C. Provide information required for complete review of each item in one submittal.

1. Do not highlight pertinent information with markings that turn opaque or do not reproduce on electrostatic copies.

D. Do not submit partial submittals unless specifically stated in the applicable section that one item is to be approved before another item is submitted.

E. Provide submittals sufficiently in advance of date required to allow COTR reasonable time for review, and resubmission if necessary. Closely coordinate with submittal activity requirements of Section 01310.
   1. Schedule submittals requiring COTR approval and Project Information during first half of construction period.
      a. Schedule submittals requiring COTR color selection within 30 calendar days of Notice to Proceed.
   2. Allow minimum 3 weeks, excluding mailing, for COTR review.
   3. Items not submitted in accordance with provisions of this Section will be returned, without action, for resubmission.
   4. Items submitted but not required by Contract Documents may be returned without action.
   5. Submissions on items not approved for use by Contract Documents will be rejected.

1.04 SHOP DRAWINGS AND PRODUCT DATA

A. Shop Drawing and Product Data submittals are required as called for by Specification Section submittal paragraph.

B. Identify drawings with Project name, date, Subproject name and number, and address of COTR, name and address of Contractor, name and address of Subcontractor, name and address of supplier, name of manufacturer, number and title of appropriate specification section and drawing number and detail references, as appropriate. Provide in SI format.

C. Submit one reproducible transparency and six prints of each Shop Drawing until review is complete.
   1. Do not submit PRINTS ALONE.
   2. Submit in mailing tube.
   3. Do not fold.
   4. Submit drawings in size not less than 610 x 915 mm and not larger than 760 x 1065 mm.
   5. Allow clear space, approximately 10 000 mm2, for stamping on right hand side.
   6. Contractor shall receive only one reproducible return copy of submittals processed by the Government.

D. Submit six hard copies and one electronic copy (either on 90 mm floppy disk or CD) of Product Data items such as equipment brochures, cuts of fixtures, or standard catalog items, plus number of copies required for Contractor use.
   1. Indicate exact item or model and proposed options.
   2. Include scale details, sizes, dimensions, performance characteristics, capacities, wiring diagrams, controls and other pertinent data in SI format.
   3. Submit in envelope.
   4. Do not fold.
   5. Submit minimum 213 x 280 mm to maximum 213 x 355 mm size hard copy.
   6. Identify Subproject name and number on transmittals.

1.05 SAMPLES

A. Sample submittals are required as called for by submittal paragraphs in each Specification Section.

B. Identify two copies of samples with manufacturer's name, item, use, type, Project designation, Subproject name and number, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.

C. Submit samples to COTR.

D. COTR may, at its option, retain samples for comparison purposes.

E. Field mockups: Fabricate on site in accordance with Specification Section requiring them.

1.06 PROJECT INFORMATION AND CONTRACT CLOSEOUT INFORMATION

A. Information submittals are required as called for in each Specification Section submittal paragraph.

B. Submit one copy each of Project and Contract Closeout Information items unless method of submittal is indicated elsewhere.
   1. Include pertinent data.
   2. Submit in envelope.
   3. Do not fold.
   4. Submit minimum 213 x 280 mm to maximum 213 x 355 mm size copy.

C. Project Information:
   1. COTR may review at it's sole discretion project information for compliance with Contract Documents only.

2. Review will not constitute a detailed check of submitted design calculations.
3. Appropriateness and accuracy of calculations is responsibility of Contractor (and Contractor's professional engineer when such calculations are required to be professionally sealed).
4. When professional or other Certification of performance criteria of materials, systems or equipment is required by Contract Documents, COTR shall be entitled to rely upon accuracy and completeness of such calculations and Certifications.

D. Contract Closeout Information:
1. COTR may review at its sole discretion Contract Closeout Information for compliance with Contract Documents only.

1.07 CONTRACTOR ACTION

A. Review, approve, stamp, and sign items prior to submission to COTR.

B. Stamp provided by Contractor to indicate that Contractor has:
1. Verified field dimensions and quantities.
2. Verified field construction criteria, materials, catalog numbers and similar data.
3. Reviewed and coordinated submittal data with requirements of work and Contract Documents.
4. Certifies that submittals comply with Contract Documents.

C. Reproduce and distribute submittals:
1. Subcontractor/vendor.
2. COTR: 3 copies of "approved" or "approved as noted" submittals.
3. Other Contractors, Subcontractors or vendors as required for coordination purposes.

D. Resubmit items stamped "revise and resubmit" or "not approved" until approval is received or submittal is returned by Government indicating that no further action is required.
1. Add letter suffix to previous transmittal number, to indicate resubmission, for example 03450A-1A.
2. Direct specific attention, in writing, on resubmitted Shop Drawings, Product Data or Samples, to revisions other than those requested by COTR on previous submittals.

E. Direct specific attention, in writing or on Shop Drawings,

Product Data or Samples, to deviations from Contract Documents.

1. Contractor shall not be relieved of responsibility for deviation from requirements of Contract Documents by COTR's approval of Shop Drawings, Product Data and Samples unless Contractor has specifically informed COTR in writing of such deviation at time of submission and COTR has given written approval to specific deviation. Such deviations shall require a change order unless Government considers them minor changes in work and subject deviations do not involve adjustment in Contract Price or Contract Time.

F. Contractor shall not be relieved from responsibility for errors or omissions in Shop Drawings, Product Data or Samples by COTR's approval thereof.

G. Contractor represents and warrants that all submittals shall be prepared by persons and entities possessing expertise and experience in the trade for which the submittal is prepared and, if required by COTR or applicable law, by a licensed professional engineer.

H. Contractor is responsible for confirmation and correlation of dimensions at job site; for information that pertains solely to fabrication processes or to techniques of construction; and for coordination of work of all trades.

I. Completed work shall strictly conform to approved samples.

J. Do not start work which requires submittals, prior to return of submittals with COTR's stamp indicating approval.

1.08 SUBMITTALS

A. Shop Drawings:
   1. As required by applicable sections.

B. Product Data:
   1. As required by applicable sections.

C. Samples:
   1. As required by applicable sections.

D. Project Information:
   1. Schedule of submittals: Prior to second application for payment.
   2. Product list.
   3. Spare parts list.
   4. Equipment delivery schedule.

5. Software as specified in this section.
6. Other project information as required by applicable sections.

E. Contract Closeout Information:
1. As required by applicable sections.

1.09 SCHEDULE

A. Within 60 calendar days following submission of the Preliminary Network Analysis, submit a complete schedule of required submittals indicating proposed submittal dates for items that are developed by the Contractor in EXPEDITION software.
1. Include Shop Drawings, Product Data, Samples, Spare Parts Data, Project Information, Subproject Name and Number, and Contract Closeout Information.

B. Government may withhold full or partial payment, at Government's sole discretion, until satisfactory schedule of submittals has been received.

C. Furnish all submittals to Government, for entire Contract, within the first half of the project except for Contract closeout information, training data, maintenance and operations manuals, and other submittals excluded by Government's written consent. Furnish all maintenance, operations, and training submittals within 120 days of scheduled project completion. Furnish all other Contract closeout information 90 days preceding date indicated in the latest approved Contract Schedule for completion of the work, as indicated on the schedule for the work approved by the Government. The Government may withhold full or partial payment, at Government's sole discretion, should the Contractor fail to deliver submittals as indicated in this paragraph.

1.10 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES REVIEW

A. Government review is only for conformance with design concept of Project and compliance with intent of information given in Contract Documents.

B. Government will stamp submittals indicating action taken.
1. Sample stamp:

□(s3BARCHITECT'S SUBMITTAL ACTION□(s0B

[ ] A-APPROVED
[ ] B-APPROVED AS NOTED
[ ] C-REVISE AND RESUBMIT
[ ] D-NOT APPROVED
[ ] E-NO ACTION REQUIRED

Action taken in accordance with
provisions of the Contract Documents

BY_____DATE_____
SUBMITTAL NO._____

C. Review shall not constitute approval of safety precautions or, unless otherwise specifically stated by COTR, of any construction means, methods, techniques, sequences or procedures.

D. Approval of a specific item shall not indicate approval of an assembly of which item is a component.

1.11 SUBMITTAL TRANSMITTAL FORM

A. Contact COTR for Project specific copy.

B. Submittal number.
1. Identify each transmittal using a sequence number system included in the EXPEDITION software.
2. Identify each transmittal using applicable 5 digit specification section number.
3. After section number insert a hyphen, "-".
4. Indicate sequence number, i.e., first submittal of Section 03450 series would be numbered, 03450-01. If returned for re-submission, second submission would be 03450-01A.

C. Indicate description and manufacturer.

1.12 PRODUCT LIST

A. Within 30 calendar days after Award of Contract, and prior to the commitment for purchase of any materials and equipment to be utilized on this Contract, submit for review and for tentative approval only, four copies of a complete listing of such materials and equipment. The listing shall include sufficient data to identify the materials and equipment as to type, quality, sizes when applicable, and manufacturer or source. Tentative approval of the items in the materials and equipment list will be given, however, all items will be subject to final review and approval by the Government upon Contractor provision of proper submittals when specified. Materials

and equipment shall not be fabricated or installed by Contractor without prior approval.

1.13 EQUIPMENT DELIVERY SCHEDULE

A. Within 90 calendar days after Notice to Proceed, submit to the COTR for approval, a schedule for procurement of materials and equipment. The submittal shall be in the format prescribed by COTR and include as a minimum the following information:
   1. Description.
   2. Date of purchase order.
   3. Promised shipping date.
   4. Name of manufacturer or supplier.
   5. Date delivery is expected.
   6. Date material or equipment is required, according to current progress schedule or network.

B. Update the equipment delivery schedule at monthly intervals or as directed by the COTR. This delivery schedule shall reflect any changes occurring since the last update. Submit copies of purchase orders.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART I - GENERAL

1.01 SUMMARY

A. The requirements of this section apply to, and are part of, each section of the specifications.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extended reference. The publications are referred to in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):
1. ASTM A 1980-1989 Criteria for Use in Evaluation of Testing Laboratories and Organizations for Examination and Inspection of Steel, Stainless, and Related Alloys.
2. ASTM C 1077 1990 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
3. ASTM D 3666 1990 (Rev. A) Evaluating and Qualifying Agencies Testing and Inspecting Bituminous Paving Materials.
4. ASTM D 3740 1988 Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction.
5. ASTM E 329 1990 Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.
6. ASTM E 543 1989 (Rev. A) Determining the Qualification of Non-Destructive Testing Agencies.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
1. Reports and records, as indicated in this section.
2. Quality Control (QC) Plan. Submit a QC Plan within 30 calendar days after receipt of Notice to Proceed.

E. Contract closeout information:
1. Completion documentation, as indicated in this

section.

1.04 INFORMATION FOR THE CONTRACTING OFFICER

A. Deliver the following to the Contracting Officer or the Contracting Officers designated representative:
   1. Combined Contractor Production Log/Contractor Quality Control Report electronic and two hard copies, by 10:00 a.m. the next working day after each day the work is performed.
   2. QC Specialist Reports and Test Results, electronic and two hard copies, by 10:00 a.m. the next working day after each day that work is performed.
   3. Testing Plan and Log, one copy electronic and hard copy, at the end of each month.
   4. QC Meeting Minutes, one copy electronic and two hard copies, within two calendar days of the meeting.
   5. Rework Items List, one copy electronic and two hard copies, prior to the 15th and the last working day of the month.
   6. QC Certifications, as required by the paragraph entitled "QC Certifications".

1.05 QC PROGRAM REQUIREMENTS

A. The Contractor is responsible for quality control and shall establish and maintain an effective quality control system in compliance with the Contract Clause entitled "Inspection of Construction". The quality control system shall consist of plans, procedures, and organization necessary to produce an end product, which complies with the contract requirements. The system shall cover all construction operations, both onsite and offsite, and shall be keyed to the construction schedule. The QC program consists of QC Organization, a QC Plan, attending a QC Plan Meeting, attending a Coordination and Mutual Understanding Meeting, conducting QC meetings, performing three phases of control, performing submittal review, ensuring testing is performed, and preparing QC certifications and documentation necessary to provide materials, equipment, workmanship, fabrication, construction, and operations which comply with the requirements of this Contract.

1.06 QC ORGANIZATION AND MANAGEMENT

A. QC Manager
   1. Duties: Provide a full time QC Manager at the work site to manage and implement the QC program. The only duties and responsibilities of the QC Manager shall have on this Contract is managing and implementing the

QC program. The QC Manager is required to attend the QC Plan meeting, attend the Coordination and Mutual Understanding meeting, conduct the QC meetings, perform the three phases of control, perform submittal review, ensure testing is performed and prepare QC certifications and documentation required in this Contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by the QC specialists. No work or testing may be performed unless the QC Manager is on the work site. The QC Manager shall report directly to an officer of the firm and shall not be the same individual as, nor be subordinate to the Superintendent or the Project Manager.

2. Qualifications: A graduate of a four-year accredited college program in one of the following disciplines: Engineering, Construction Management, Engineering Technology, Building Construction with a minimum of 10 years experience as a Superintendent, Inspector, QC Manager, Project Manager, or Construction Manager on similar size construction contracts which included the major trades that are a part of this Contract.

B. Assistant QC Manager Duties and Qualifications: Designate an assistant for the QC Manager at the work site to perform QC duties for work occurring during non-normal work hours and/or to perform QC duties in the event of the QC Manager's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Assistant QC Manager shall be an individual with a minimum of 5 years experience as a Foreman, Superintendent, Inspector, Project Manager, or Construction Manager on similar size construction contracts, which included the major trades that are part of this Contract. This individual may perform QC Specialist activities on the project.

C. Quality Control Specialists:

1. Provide a separate QC specialist at the work site for each of the areas of responsibility specified below who shall assist and report to the QC Manager, and who shall have no duties other than performing the three phases of control and preparing documentation for each definable feature of work in their area of responsibility at the frequency specified.
2. In addition to the requirements of the "Contractor's Quality Control Plan", the QC Specialists shall be available on site for consultation with the COTR at least two (2) hours per day, three (3) days per week during construction/installation of features of work under their

responsibility. The QC Specialists shall be on site (or off-site as required) full time for testing and commissioning of work under their responsibility. Resumes of all contractor proposed Quality Control Specialists shall be submitted to the COTR for approval. Upon the Government's acceptance of the Contractor's Quality Control Plan, the contractor shall update their Detailed CPM Schedule (DCS) to include activities and durations for the Quality Control organization.

1.07 QC PLAN

A. Requirements: The QC Plan shall include, as a minimum, the following to cover all construction operations, both onsite and offsite, including work by Contractor's own workforce, Subcontractors, Fabricators, Suppliers, and Purchasing Agents:

1. A description of the quality control organization, including a chart showing lines of authority and acknowledgement that the QC staff shall implement the three phase control system for all aspects of the work specified.
2. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
3. A copy of the letter to the QC Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the QC Manager, including authority to stop work which is not in compliance with the Contract. The QC Manager shall issue letters of direction other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters will also be furnished to the Government.
4. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of Subcontractors, Offsite Fabricators, Suppliers and Purchasing Agents.
5. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, anticipated test date, and person responsible for each test. The Contracting Officer will approve laboratory facilities.
6. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
7. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that

identified deficiencies have been corrected.

8. Documentation procedures, including proposed electronic report formats to be used.
9. A list of the definable features of work. A definable feature of work is a task, which is separate and distinct from other tasks, and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there is frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.
10. A personnel matrix showing, for each section of the specification, who will review and approve submittals, who will perform and document the three phases of control, and who will perform and document the testing.

B. Preliminary Work Authorized Prior to Approval: The only work that is authorized to proceed prior to the approval of the QC plan is mobilization of storage, office trailers and surveying.

C. Approval: Approval of the QC Plan is required prior to the start of construction. The Contracting Officer reserves the right to require changes in the QC Plan and operations as necessary to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC organization at any time in order to verify his/her submitted qualifications.

D. Notification of Changes: Notify the Contracting Officer in writing, of any proposed change, including changes in the QC organization personnel, a minimum of 7 calendar days prior to a proposed change. The Contracting Officer must approve proposed changes.

1.08 QC PLAN MEETINGS

A. Prior to the submission of the QC Plan, and no later than 10 days after Notice to Proceed, meet with the Contracting Officer and his designated representatives to discuss the QC Plan requirements of this Contract. The purpose of this meeting is to develop a mutual understanding of the QC Plan requirements prior to plan development and submission.

1.09 COORDINATION AND MUTUAL UNDERSTANDING MEETING

A. Before start of construction, and prior to acceptance by the Government of the QC Plan, the Contractor shall meet with the Contracting Officer or authorized representative and discuss the Contractor's quality control system. The QC Plan shall be submitted for review a minimum of 5 calendar days prior to the coordination meeting. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the QC operations, control activities, testing, and administration of the system for both onsite and offsite work; and the inter-relationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting shall be prepared by the government and signed by both the Contractor, and the Contracting Officer. The minutes shall become a part of the contract file. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the QC system or procedures, which may require corrective action by the Contractor.

1.10 QC MEETINGS

A. After the start of construction, the QC Manager shall conduct weekly QC meetings at the work site with the Project Superintendent, Environmental Safety Officer, and QC Specialists. The QC Manager shall prepare the meeting minutes, in EXPEDITION CONTRACT CONTROL software (refer to Section 01340), and provide a copy to the Contracting Officer within 2 working days after the meeting. The Contracting Officer and/or his representative may attend these meetings. The QC Manager shall notify the Contracting Officer at least 48 hours in advance of each meeting. As a minimum, the following shall be accomplished at each meeting:
   1. Review the minutes of the previous meeting.
   2. Review the schedule and status of work:
      a. Work or testing accomplished since last meeting.
      b. Rework items completed since last meeting.
      c. Use of premises.
      d. Work sequence.
      e. Coordination of trades.
      f. Safety and health.
      g. NIST controlled material.
   3. Review the status of submittals:
      a. Submittals reviewed and approved since last meeting.
      b. Submittals required in the near future.
   4. Review the work to be accomplished within the next 2 weeks, and documentation required. Schedule the three phases of control and testing:

a. Establish completion dates for rework items.
b. Preparatory phases required.
c. Initial phases required.
d. Follow-up phases required.
e. Testing required.
f. Status of off-site work or testing.
g. Documentation required.

5. Resolve QC and production problems; and address items that may require revising the QC Plan:
a. Changes in QC organization personnel.
b. Changes in procedures.

1.11 THREE PHASES OF CONTROL

A. The QC Manager shall perform and document the three phases of control to ensure that work complies with Contract requirements. The three phases of control shall adequately cover both onsite and offsite work, and shall include the following for each definable feature of work: a definable feature of work is a task, which is separate and distinct from other tasks and requires separate control requirements.

1. Preparatory Phase: Notify the Contracting Officer at least 48 hours in advance of each preparatory phase. Conduct the preparatory phase with the QC Specialists, the Superintendent, and the Foreman responsible for the definable feature. Document the results of the preparatory phase actions in the daily Contractor Quality Control Report. Perform the following prior to beginning work on each definable feature of work.
a. Review each paragraph of the applicable specification sections.
b. Review the Contract drawings.
c. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.
d. Review the testing plan and ensure that provisions have been made to provide the required QC testing.
e. Examine the work area to ensure that the required preliminary work has been completed.
f. A physical examination of required materials, equipment, and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.
g. Review the safety plan and appropriate activity hazard analysis to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted.
h. Discussion of procedures for controlling quality of the work, including repetitive deficiencies.

Document construction tolerances and workmanship standards for that feature of work.

i. A check to ensure that the Contracting Officer has accepted the portion of the plan for the work to be performed.

2. Initial Phase: Notify the Contracting Officer at least 48 hours in advance of each initial phase. When construction crews are ready to start work on a definable feature of work, conduct the initial phase with the QC Specialists, the Superintendent, and the Foreman responsible for that feature of work. Observe the initial segment of the definable feature of work to ensure that the work complies with the Contract requirements. Document the results of the initial phase in the daily Contractor Quality Control Report. Repeat the initial phase for each new crew to work onsite, or when acceptable levels of specified quality are not being met. Perform the following for each definable feature of work:
   a. Establish the quality of workmanship required.
   b. Resolve conflicts.
   c. Review the Safety Plan, and the appropriate activity hazard analysis to ensure that applicable safety requirements are met.
   d. Ensure that testing is performed, by the approved laboratory.
   e. Review minutes of the preparatory meeting.
   f. Verify adequacy of controls to ensure full contract compliance, verify required control inspection, and testing.
   g. The initial phase should be repeated for new crew to work onsite, or anytime that acceptable specified quality standards are not being met.
3. Follow-up Phase: Daily checks shall be performed to assure control activities, including control testing, are providing compliance with contract requirements, until completion of the particular feature of work. The checks shall be made a matter of record in the QC documentation. Perform the following for ongoing work daily, or more frequently, as necessary until the completion of each definable feature of work and document in the daily Contractor Quality Control Report.
   a. Ensure the work is in compliance with Contract requirements.
   b. Maintain the quality of workmanship required.
   c. Ensure that testing is performed by the approved laboratory; and ensure that rework items are being corrected.
4. Notification of Three Phases of Control for Offsite Work: Notify the Contracting Officer at least 14

calendar days prior to the start of the preparatory and initial phases.

1.12 COMPLETION INSPECTION

A. Pre-final Inspection: At the completion of all work or any increment thereof established by a completion time stated in the Project Schedule, the QC Manager shall conduct an inspection of the work and develop a "punch list" of items, which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the QC documentation, as required by paragraph titled DOCUMENTATION; and shall include the estimated date by which the deficiencies will be corrected. Once this is accomplished the Contractor shall notify the Government that the facility is complete and ready for the Government's "pre-final" inspection. The Government will perform this inspection to verify that the facility is complete and ready to be occupied. A Government "Pre-final Punch List" will be developed as a result of this inspection.

B. Final Acceptance Inspection: The Contractor's QC Manager shall ensure that all items on the Pre-Final Punch List have been corrected and will notify the Government that a "Final" inspection with the customer can be scheduled. Any items noted on the "Final" inspection shall be corrected in a timely manner. These inspections, and any deficiency corrections required by this paragraph will be accomplished within the time slated for completion of the entire work or any particular increment thereof, if the project is divided into increments by separate completion dates. Refer to specification Section 01310, for scheduling and subproject requirements. The Contractor's Quality Control Inspection personnel, his Superintendent or other primary management person, and the Contracting Officer's representative will be in attendance at this inspection. Additional government personnel may also be in attendance. The Contracting Officer will schedule the inspection based upon proper notice from the Contractor. Proper notice is defined as notice received at least 14 calendar days prior to the final inspection, and which includes the Contractor's assurance that all specific items previously identified as unacceptable and all remaining Contract work have either been corrected or will be corrected by the final inspection date. Failure of the Contractor to have all Contract work acceptably completed for this inspection will require the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the Contract Clause entitled "Inspection of Construction".

1.13 SUBMITTAL REVIEW

A. Procedures for submittals are as described in Section 01340.

1.14 TESTING

A. Perform sampling and testing as required under this Contact.
   1. Testing Procedure: The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product, which conforms to control requirements. Upon request, the Contractor shall furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of a Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site. The Contractor shall perform the following activities; and record and provide the following data.
      a. Verify that testing procedures comply with contract requirements.
      b. Verify that facilities and testing equipment are available and comply with testing standards.
      c. Check test instrument calibration data against certified standards.
      d. Verify that recording forms and test identification control number system, including all of the test document requirements, have been prepared.
   2. Testing Laboratories:
      a. Capability Check: The Government reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the Contract documents, and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM-D3740 and ASTM-E329.
      b. Capability Recheck: If the selected laboratory fail the capability check, the Contractor will be assessed a charge to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.

B. Additional requirements are specified in Section 01410.

1.15 CERTIFICATIONS

A. Contractor Quality Control Report Certification: Each Contractor Quality Control Report shall contain the following statement: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the Contract drawings and specifications to the best of my knowledge, except as noted in this report".

B. Invoice Certification: Furnish a certificate to the Contracting Officer with each payment request, signed by the QC Manager, attesting that as-built drawings are current and attesting that the work for which payment is requested, including stored material, is in compliance with Contract requirements.

C. Completion Certification: Upon completion of work under this Contract, the QC Manager shall furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested, and is in compliance with the Contract".

1.16 DOCUMENTATION

A. Maintain current and complete records of onsite and offsite QC program operations and activities.
   1. Contractor Daily Production Log: Contractor Daily Production Log is required for each day that work is performed and shall be attached to the Contractor Quality Control Report prepared for the same day. The Contractor's Quality Control Reports will be completed in EXPEDITION CONTRACT CONTROL software. Account for each calendar day throughout the life of the Contract. Results of all tests taken, both passing and failing test, will be recorded on the QC report for the date taken. Include the specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the COTR, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility will be provided directly to the Contracting Officer. Failure to submit timely test reports as stated may result in nonpayment for related work performed. Contractor Production Logs are to be prepared, signed, and dated by the Project Superintendent and shall contain the following

information:

a. Date of log, report number, name of contractor, contract number, title and location of Contract, and superintendent present.
b. Weather conditions in the morning and in the afternoon including maximum and minimum temperatures.
c. A list of Contractor and subcontractor personnel on the worksite, their trades, employer, work location, description of work performed and hours worked.
d. A list of job safety actions taken and safety inspections conducted. Indicate that safety requirements have been met including the results on the following:
    (1) Was a job safety meeting held? If yes, attach a copy of the meeting minutes.
    (2) Were there any lost time accidents? If yes, attach a copy of the accident investigation report.
    (3) Was trenching/scaffold/high voltage electrical/high work done? If yes, attach a statement or checklist showing inspection performed.
    (4) Was hazardous material/waste released into the environment? If yes, include meetings held and state accidents that happened, including description of incident, type of materials being used, quantity, clean-up action and steps taken to prevent future accidents.
e. A list of equipment and material received each day that is incorporated into a job.
f. A list of construction and plant equipment on the worksite including the number of hours used, idle and down for repair.
g. Include a "remarks" section in this log which will contain pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered, and a record of visitors to the worksite.

2. Reports are required for each day that work is performed and for every 7 consecutive calendar days of no work and on the last day of a no work period. Account for each calendar day throughout the life of the Contract. The reporting of work shall be identified by terminology consistent with the construction schedule. Contractor Quality Control

Reports are to be prepared, signed and dated by the QC Manager and shall contain the following information:

a. Identify the control phase and the definable feature of work.
b. Results of the Preparatory Phase meetings held including the location of the definable feature of work and a list of personnel present at the meeting. Indicate in the report that for this definable feature of work, the drawings and specifications have been reviewed, submittals have been approved, materials comply with approved submittals, materials are stored properly, preliminary work was done correctly, the testing plan has been reviewed, and work methods and schedule have been discussed and approved.
c. Results of the Initial Phase meetings held including the location of the definable feature of work and a list of personnel present at the meeting. Indicate in the report that this definable feature of work the preliminary work was done correctly, samples have been prepared and approved, the workmanship is satisfactory, test results are acceptable, work is in compliance with the Contract, and the required testing has been performed and include a list of who performed the tests.
d. Results of the Follow-up Phase inspections held including the locations of the definable feature of work. Indicated in the report for this definable feature of work complies with the Contract as approved in the Initial Phase, and that required testing has been performed and include a list of who performed the tests.
e. Results of the three phases of control for offsite work, if applicable, including actions taken.
f. List the rework items identified, but not corrected by close of business.
g. List the rework items corrected from the rework items list along with the corrective action taken.
h. Include a "remarks" section in this report, which will contain pertinent information including directions received, quality control problem areas, deviations from the QC Plan, construction deficiencies encountered, QC meetings held, acknowledgement that as-built drawings have been updated, corrective direction given by the QC Organization and corrective action taken by the Contractor.
i. Delayed activities.
j. Anticipated delays.

3. Reports for the QC Specialist: Reports are required

for each day that work is performed in their area of responsibility. QC Specialist Reports shall include the same documentation requirements as the Contractor Quality Control Report for their area of responsibility. QC Specialist Reports are to be prepared, signed and dated by the QC Specialists and shall be attached to the Contractor Quality Control Report, prepared for the same day.

4. Testing Plan and Log: As tests are performed, the QC Manager shall record on the "Testing Plan and Log" the date the test was conducted, the date the test results were forwarded to the Contracting Officer, remarks and acknowledgement that an accredited or Contracting Officer approved testing laboratory was used. Attach a copy of the updated "Testing Plan and Log" to the last daily Contractor Quality Control Report of each month.
5. Rework Items List: The QC Manager shall maintain a list of work that does not comply with the Contract, identifying what items need to be reworked, the date the item was originally discovered, and the date the item was corrected. There is no requirement to report a rework item that is corrected the same day it is discovered. A copy of the "Contractor Rework Items List" shall be attached to the daily Contractor Quality Control Report twice each month. The Contractor shall be responsible for including on this list items needing rework, including those identified by the Project Officer.
6. As-built Drawings: The QC Manager is required to review the as-built drawings required by Section 01720 "Project Record Documents", to ensure that as-built drawings are kept current on a daily basis and marked to show deviations, which have been made from the Contract drawings. The QC Manager, or QC Specialist assigned to an area or responsibility, shall initial each deviation and each revision. Upon completion of work, the QC Manager shall furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer.
7. Report Forms: Report forms that are not available in PRIMAVERA EXPEDITION will be developed by the Contractor with input and final approval by the Government. All forms shall be developed in electronic form.
8. Monthly Reports: Contractor shall submit a monthly report that shall be a summary of the Contractor's Daily Production Logs, Daily Quality Control Reports, construction photographs, and other supporting data and information with the monthly report identified in Section 01310 as components of the Contractor Prepared

Network Analysis System (NAS).

9. Submission Schedule:
   a. Daily Production Logs and Quality Control Reports to be submitted by close of business daily.
   b. Monthly Reports shall be completed and submitted on or before the 5th day of the month following the date of the monthly report.
10. Document Tracking Software:
   a. EXPEDITION CONTRACT CONTROL software package will be used during this Contract. This package will ensure timely and accurate responses to all incoming correspondence. To facilitate the use of this software, the Contractor will be required to submit all incoming correspondence in electronic form.
   b. All correspondence shall be electronically submitted to the Government. The Contractor shall use the latest available version of ADOBE ACROBAT to convert all electronic files into the *.PDF format. The Contractor shall be required to scan and save with the *.PDF format all standard 216 x 279 mm documents, if the documents are not available in electronic format i.e., submittals, Operation and Maintenance Manuals, etc. Minimum required scanning resolutions; black and white text at 300 to 600 DPI, color images grayscale or color images at 300 to 400 DPI.
   c. The Government will provide the Contractor with restricted access to the tracking system to allow electronic submittal of correspondence, via modem, directly to the Government. In addition the Government will supply the Contractor with a direct restricted access (T1-Line) from their onsite trailer into the tracking system. The Contractor will be responsible for all costs associated with connecting to the NIST LAN.
   d. The Contractor shall develop with input and approval by the Government, standard electronic forms to be used for the following documents:
      (1) Request for Information (RFI).
      (2) Standard correspondence.
      (3) Progress Meeting Minutes.
      (4) QC Reports.
      (5) QC Meeting Minutes.
      (6) Daily Reports.
      (7) Submittal Transmittal.
      (8) Submittals (scanned).
      (9) Request for Utility Shutdowns.
      (10) Request for Road Closure.
   e. The Contractor will be responsible for providing, for use by the Contractor, two computers with

EXPEDITION CONTRACT CONTROL software, as specified in Section 01340. Items 1 through 10 above shall be developed and stored in the EXPEDITION CONTRACT CONTROL software.

1.17 PAYMENT

A. Separate payment will not be made for providing and maintaining an effective Quality Control program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Bidding Schedule.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES, TEMPORARY CONTROLS, UTILITIES AND SAFETY

PART 1 - GENERAL

1.01 SUBMITTALS

A. Project information:
   1. Plan for temporary facilities, for approval by COTR at least 14 calendar days before mobilization, and to include but not be limited to:
      a. Electricity and lighting.
      b. Storage and staging areas.
      c. Water and sewage.
      d. Fences and barricades.
      e. Access roads and parking.

B. Contract closeout information: Not required for COTR review.

1.02 COLD WEATHER PROTECTION

A. Relocation of laboratory and/or office equipment, furnishings and contents may be conducted during adverse weather conditions. Contractor shall take adequate precautions to properly protect items in transit.

1.03 TEMPORARY ELECTRICITY

A. Temporary electrical power derived from existing site distribution system will be paid for by Government. Any other power generation shall be paid for by Contractor.
   1. Prohibit use of resistive heating devices.
   2. Turn off all lighting and/or equipment not in use.

B. Provide UL approved extension cords where necessary.

C. Provide temporary electrical systems which meet Government approval.

D. The Government can not guarantee the availability of power.

1.04 TEMPORARY TELEPHONE

A. Provide all temporary telephone services to perform the work in or adjacent to Contractor's Office on Project site. Pay for temporary telephone installation, equipment, local and long distance service, disconnection, removal and any incidental fees or charges.

B. Contractor shall be responsible for the entirety of the costs for providing telephone service to Contractors trailer complex.
   1. Contractor should not assume utilization of existing NIST underground telephone duct system to distribute cabling without NIST approval.

1.05 TEMPORARY WATER

A. Make all arrangements, Install equipment, backflow preventer, piping, and outlets for an adequate supply of clean water for construction purposes.
   1. Existing water line may be used for temporary service.

B. Government will pay for all domestic system water used by Contractor.

C. Furnish drinking water and cups for all those connected with the work.

D. Contractor shall tie into existing domestic water line which runs along east side of the site and shall provide all materials, labor and equipment necessary for the connection of all trailers requiring a domestic water connection.
   1. Contractor shall install all pipes serving these trailers underground with appropriate shut-off valves for isolation of each branch connection and shall provide measures to prevent them from freezing.
   2. Piping shall be run in an organized and pre-planned fashion and all piping shall be removed from the NIST campus upon demobilization, and the domestic water main piping shall be restored to its original condition.

1.06 TOILET FACILITIES

A. Provide toilet facilities for use of all workmen.

B. Maintain in clean, sanitary condition.

C. Provide adequate supplies of toilet paper, cleaning and other required items.

1.07 CONTRACTOR'S FIELD OFFICE

A. Provide field office for Contractor's use.

B. Provide keys to the Fire Chief.

1.08 TEMPORARY ENCLOSURES AND PARTITIONS

A. Provide following:
   1. Provide temporary enclosures, doors, etc. as required to protect building from damage due to vandalism, or the elements, or to maintain suitable temperature during installation of finishes.
   2. Maintain existing means of egress from occupied facilities. Should blocking of a point of egress be necessary, provide plan for temporary egress to COTR at least 14 calendar days prior to work.
   3. Maintain fire exits as required by Government fire authority.

B. Polyethylene sheet used in dust barrier construction shall be a rated fire retardant material. Wood, if used, shall be treated so as to render it fire retardant; see Section 06000. Product data for fire retardant polyethylene sheeting and wood shall be submitted for review and approval.

1.09 TEMPORARY STORAGE AND STAGING AREAS

A. Prior to start of work, Contractor shall meet with all Subcontractors to arrange and prepare plot plan defining staging, storage, field office and traffic areas within laydown/staging and trailer/parking areas designated on the drawings.
   1. Obtain COTR's approval of plan at least 14 calendar days prior to the installation of the temporary facilities.
   2. Except as specifically provided, working and storing outside these areas will not be permitted.
   3. Arrange and locate temporary structures and storage to avoid interfering with construction.

B. Within area designated for its use, provide suitable and sufficient enclosed and covered spaces, with raised flooring, to protect materials and equipment from damage by weather or construction work.
   1. Maintain storage and working areas in clean and orderly condition.
   2. Tie down canvas and other coverings sufficiently to be maintained in conditions of high winds.

1.10 PROJECT SIGNS

A. Limit signs located on site to Contractor, Government's and the Project Sign.
   1. Post no other signs on site except those required by

law and those approved by COTR.
2. Immediately proceeding Completion, or sooner if directed, remove Project signs.

B. Locate signs on site where indicated on drawings or as directed by COTR.

1.11 TRAFFIC CONTROL

A. Provide traffic control to effect safe and smooth operations for Government or potentially affected entities in vicinity of Project in accordance with "Work Zone Traffic Controls" published by the Maryland Department of Transportation.

1.12 PARKING

A. Personnel performing the work shall not park in any Government parking lot without prior express consent of COTR.

B. Contractor acknowledges that any personnel violating this requirement, do so at their own risk. Make personnel aware that their vehicles may be towed at their own expense.

C. Prohibit parking in residential and other areas in immediate vicinity of Project site.

D. Contractor to keep all personnel, vehicles and operations on Project site within designated limits. If authorized by the COTR, temporary parking areas shall be surfaced with crushed stone and maintained to prevent deterioration (ruts, mud, etc.) as approved by the COTR.

E. Direct personnel performing the work to use access to site designated by COTR.

F. Provide parking and transportation for Contractor personnel off the Project site if designated on site parking areas are inadequate for Contractor needs.

1.13 PUBLIC RELEASE OF INFORMATION

A. The Contractor shall not publicly release information, photographs, or other documents concerning any aspect of the materials or services relating to Contract without the prior written approval of the Government.

B. The Contractor shall insert this requirement in each Subcontract and purchase order related to this Contract.

1.14 NIST SITE REGULATIONS

A. Ensure Contractor employees and Subcontractors become familiar with and obey all NIST site regulations, including fire, traffic, and security regulations. All personnel employed on the site shall keep within the limits of the work (and avenues of ingress and egress), and shall not enter any restricted areas unless required to do so and are cleared for such entry. The Contractor's vehicles and equipment shall be conspicuously marked for identification.

1.15 SECURITY AND PROJECT WORK HOURS

A. This Contract requires that the Contractor's employees, who will work on the premises of the AML building project or other buildings associated with this project, to undergo specific suitability assessment processing.

B. Suitability or Risk Level: The suitability or risk level for this Contract has been determined to be: Low Risk.

C. Contractor Performance Requirements:
   1. The Contractor shall pre-screen their employees to eliminate anyone who does not meet the following criteria: The prospective employee shall either be a United States (U.S.) Citizen, or if a non-U.S. Citizen, have official legal status in the U.S.
   2. Prior to commencing work under this Contract, the Contractor shall submit or have their employee submit the forms and number of copies delineated by the Office of Security in the Personnel Security Manual to the Contracting Officer's Technical Representative (COTR) for processing. Only Contractor's and Subcontractors' supervisors, and foremen are required to submit the necessary documentation. These individuals will be required to wear a badge issued by NIST, and will be responsible for their workers at all times. The documentation required includes: (1) OF 86C-Special Agreement Check, (2) FD-258-Fingerprint Chart, (3) Authorization for Release of Information, (4) Fair Credit Release Form, and (5) NIST 1085-Request for Security Assurance.
   3. The Contractor, when notified that the Government rejected the suitability assessment forms shall either have the rejected forms made compliant and resubmitted, or withdraw the employee from consideration from working under this Contract.
   4. The Contractor shall immediately remove any employee from any work requiring access to NIST's buildings or

facilities if directed in writing by the Contracting Officer.

5. Failure to comply with the suitability processing requirements may result in termination of the Contract for default.

D. Government Responsibilities:

1. The Government's suitability processing will consist of limited personal background inquiries pertaining to verification of name, physical description, criminal history record, credit history check, fingerprint classification, and other pertinent information as dictated by level of risk. The Government may, at its discretion, repeat the suitability processing on any contract employee or expand the investigation to resolve issues.
2. The Government will inspect and either accept or reject the Contractor's suitability assessment forms as delineated in the Personnel Security Manual.
3. The Government will notify the Contractor in writing when any of the following occur: A contract employee is acceptable based on the suitability checks and assessment conducted; a contract employee is unacceptable based on the suitability checks and assessment processing; or a contract employee or prospective contract employee is barred from working on Government facilities because of any of the following:
   a. Conviction of a felony, a significant history of violent behavior or moral turpitude.
   b. Falsification of information entered on suitability screening forms or of other documents submitted to the Department.
   c. Improper conduct once performing on the Contract, including criminal, infamous, dishonest, or notoriously disgraceful conduct or other conduct prejudicial to the Government regardless of whether the conduct was directly related to the Contract.
   d. Any behavior judged to pose a threat to personnel, property or programs of the Department.
4. In as much as this Contract does not involve access to national security classified information, the Government will not use the resultant suitability assessment processing as a basis to issue a security clearance to any employee.

E. Access to NIST Site:

1. The Contractor shall be on the NIST grounds only between the hours of 7:00 am and 6:30 pm, Monday through Friday, on normal Federal workdays. Should

the Contractor desire to work at times other than those specified above, the dates and hours must be scheduled at least 7 working days in advance and approved in writing by the COTR.

2. Use Gate F at the National Institute of Standards and Technology site for materials supply and entry for personnel by the Contractor and Subcontractors unless otherwise directed by the COTR. The Contractor shall provide identification for all employees who will be accessing the site.
3. Employer identification shall include the name, country of citizenship, and employer for each Contractor and Subcontractor's employee working on the NIST site. These shall be submitted to the COTR for review 3 days prior to the work date. After hours work will require a Government escort 100 percent of time. Follow the specific procedures pertaining to security and work hours prescribed by the COTR.

1.16 ENVIRONMENTAL PROTECTION

A. Disposal of refuse: An approved recycling plan shall be submitted and approved by Government prior to disposal of any refuse. Remove all refuse associated with work. Dispose refuse in accordance with the requirements of the local jurisdiction and recycling plan.

B. Covered chutes: All chutes for refuse, and the like, shall be covered, or of such a design to fully confine the material to prevent the dissemination of debris and dust.

C. Trucking:
1. Load all trucks leaving the site with loose debris in a matter that will prevent dropping of materials on streets. Provide truck wheel wash station at exit from site, to ensure full removal of mud and debris from exterior of Contractor vehicles leaving the project site. Fasten suitable tarpaulins over the load before they enter surrounding paved streets. Trucks transporting earthen materials to and from the site shall be covered. Spray debris with water to reduce dust generation.

D. Construction site maintenance:
1. Store all supplies and equipment on Project site so as to preclude mechanical and climactic damage. Maintain site in a neat and orderly manner.
2. Maintain any temporary structures in good repair and visually pleasant.

E. Noise control: Comply with all applicable local laws,

ordinances, and regulations relative to noise control. Equipment to be employed on this site shall not produce a noise level exceeding the following limits in dB(A) at a distance of 15 meters from the equipment under test.

Equipment:

Earthmoving

Front loader	79
Backhoe	85
Dozer	80
Tractor	80
Scraper	88
Grader	85
Truck	91
Paver	89

Materials Handling

Concrete mixer	85
Concrete pump	82
Crane	83
Derrick	88

Stationary

Pumps	76
Generators	78
Compressors	81

Impact

Jack hammers	88
Pneumatic tools	86

Other

Saws	78
Vibrators	76

F. Asbestos/hazardous material:

1. Some ductwork and piping may be insulated with asbestos containing materials. If material is encountered that looks suspicious but must be disturbed, do not touch the material and immediately notify Government in writing. Within 14 calendar days, the Government will perform laboratory tests to determine if there is asbestos. If asbestos is not a danger, Government will direct the Contractor to proceed without change. If the material encountered is asbestos or hazardous and must be handled, Government will direct a change.

G. Disposal of fluorescent light fixtures in existing site building:
   1. Take all necessary safeguards to inspect the ballasts in fluorescent light fixtures for PCBs. Those with PCBs shall be turned over to the Government in approved marked barrels for the disposal by the Government.

H. Prohibit burning of debris on the Project site.

I. Dust control/street cleaning:
   1. Provide appropriate dust control/street cleaning operations for all paved and unpaved areas utilized during construction operations to the satisfaction of the COTR. Dust control shall be obtained by wetting or other approved methods. Street cleaning method shall be approved by COTR.

J. No smoking is permitted on the Project site.

1.17 FIRE PREVENTION AND PROTECTION

A. Comply with all fire prevention recommendations of the National Fire Protection Association (NFPA) Regulations which are incorporated herein by reference. A written fire permit shall be obtained from the COTR for use of open flame devices, such as blow torches, portable furnaces, tar kettles or gas and electric welding and cutting equipment in or within 5 meters of occupied buildings. The Contractor shall be liable for any fire loss to Government property attributable to negligence on the part of the Contractor or Subcontractor, included in part, failure to comply with fire prevention measures prescribed by terms of this Contract. Gasoline-driven equipment will not be allowed within any buildings or enclosed improvements.

B. Fire hydrant service to the construction area must be provided by the Contractor. Location of the hydrant(s) should be obtained from the COTR. Test fire hydrants per Government fire authority requirements and arrange to have test witnessed by Government fire authority. Installation shall be in accordance with Division 15 of the Specifications.

C. Develop and maintain fire protection plan.

D. In Case of Emergency, call x2222 from a campus phone. State your name, building name or number, room number, and a description of emergency. The NIST Fire Protection Group provides fire and ambulance service onsite. If a

phone other than NIST (975 exchange) is used, "911" shall be used for emergency calls. The Contractor shall state that he/she is located at NIST and give the details described above.

E. Standpipes and automatic sprinklers systems shall be placed in service as soon as practical. The plan for placing standpipes and automatic sprinklers system in service shall be part of the construction schedule.

1.18 COMPLETION OF WORK

A. Immediately proceeding Completion or sooner if directed by COTR, remove all temporary facilities, and return all improvements on or about site and adjacent property which are not indicated to be altered, removed or otherwise changed; to condition which existed previous to starting work.

1.19 OCCUPATIONAL SAFETY AND HEALTH

A. Contractor acknowledges that by working at NIST, a Federal Government facility located in Maryland, they are under the jurisdiction of the U.S. Department of Labor's Occupational Safety and Health Administration (Federal OSHA). OSHA's Region III Office through its Baltimore field office may assign a Compliance Officer to conduct a safety and health inspection of the Contractors operations at NIST. Accordingly, The Contractor is subject to OSHA Citations and Notice of Penalty for noncompliance with OSHA Standards.
   1. The Maryland Department of Environment (MDE) has jurisdiction on federal facilities located in the State of Maryland. MDE may assign field inspectors to conduct an inspection of the Contractors operations. The Contractor is subject to MDE Citations and Notice of Penalty for noncompliance with environmental standards.
   2. To Protect NIST's interest, the Contractor acknowledges that NIST may also conduct periodic safety, health and environmental inspections to assure that NIST and its consultant's employees or property are not at risk of injury or damage from Citation under OSHA multi employer worksite provisions or MDE regulations.

B. The Contractor is expected to effectively manage a job specific Safety, Health and Environmental program. NIST will review the Contractor past safety performance and its Safety, Health and Environmental program to and determine if it is acceptable. The determination will be made using

the NIST Contractor Safety Evaluation and Review Checklist for Contractor's Safety Program (copy available from COTR upon request). The Contractor's safety, health and environmental plan shall address the following topics:

1. Health, Safety, and Environmental Policy.
2. Program Management Employee Training.
3. Subcontractors Management.
4. Emergency Response.
5. Hazard Control Programs.
6. Environmental protection.

C. Pre-work Safety Meeting: Arrange for representatives of the Contractor to meet with the COTR and Government safety representative prior to the start of work to discuss implementation of the Contractor's Safety and Health program. Be prepared to discuss, in detail, the measures the Contractor intends to use to promote safety and health on the site as well as to control unsafe or unhealthy conditions. If directed by the COTR, this meeting may be held in conjunction with other meetings, which are scheduled to take place prior to the start of work. Ensure Contractor's principal onsite representative, general superintendent, and safety representative attends this meeting.

D. The Contractor is responsible for keeping the Government informed of incidents happening on the site. A summary of all incidents occurring on the site shall be reported monthly to the COTR or designate representative. The incident report shall contain date of incident, type of incident (injury, fire, property damage, spill), brief description of the accident, the cause of the incident and actions taken to prevent it from reoccurring.

E. Hazardous Materials: The Contractor shall keep a list of the hazardous materials (define by OSHA's Hazard Communication Standard, 29 CFR 1910.1200) use on the project. An updated list shall be given to the COTR and NIST's Fire Protection Group (FPG) at least quarterly or more often if FPG determines it necessary.

F. Safety and Health Standards Compliance: Comply (and ensure that all personnel and entities which are a part of the organization performing the work also comply) with all applicable OSHA Safety and Health Standards for Construction (29CFR1926) and OSHA General Industry Occupational Safety and Health Standards (29CFR1910). Additionally, comply with all applicable site safety and health requirements. Government will provide guidance/consultation regarding specific site requirements, as requested by Contractor and as the

Government may determine.

G. Special Emphasis Standards: While Contractor acknowledges that it is responsible for compliance with all applicable OSHA Safety and Health Standards, Contractor shall place special emphasis upon ensuring that the following provisions are satisfied in execution of the work:
   1. Fall Protection: Implement fall protection measures via use of suitable guardrails/barricades; safety belts/harnesses/lanyards/lifelines; safety nets; or other approved means. Focus particular emphasis on the requirements stipulated in Subpart L (Scaffolding), Subpart M (Floor and Wall Openings), Subpart R (Steel Erection) and Subpart X (Stairways and Ladders) of 29CFR1926 (Safety and Health Standards for Construction).
   2. Excavations and Trenching: With regard to excavations (including trenches), the soil at the NIST site shall be considered previously excavated and therefore unstable. Accordingly, ensure that persons entering excavations 1.3 m or more deep are protected from cave-ins by an adequate protective system designed in accordance with the requirements of 29CFR1926.652 (b) or (c) Implement all other applicable requirements for excavations as contained in Subpart P (Excavations) of 29CFR1926.
   3. Confined Spaces: Ensure that entry into permit-required confined spaces is in accordance with the requirements stipulated in the OSHA Permit-Required Confined Space Standard (29CFR1910.146). Properly satisfy all confined space entry requirements including personnel training, documented entry permit system, atmospheric testing/monitoring, forced ventilation, personal protective equipment, and emergency procedures/equipment.
   4. Hazard Communication: As applicable (i.e., when chemicals are used on-site by the Contractor), develop, implement and maintain at the workplace a written hazard communication program meeting the requirements of 29CFR1926.59 (for construction contracts) or 29CFR1910.1200 (for other than construction contracts). Ensure that each container of hazardous chemicals at the worksite is labeled, tagged or otherwise marked with the identity of the hazardous chemical(s) contained therein and that such markings indicate hazard warnings appropriate for employee protection. Provide employees with information and training on hazardous chemicals in their work area at the time of initial assignment and whenever a new hazardous chemical is introduced into

their work area. Also provide employees with information on any operations in their work area where hazardous chemicals are present; and the location and availability of the written hazard communication program, including the required lists of hazardous chemicals, and material safety data sheets (MSDS) required by the standard. Contractor shall furnish updated MSDS sheets, in their entirety, on a quarterly basis to the COTR for review.

5. Control of Hazardous Energy (Lockout/Tagout): In accordance with the provisions of OSHA standards 29CFR1910.147 and 29CFR1926.417, establish and implement a program consisting of energy control procedures, employee training and periodic inspections to ensure that before any employee performs any servicing or maintenance on electrical circuits/equipment, machines or other equipment/systems where the unexpected energizing, start up or release of stored energy could occur and cause injury, the circuit/machine/equipment/system shall be isolated from the energy source and rendered inoperative.
6. Electrical Installation and Work Practices: Comply with all applicable installation safety requirements, safety-related maintenance and environmental considerations, and safety requirements for special equipment as contained in Subpart K (Electrical) of 29CFR1926.
7. Personal Protective and Life Saving Equipment: In accordance with the provisions of Subpart E (Personal Protective and Life Saving Equipment) of 29CFR1926, ensure that protective equipment (including personal protective equipment for eyes, head, face, head and extremities; protective clothing; respiratory devices; and protective shields and barriers) is provided, used and maintained in a sanitary and reliable condition by all personnel in and around the area of the work, whenever it is necessary by reason of hazards of process or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of the body through absorption, inhalation or physical contact.
8. Tools-Hand and Power: Ensure compliance with all applicable safety requirements for tools (hand and power) as outlined in Subpart I (Tools-Hand and Power) of 29CFR1926.
9. Welding and Cutting: Ensure compliance with all applicable safety requirements pertaining to welding and cutting operations as outlined in Subpart J (Welding and Cutting) of 29CFR1926.

10. Motor vehicles and Mechanized Equipment: Ensure compliance with the safety requirements pertaining to motor vehicles and mechanized equipment (materials handling equipment) as contained in Subpart O (Motor Vehicles, Mechanized Equipment, and Marine Operations) of 29CFR1926.
11. General Site Safety Requirements: For the protection of NIST employees, other agency employees and the general public, observe the following general worksite safety requirements:
    a. Precautions: Take all necessary precautions to prevent injury to the public, building occupants, and damage to property of others. For the purposes of this Contract, the public or building occupants shall include all persons not employed by the Contractor or a Subcontractor engaged in the work.
    b. Housekeeping: Ensure that form and scrap lumber with protruding nails/fasteners and all other debris shall be kept clear from all work areas. Remove combustible scrap and debris at regular intervals. Provide containers for collection and separation of all refuse. Provide covers on containers used for flammable or harmful substances. Dispose of wastes at frequent intervals.
    c. Storage: Prohibit and prevent storing, positioning, and use of equipment, tools, materials, scraps, and trash in a manner likely to present a hazard to the public or building occupants by its accidental shifting, ignition, or other hazardous qualities is prohibited.
    d. Obstructions: Prohibit and prevent obstruction or use of any corridor, aisle, stairway, door, or exit, which results in encroachment upon routes of ingress or egress utilized by the public or building occupant, or presents unsafe or unhealthy condition to the public or building occupants.
    e. Radiation safety: Obtain COTR's written advance approval to bring any radioactive materials onto the Project site. See Radiation Safety Regulations in this section.
    f. Work Area Restrictions: Do not perform work in any area occupied by the public or Federal employees unless specifically permitted by the Contract or the COTR, and unless adequate steps are taken for the protection of the public or Federal employees.
    g. Fences and Barricades: Wherever practicable, fence, barricade, or otherwise block off the work area from the public or building occupants to

prevent unauthorized entry into the area of the work.

h. Alternate Precautions: When the nature of the work prevents isolation of the work area and the public or building occupants may be in or pass through, under, or over the work area, implement alternate precautions such as the posting of signs, the use of signal persons, the erection of barricades, or similar protection around particularly hazardous operations.

i. Public Thoroughfare: When work is to be performed over a public thoroughfare, such as a sidewalk, road, lobby, or corridor, close the thoroughfare, if possible, or take other precautions such as the installation of screens or barricades.

j. Removal of Fences and Barricades: Remove fences and barricades upon completion of the work, in accordance with local ordinances and at the satisfaction of the COTR.

12. Radiation Safety Regulations: The Contractor shall not bring to or use at NIST any radioactive materials or radiographic devices without explicit prior approval from NIST Health Physics Group for each use of devices. Any such use shall be in compliance with restrictions and procedures prescribed by NIST Health Physics (Bldg. 245, Room C125, x5800). Any work conducted in a NIST restricted area (as defined by the Nuclear Regulatory Commission and applied by NIST) shall comply with NIST procedural requirements and, in particular, specific training requirements for all persons entering that area. No area posted with Radioactive Material, Radiation Area, High Radiation Area, or Very High Radiation Area sign shall be entered without prior approval from Health Physics (i.e., all work in such areas requires prior clearance from NIST Health Physics).

1.20 SETTING OUT AND SURVEYING

A. Contractor is responsible to perform all necessary setting out and surveying work required to perform the work in Contract.

B. There are survey monuments on the Project site for Contractor's use. All points indicated on drawings may not be intact for use.

C. Contractor shall coordinate its layout requirements with other persons and organizations on the Project site as required to support their respective schedules and an organized work flow.

1.21 SALVAGE

A. Contractor acknowledges that the Government does not assume responsibility or accountability for any loss or damage to material or structures on the site, salvage value of which the Contractor may have reflected in its offer.

1.22 INTERRUPTION TO OPERATIONS AND SERVICES

A. Schedule work as to cause the least amount of interference with Project site operations. Work schedules shall be subject to the approval of the Government. Request permission in writing to interrupt any site road and/or utility service, a minimum of fourteen calendar days prior to the desired date of interruption. Schedule all electrical interruptions on weekends. Coordinate the requirements of this Section with requirements of other sections pertaining to continued occupancy of existing facilities.

B. Ensure that new utility lines are complete, except for the connection, before interrupting existing service.

C. Outages and closures: Do not close or partially block any roads or cause utility outages (electrical, steam, chilled water, water, compressed air, gas, sewer, telephone, fire alarm and signal systems) without the written authorization of the Government. Request authorization in writing not less than fourteen days in advance and not before all material necessary for the work to be done during the road blockage or utility outage is on the site. The request for authorization shall include in writing the following information: Contractor's name, Contract number, Project title, description and drawings of roads and utilities to be shut down, times, dates and reasons for shut downs, and any pertinent suggestions or comments. Minimize all outages and closures and do not exceed the authorized time. Provide cautionary and directional signs as needed. Work which necessitates an outage affecting the areas beyond the work site shall be performed by Contractor on Saturday, Sunday or after normal working hours.

1.23 CONTRACTOR'S USE OF PREMISES

A. Leave undisturbed as much of the site as practical.
   1. Land disturbed but not designated for disturbance on the drawings or by the Government shall be restored to its original condition at Contractor's cost.

2. Leave root zones of trees undisturbed.

B. Provide warranty and/or guarantee on permanent items and systems used during construction, commencing on date of acceptance, for specified duration(s).

C. Contractor acknowledges that there is wildlife on the Project site. Take all necessary measures to ensure that all such wildlife is protected from execution of the work. Prohibit hunting of any sort.

D. Investigation Equipment: Site investigations and field work may require the use of a stepladder and/or other investigative equipment (measuring tapes, flashlights, screwdrivers, etc.). Contractors and A/E firms shall provide their own stepladders and/or investigative equipment. The stepladders shall be Type 1 (industrial) or Type II (commercial).

E. Operating Equipment: Do not turn off, or adjust any equipment without prior authorization from Plant Division. Work carefully around rotating equipment. Loosely fitting clothes (neckties, dangling jewelry, etc.) shall not be worn when near rotating equipment. Long hair shall be secured. Some equipment may start automatically. Take care when working around this equipment. (NOTE: It may become necessary to implement appropriate lock-out, tag-out procedures to control hazardous energy sources to ensure that personnel do not activate equipment during investigation, servicing, or maintenance).

F. Mechanical/Electrical Rooms: Obtain authorization from the Contracting Officer's Technical Representative (COTR) prior to working in electrical and/or mechanical rooms. Lock rooms after use. Do not operate any valves, switches, or breakers without prior approval from the COTR. Adhere to all OSHA Lock-Out, Tag-Out Regulations (29 CFR 1910.147).

G. Transmitters: Do not use transmitters without prior written approval by the COTR.

1.24 CONCRETE WASTE AREA

A. Designate an area approved by COTR where surplus mortar and concrete will be placed, including clean-out from ready-mix trucks. Configure area such that such surplus materials are not displaced by weather. Prohibit disposal of surplus concrete or mortar in any other areas. Remove all surplus concrete and mortar from the Project site before completion.

1.25 SAFETY EQUIPMENT FOR GOVERNMENT PERSONNEL

A. Provide safety equipment and devices needed by Government personnel to inspect the work.

1.26 KEY CONTRACTOR AND SUBCONTRACTORS PERSONNEL

A. Submit to the COTR and the Government Fire Chief a list of the key personnel of the Contractor and Subcontractors (including assigned responsibilities, addresses and telephone numbers) for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01610

DELIVERY, HANDLING AND STORAGE: MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 JOB CONDITIONS

A. Accomplish Work to avoid damage to property.

B. Clean debris from streets and walks.

C. Provide fire protection.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY

A. In accordance with manufacturer's recommendation.

B. In original labeled containers.

C. Configure order to venders providing materials and equipment to ensure that packaging indicates qualifications or materials contained therein. This may include UL labels, ANSI Standards, ASTM and labels of other agencies and organizations listed in Specifications.

D. Contractor responsible for acceptance at site.

E. Schedule deliveries in accordance with the Equipment Delivery Schedule required by Section 01340.

F. Require Material Safety Data Sheets (MSDS) to be delivered with pertinent equipment and materials.

G. Inspect items for damage upon delivery, reorder as required to avoid delays.

H. Provide copy of MSDS to Government immediately upon delivery.

3.02 PRODUCT HANDLING AND STORAGE

A. Use methods to avoid damage to item or structure.

B. Protect weather fragile items from weather damage.

C. Store to allow air circulation.

D. Store only in authorized areas on site.

E. Replace or repair damaged items.

F. Protect installed items as required until final completion.

G. Uncrate, assemble, if required, and remove debris.

H. When off-site storage is authorized, perform rehandling to move items to Project site at no added cost.

I. All material must be stored in the laydown area.

J. The Contractor shall not store any material in the existing building.

3.03 CLEANUP

A. Remove excess materials from site.

B. Turn over to Government, excess materials scheduled to remain.

C. Restore site storage areas to original condition or as directed by COTR.

END OF SECTION

SECTION 01640

SUBSTITUTIONS PRIOR TO OFFERING

PART 1 - GENERAL

1.01 PRODUCT SELECTION - GENERAL

A. Certain types of products are described in Project Manual by means of trade names, catalog numbers and/or manufacturer's names. This is not intended to exclude from consideration other products which may be capable of accomplishing purpose Indicated.

B. Other types of products may be considered acceptable to COTR in place of those specified.

C. Listing of a manufacturer implies acceptance of them only as supplier of a product which complies with specified item.
   1. See Section 01340 for definition of Base and Optional manufacturers.

D. No substitution permitted after execution of Contract, except as allowed in Section 01641.

E. Conditional offers and voluntary alternates will not be considered.

1.02 REQUESTS FOR SUBSTITUTION

A. Only written requests with complete data for evaluation will be considered. Submit 3 copies of SUBSTITUTION FORM (OFFER OPTION) at the end of this section.

B. In making request for substitution, Contractor represents that it and all pertinent entities in Contractor organization:
   1. Have personally investigated proposed product or method, and have determined that it is equal or superior in all respects to that specified, and that it will perform intended function.
   2. Will provide same warranty for substitute item as for product or method specified.
   3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.
   4. Waive all claims for additional costs or time related to substitution which subsequently become apparent.
   5. Will pay all redesign by Government and other costs

caused by substitution.
6. Acknowledge acceptance of these provisions in request.

C. For offering purposes, base all offers on materials, equipment and procedures specified or approved by amendment.

D. Amendment listing approved substitutions will be distributed to all prospective offerers.

E. No verbal or written approvals other than by amendment will be valid.

F. See specific Specification Sections for other requirements for substitutions.

G. Submit substitution requests to COTR at least 14 calendar days prior to bid date. Substitution requests received less than 14 calendar days prior to bid date will not be considered.

1.03 SUBSTITUTION PRIOR TO OFFERING REQUEST

A. Contractor, as offerer, shall cause supplier to submit complete data substantiating compliance of proposed substitution with Contract Documents.

B. For products: Contractor shall submit:
1. Product identification, including manufacturer's name.
2. Manufacturer's literature, marked to indicate specific model, type, size, and options to be considered:
a. Product description.
b. Performance and test data.
c. Reference standards.
d. Difference in power demand, air quantities, etc.
e. Dimensional differences from specified unit.
3. Full size samples if requested.
4. Government reserves right to retain sample until physical units are installed on Project for comparison purposes.
5. Requester pay all costs of furnishing and return of samples.
6. Government is not responsible for loss of, or damage to, samples.
7. Name and address of at least two similar projects and name of representative Government can contact; to discuss product, installation, and field performance data.

C. For construction methods: Contractor shall submit:
1. Detailed description of proposed method.

2. Illustrate with drawings.

D. Contractor shall submit an itemized comparison of proposed substitute to specified item.

E. Contractor shall identify any change in relation to separate contracts, if applicable.

1.04 REJECTION OF SUBSTITUTIONS

A. Substitutions will not be considered if:
1. They are not submitted in accordance with this document.
2. Acceptance will require substantial revision of Contract Documents, or building spaces.
3. Request for substitution does not indicate specific item for which request is submitted.
4. Request form is not properly executed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SUBSTITUTION REQUEST (OFFER PERIOD)

PROJECT: _____

PROJECT NUMBER: _____

TO: COTR

FROM: _____
_____
_____

ABOVE FIRM HEREBY REQUESTS ACCEPTANCE OF FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORDANCE WITH PROVISIONS OF CONTRACT DOCUMENTS.

SPECIFIED PRODUCT OR SYSTEM:

Substitution request for: _____
Specification Section Number: _____
Article(s)/Paragraph(s): _____

SUPPORTING DATA:

Product Data for proposed substitution in accordance with requirements of Section 01640.

Sample is attached: Yes ___ No ___
Sample will be sent if requested: Yes ___ No ___

QUALITY COMPARISON:

	SPECIFIED PRODUCT	PROPOSED SUBSTITUTION
Name, brand:	_____	_____
Catalog No.:	_____	_____
Manufacturer:	_____	_____
Variations:	_____	_____

Maintenance Service Available: Yes ___ No ___
If yes, location: _____
Spare Parts Source: _____

List minimum of 5 previous installations giving data regarding projects on which proposed substitution was used:

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

REASON FOR NOT GIVING PRIORITY TO SPECIFIED ITEMS:

_____
_____
_____
_____
_____
_____

EFFECT OF SUBSTITUTION:

Proposed substitution affects other parts of Work: Yes __ No __
(If yes, explain) _____
_____
_____
_____

Substitution requires dimensional revision or redesign of structure or Mechanical and Electrical Work: Yes ___ No ___
(If yes, explain) _____
_____
_____
_____

STATEMENT OF CONFORMANCE OF PROPOSED
SUBSTITUTION TO CONTRACT REQUIREMENTS:

I/we have personally investigated the proposed substitution.
I/we believe that it is equal or superior in all respects to specified product, except as stated above;
will provide same warranty as specified;
have included complete cost data and implications of substitution;
will pay redesign and special inspection costs caused by use of this product;
will pay additional costs to other Contractors caused by substitution;
will coordinate incorporation of proposed substitution in Work;
will modify other parts of Work as may be needed,
to make all parts of Work complete and functioning;
waive future claims for added cost to Contractor caused by substitution.

Comments: _____
_____
_____
_____

Firm: _____
Date: _____
By: _____
Position: _____

END OF SUBSTITUTION REQUEST

SECTION 01641

PRODUCT OPTIONS AND SUBSTITUTIONS AFTER EXECUTION OF CONTRACT

PART 1 - GENERAL

1.01 PRODUCT SELECTION - GENERAL

A. Certain types of products are described in Project Manual by means of trade names, catalog numbers and/or manufacturer's names. This is not intended to exclude from consideration other products which may be capable of accomplishing purpose Indicated.

B. Other types of products may be considered acceptable to Government in place of those specified.

C. Listing of a manufacturer implies acceptance of them only as supplier of a product which complies with specified item.
   1. See Section 01340 for definition of Base and Optional manufacturers.

D. Government reserves right to require substitutions to comply colorwise and patternwise with base specified items.

E. No substitution permitted after execution of Contract, except as allowed by Change Order.

1.02 CONTRACTOR'S OPTIONS

A. For products specified only by reference standards, use any product meeting standards.

B. For products specified by naming several products or manufacturers, use any product or manufacturer named.

C. For products specified by naming one manufacturer and product and several optional manufacturers or products, select any named product and manufacturer which meets all specification criteria.
   1. Contract Documents are based on use of base specified manufacturer.
   2. By using an optional manufacturer or product, Contractor represents that Contractor will be responsible for all adjustments to fit product to the Work and for providing all additional Work, equipment, and services required by use of product, including Work by separate contractors or individuals, at no additional cost.

1.03 SUBSTITUTION AFTER EXECUTION OF CONTRACT

A. No substitution will be considered after execution of Contract except for non-availability of specified item due to:
   1. Strikes.
   2. Lockouts.
   3. Bankruptcy.
   4. Discontinuance of production.
   5. Proven shortage.
   6. Similar occurrences.

B. Notify COTR, in writing, with substantiating data as soon as non-availability becomes apparent.

C. Notify in time to avoid delay in construction.

D. Provide submittal data for substitutions in accordance with Contract Documents.

1.04 REQUESTS FOR SUBSTITUTION

A. Only written requests with complete data for evaluation will be considered.
   1. Submit evaluation data with copy of SUBSTITUTION FORM (POST AWARD) at the end of this section.

B. In making request for substitution, or in using an approved substitute item, Contractor represents that it and all pertinent entities in the Contractor organization:
   1. Have personally investigated proposed product or method, and have determined that it is equal or superior in all respects to that specified, and that it will perform intended function.
   2. Will provide same warranty for substitute item as for product or method specified.
   3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.
   4. Waive all claims for additional costs or time related to substitution which subsequently become apparent.
   5. Will pay all Government's redesign cost and other costs caused by substitution.
   6. Acknowledge acceptance of these provisions in request.

C. Sign request in space provided on form acknowledging acceptance of its terms.

D. No approvals other than by Change Order will be valid.

E. Submit to COTR.

1.05 SUBSTITUTION DATA

A. Submit complete data substantiating compliance of proposed substitution with Contract Documents.

B. For products: Contractor shall submit:
   1. Product identification, including manufacturer's name.
   2. Manufacturer's literature, marked to indicate specific model, type, size, and options to be considered:
      a. Product description.
      b. Performance and test data.
      c. Reference standards.
      d. Difference in power demand, air quantities, etc.
      e. Dimensional differences from specified unit.
   3. Full size samples if requested.
   4. Government reserves right to retain sample until physical units are installed on Project for comparison purposes.
   5. Requester pay all costs of furnishing and return of samples.
   6. Government is not responsible for loss of, or damage to, samples.
   7. Name and address of at least two similar projects and name of representative for each project that Government can contact; to discuss product, installation, and field performance data.

C. For construction methods: Contractor shall submit:
   1. Detailed description of proposed method.
   2. Illustrate with drawings.

D. Contractor shall submit an itemized comparison of proposed substitute to specified item.

E. Contractor shall submit data relating to potential changes in construction schedule, with Contractor warranty that Contract Time shall not be affected.

F. Contractor shall identify any change in relation to separate contracts.

1.06 REJECTION OF SUBSTITUTIONS

A. Substitutions will not be considered if:
   1. They are not submitted in accordance with this Section.
   2. Acceptance will require substantial revision of Contract Documents, or building spaces.

3. Request for substitution does not indicate specific item for which request is submitted.
4. Request form is not properly executed.
5. Acceptance of manufacturer, supplier, Subcontractor or other entity within Contractor organization is not properly furnished by Contractor.

1.07 SUBMITTALS

A. Shop drawings:
1. For substitutions in construction methods, if any.

B. Product data:
1. For product substitutions, if any.

C. Samples:
1. For product substitutions, if any and if requested by COTR.

D. Project information:
1. Substitution request form accompanied by data specified, for each substitution, if any.

E. Contract closeout information:
1. Information for substitution, if any, as specified for work replaced by the substitution.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SUBSTITUTION REQUEST (POST AWARD)

PROJECT: _____

PROJECT NUMBER: _____

TO: COTR

FROM: _____
_____
_____

ABOVE FIRM HEREBY REQUESTS ACCEPTANCE OF FOLLOWING PRODUCT OR SYSTEMS AS A SUBSTITUTION IN ACCORDANCE WITH PROVISIONS OF CONTRACT DOCUMENTS.

SPECIFIED PRODUCT OR SYSTEM:

Substitution request for: _____
Specification Section Number: _____
Article(s)/Paragraph(s): _____

SUPPORTING DATA:

Product Data for proposed substitution in accordance with requirements of Section 01641.

Sample is attached: Yes ___ No ___
Sample will be sent if requested: Yes ___ No ___

QUALITY COMPARISON:

	SPECIFIED PRODUCT	PROPOSED SUBSTITUTION
Name, brand:	_____	_____
Catalog No.:	_____	_____
Manufacturer:	_____	_____
Variations:	_____	_____
Unit Cost:	_____	_____

Maintenance Service Available: Yes ___ No ___
If yes, location: _____
Spare Parts Source: _____

List minimum of 5 previous installations giving data regarding projects on which proposed substitution was used:

Project: _____
Address: _____
COTR: _____
General Contractor: _____

Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

Project: _____
Address: _____
COTR: _____
General Contractor: _____
Date Installed: _____
Dollar Value this Work: $_____

REASON FOR NOT GIVING PRIORITY TO SPECIFIED ITEMS:

_____
_____
_____
_____
_____
_____

EFFECT OF SUBSTITUTION:

Proposed substitution affects other parts of Work: Yes __ No __
(If yes, explain) _____
_____
_____
_____

Substitution requires dimensional revision or redesign of structure or Mechanical and Electrical Work: Yes ___ No ___
(If yes, explain) _____
_____
_____

STATEMENT OF CONFORMANCE OF PROPOSED SUBSTITUTION TO CONTRACT REQUIREMENTS:

I/we have personally investigated the proposed substitution.
I/we believe that it is equal or superior in all respects to specified product, except as stated above;
will provide same warranty as specified;
have included complete cost data and implications of substitution;
will pay redesign costs and special inspection costs caused by use of this product;
will pay additional costs to other contractors caused by substitution;
will coordinate incorporation of proposed substitution in Work;
will modify other parts of Work as may be needed, to make all parts of Work complete and functioning;
waive future claims for added cost to Contractor caused by substitution.

List of Attachments: _____

Comments: _____
_____
_____
_____

Requested by:
Contractor:_____
Date: _____
By: _____
Position: _____

COTR/Engineer Recommendation

__ Recommend
__ Do not recommend
__ Need more information

Comments: _____
_____
_____
_____

Firm: _____
Date: _____
By: _____
Position: _____

COTR Recommendation

__ Recommend, incorporate substitution into Change Order for COTR acceptance
__ Do not recommend
__ Need more information

Comments: _____
_____
_____
_____

Firm: _____
Date: _____
By: _____
Position: _____

END OF SUBSTITUTION REQUEST

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop Drawings: Not required for COTR review.

B. Product Data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project Information: Not required for COTR review.

E. Contract Closeout Information:
1. List of all items to be completed or corrected.
2. Contractor's Notice and Certification of Completion. Form is attached at end of this section.
3. Certificates of Government authorities.
4. Consent of surety.
5. Closeout submittals required by other Sections.
6. Certificate from licensed surveyor verifying Contractor's conformance to elevations, locations, grade and site work to contours Indicated.
7. Coordination drawings.
8. Evidence of payments and release or waiver of liens in triplicate.
9. Final application for payment, including Contractor's release of claims.
10. List of Subcontractors and equipment suppliers. Include:
a. Company name.
b. Address.
c. Telephone number.
d. Representative's name.
11. Operations and maintenance manuals.

1.02 FOR COMPLETION

A. Obtain evidence of compliance with requirements of governing authorities:
1. Certificates of inspection of:
a. Mechanical.
b. Electrical.
c. Plumbing.
d. Fire protection systems.
e. Elevators.
2. Other authorities having jurisdiction.

B. Comply with all requirements of Section 01400, Aticle 1.12 Completion Inspection. In addition, submit Notice and Certification of Completion. Utilize form at end of this section. Certify that:
   1. Work performed under this Contract has been reviewed and considered to be complete, to be ready for use by Government, in accordance with the Contract Documents, so Government can occupy or utilize Project for use which it is intended, and is ready for review.
   2. Work has been reviewed and inspected for compliance with the Contract Documents.
   3. Equipment and systems have been tested and are operating in accordance with Contract Documents.
   4. Contract closeout requirements have been completed and submitted.

G. Preserve monuments and property lines. If displaced, reset at Contractor's expense.

H. Redo work found not in accordance with Contract Documents at Contractor's expense.

I. Government will make final walk through within reasonable period after receipt of notice that all items listed as incomplete or requiring corrective work have been completed.

J. Remedy any remaining deficiencies or incomplete Work.

K. Government will issue Certificate of Acceptance when all outstanding items have been completed.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

CONTRACTOR'S NOTICE AND CERTIFICATION OF COMPLETION

PROJECT:
CONTRACT FOR:
TO COTR:
CONTRACT DATE:

This is to certify that I am an authorized official of, and have been properly authorized by said firm or corporation to certify following: I know of my own personal knowledge, and do hereby certify on behalf of Contractor that the Work has been reviewed and inspected for compliance with Contract Documents, that it has been completed in accordance with Contract Documents, that all equipment and systems have been tested and are operating as required by the Contract Documents, that all Contract closeout requirements have been completed and submitted.

Attached are three (3) copies of the following documents, which are required prior to final payment:

[ ] Certificates of inspections indicating compliance with requirements of Government authorities have been obtained, and are attached hereto.

[ ] A list of items to be completed or corrected, prepared by the Contractor is attached, hereto. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

[ ] Certificate of site conformance by licensed surveyor.

CONTRACTOR: _____
BY: _____
TITLE: _____
DATE: _____

Subscribed and sworn to me this
____ day of _____, 19____.
NOTARY PUBLIC:
My commission expires:

DISTRIBUTION: [ ] COTR

SECTION 01710

CLEANING

PART 1 - GENERAL

1.01 FIRE PROTECTION

A. Store volatile waste in covered metal containers.

B. Remove volatile waste from Project daily.

1.02 POLLUTION CONTROL

A. Conduct cleanup and disposal operations to comply with local ordinances and anti-pollution laws.

B. Do not burn or bury rubbish and waste on site.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS

A. Use materials recommended by manufacturers of surfaces to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

A. Clean all items installed under this Contract.
   1. Leave free of stains, dirt, dust, damage, or defects prior to Acceptance.
   2. Sweep, vacuum, and wash the Work. Polish wall surfaces, floors, windows, hardware, mirrors, lighting fixtures, equipment, ductwork, piping, control panels, etc.
   3. Replace damaged or defaced items not acceptable to Government, to Government's satisfaction.

B. For cleanroom areas, refer to Section 01021.

3.02 FINAL CLEANING

A. Use experienced workmen or professional cleaners for final cleaning.

B. At completion of construction, but prior to Acceptance, perform final cleaning.

C. Remove dirt, dust, stains, temporary labels, and foreign materials.

D. Repair, patch, and touch-up marred areas to match adjacent undamaged finished damaged by Contractor.

E. Broom clean paved surfaces; rake clean other surfaces of grounds; vacuum, mop, and polish floors.

F. Replace HVAC filters if units were operated during construction.

G. Clean ducts, blowers, and coils if HVAC units were operated during construction.

H. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from interior and exterior surfaces of fixtures, hardware, and equipment.

I. Clean all glass, aluminum, stainless steel, plastic, rubber and plated surfaces.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definitions:
1. Documents required for construction: Complete set of all documents required by Contract Documents, including but not limited to:
a. Contract Drawings.
b. Project Manual/Specifications.
c. Addenda.
d. Shop Drawings.
e. Product Data.
f. Samples and mock-ups.
g. Project Information.
h. Change orders.
i. Directives, clarifications, interpretations, etc.
j. Field test records.
k. Warranties.
2. Field documents: Complete set of all documents required for construction.
a. Used for construction of Project.
b. Contract Drawings in form of prints.
3. Periodic Update Documents: Complete separate set of all documents required for construction with exception of samples and mock-ups.
a. Do not use for construction of Project.
b. Contract Drawings in form of clean prints.
4. Project Record Documents: Complete set of all documents required for construction with exception of samples and mock-ups.
a. Do not use for construction of Project.
b. Provide Contract Drawings in form of correctable, reproducible electrostatic process mylars.

1.02 SUBMITTALS

A. Shop Drawings: Not required for COTR review.

B. Product Data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project Information: Not required for COTR review.

E. Contract Closeout Information:
1. Project Record Documents; at completion of Work,

turnover to COTR with letter of transmittal.
a. Submit Record Documents in containers used for Periodic Update Documents.

2. Provide Transmittal Letter containing:
a. Date.
b. Project title.
c. Contractor's name and address.
d. Title and number of each Project Record Document.
e. Certification that Project Record Documents submitted are complete, accurate and reflect actual construction of Work.
f. COTR's signature indicating receipt and acceptance of Project Record Documents.

3. As-built record of materials.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 POSTING PRIOR TO CONSTRUCTION

A. After Contract is executed, but prior to start of construction, obtain Contract Drawings and Specifications which will be used for Field Documents and Periodic Update Documents.

B. Obtain copies of all addenda and post addenda in all above documents.

3.02 FIELD DOCUMENTS

A. Maintain minimum of one copy at Project site.

B. Label each document "FIELD".

C. These documents will be used for construction of Project.

D. Make documents available at all times for review by Government and authorities having jurisdiction.

3.03 PERIODIC UPDATE DOCUMENTS

A. Maintain one copy at Project site.

B. Label each document "PERIODIC UPDATE".

C. Do not use these documents for construction purposes.

D. Make documents available at all times for review by

Government and authorities having jurisdiction.

E. Maintain in clean, dry, legible condition.

F. Maintain Contract Drawings in stackable, enclosed file drawers designed to hold drawings horizontally.
   1. Provide index of contents of each file drawer on outside of drawer.

G. Maintain all other Periodic Update Documents in stackable, enclosed file boxes designed to hold specific type of document.
   1. Provide index of contents of each box on outside of box.

3.04 POSTING AND UPDATING OF PERIODIC UPDATE DOCUMENTS

A. Post and update on weekly basis. Contractor acknowledges that progress payments may be affected if periodic update documents are found not to be up-to-date.

B. Contract drawings: The Contractor shall revise two sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. These working as-built marked drawings shall be kept current on a weekly basis and at least one set shall be available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. Final as-built drawings shall be prepared after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working as-built marked prints and final as-built drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final as-built drawings as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimate cost of maintaining the as-built drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of updated drawings. The working and final as-built drawings shall show, but shall not be limited to the following information:
   1. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location

of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, the as-build drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

2. The location and dimensions of any changes within the building structure.
3. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.
4. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.
5. The topography, invert, elevations and grades of drainage installed or affected as part of the project construction.
6. Changes or modifications which result from the final inspection.
7. Where contract drawings or specifications present option, only the option selected for construction shall be shown on the final as-built prints.
8. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, the Contractor shall furnish a contour map of the final borrow pit/spoil area elevations.
9. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.
10. Modifications (change order price shall include the Contractor's cost to change working and final as-built drawings to reflect modifications) in compliance with the following procedures:
    a. Directions in the modification for posting descriptive changes shall be followed.
    b. A Modification Circle shall be placed at the location of each deletion.
    c. For new details or sections which are added to a drawing, a Modification Circle shall be placed by the detail or section title.
    d. Before minor changes, a Modification circle shall be placed by the area changed on the drawing (each location).

e. For major changes to a drawing, a Modification Circle shall be placed by the title of the affected plan, section, or detail at each location.
f. For changes to schedules or drawings, a Modification Circle shall be placed either by the schedule heading or by the change in the schedule.
g. The Modification Circle size shall be 12.7 mm diameter unless the area where the circle is to be placed is crowded. Smaller size circle shall be used for crowded areas.

C. Specifications: Type on each section to record all changes including but not limited to:
1. Addenda.
2. Change order or field order.
3. Clarifications, interpretations, directives, etc.
4. Bind added Sections.
5. Indicate manufacturer, makes, and models used for actual construction of Project.

D. Do not conceal work for which information must be recorded until all required information is recorded on Periodic Update Documents.

E. Any work concealed prior to recording of required information must be uncovered by Contractor.

F. Once all required information is recorded on Periodic Update Documents, restore Work at Contractor's expense.

3.05 PRODUCTION OF PROJECT RECORD DOCUMENTS

A. Utilize set of correctable, mylar drawings.
1. Provided by Government to Contractor at start of construction.

B. Label each document "PROJECT RECORD".

C. Have skilled draftsperson transfer all changes, corrections, entries, etc., from Periodic Update Documents to Project Record Documents.

D. All other Periodic Update Documents may be used for Project Record Documents provided they are in satisfactory condition.

E. Replace any Periodic Update Document, found by Government to be in unsatisfactory condition.
1. Transfer all recorded changes from original to replacement copy.

3.06 AS-BUILT RECORD OF MATERIALS

A. Prior to completion of the Contract, the Contractor shall furnish an "as-built" record of materials used in the construction. Submission of this data is a condition for final payment under the Contract. Where several manufacturers' brands, types, or classes of the item listed have been used in the project, the specific areas where each item was used shall be designated. Designations shall be keyed to the areas and spaces depicted on the Contract Drawings.

END OF SECTION

SECTION 01740

WARRANTIES AND GUARANTEES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide written warranties/guarantees for products and installations Indicated.

B. Provide warranties/guarantees for period(s) indicated.

C. Provide manufacturer's warranties/guarantees for products.
   1. Where manufacturer's standard warranties/guarantees expire before expiration date required by Contract Documents, obtain and pay for extensions, as part of Contract Price.

D. Provide all warranties/guarantees indicated prior to Acceptance. Period of warranty and/or guarantee shall commence on the date of complete Project Acceptance.

1.02 SUBMITTALS

A. Shop Drawings: Not required for COTR review.

B. Product Data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project Information: Not required for COTR review.

E. Contract Closeout Information:
   1. Provide transmittal letter containing:
      a. Date.
      b. Project title.
      c. Contractor's name and address.
      d. Title and number of warranties/guarantees.
      e. Certification that warranties/guarantees submitted are complete and accurate.
   2. Furnish copy of transmittal letter and warranties/ guarantees to COTR.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 WARRANTIES/GUARANTEES

A. Assemble approved warranties/guarantees required by other Sections.

B. Bind or assemble in 3-ring binders, completely indexed by specification Section, with each warranty/guarantee clearly labeled.

C. Identify each warranty/guarantee in manner consistent with names and identification numbers used in Contract Documents.

D. Neatly type or draft all warranties/guarantees not furnished in printed form.

E. Organize warranties/guarantees for ease of reference.

F. Provide 4 copies of warranties/guarantees.

END OF SECTION

SECTION 01900

METRIC STANDARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The metric system the United States Government has adopted is the International System of Units, abbreviated SI, from the French "Le Systems International d'Unites", the definitive reference on the SI was published in 1991 by the International Bureau of Weights and Measures (BIPM).

1.02 BASIC METRIC STANDARDS

A. Definition of SI Units:

1. There are six metric SI base units of measurement used in the Contract Documents. The six metric base units are:

Quantity	Unit	Symbol
Unit of length *	meter	m
Unit of mass (weight)	kilogram	kg
Unit of time	second	s
Unit of electric current	ampere	A
Unit of thermodynamic temperature **	kelvin **	K
Unit of luminous intensity	candela	cd

* The term "length" includes all linear measurements - length, width, height, thickness, diameter and circumference.

** Celsius temperature (øC) is more commonly used than kelvin (K), but both have the same temperature gradients. Celsius temperature is simply 273.15 degrees warmer than kelvin, which begins at absolute zero. For design and construction use Celsius.

2. Use only two decimal multiples and submultiples of base SI units in the Work. They are the prefixes kilo (1000) and milli (0.001). For example, kilogram (kg) and millimeter (mm).
3. The following derived metric units will be used throughout the Contract Documents and execution of the Work:

Quantity	Name	Symbol
Length	millimeter	mm
Area	square millimeter	mm2
	square meter	m2
Volume	cubic millimeter	mm3
	cubic meter	m3

4. Use additional derived metric units for specific engineering disciplines as defined in the "Engineering Data".
5. The following list of units is outside of SI but may be used with the International System:

Name	Symbol	Value in SI Units
Liter	L	100 cm3
Ton	t	1000 kg
Degree	deg	ã/180 rad
Minute	'	(1/60) deg
Second	"	(1/60)'
Hour	h	h
Second	s	s

6. Do not use SI Supplemental units in design and construction of the Work.

B. Basic rules for writing metric symbols and names:
1. Print unit symbols in upright type and in lower case except for the liter (L) or unless the unit name is derived from a proper name, then the first letter of the symbol is in upper case. (i.e., millimeter = mm; newton = N).
2. Print unit names in lower case, even those derived from a proper name. (i.e., kelvin = K).
3. Do not alter unit symbols in the plural, but unit names may be written in the plural. (i.e., 100 kilograms = 100 kg not 100 kgs).
4. Do not follow unit symbols by a period, except at the end of a sentence. (i.e., write 100 mm not 100 mm.)
5. Always leave a space between a numeral and a symbol. (i.e., write 100 mm not 100mm).
6. Do not leave a space between a unit symbol and its

decimal prefix. (i.e., write millimeter not milli-meter and kg not k g).

7. Do not use a degree mark with kelvin temperature (i.e., 293 K), use "deg" with Celsius temperature. (i.e., 20 degC).
8. For technical writing, use symbols in conjunction with numerals (i.e., the total area is 100 m2). Write out unit names if numerals are not used. (i.e., area is expressed in square meters).
   a. Indicate exponent as full sized number immediately after the symbol.
9. Do not mix names and symbols. (i.e., write kilograms or kg not k-grams).
10. Always use decimals, not fractions. (i.e., write 0.75 g not 3/4 g).
11. Use a zero before the decimal marker for values less than one, in the United States the decimal marker is a dot. (i.e., write 0.45 g not .45 g).
12. Always express millimeters as whole numbers (i.e., 1200) and express meters as decimal numbers which may be taken to 3 places (i.e., 2.500).
13. Use spaces in lieu of commas to separate blocks of three digits for any number over four digits. Four digit numbers do not require a space. (i.e., write 10 500 mm not 10,500 mm, but write 1500 mm).

C. Conversion Standards:
1. Hard metric refers to products manufactured to round, nominal metric dimensions such as 300, 600, and 1200. The product must be physically modified in order to be efficiently utilized in a metric project. "Hard conversion" is a rounded, rationalized metric number that is easy to work with. Make maximum use of domestically produced, hard metric products when available, or when products are custom made.
2. For example: Rectangular metal ductwork is a custom product. Drawings will indicate hard metric sizes such as 300 x 600 mm.
3. Soft metric means no physical change. Products are metric in name only, having been "relabeled" in metric dimensions. Soft metric is mathematically converting an inch-pound measurement to its exact metric equivalent and then rounding to the highest degree possible to obtain the largest, cleanest, most easily constructable numbers.
4. When converting from inch-pound units to metric units, always convert to inches before converting to metric units and rounding. For example, 10 feet, 3 inches = 123 inches x 25.4 mm = 3124.2 mm, rounded to 3124 mm. It is preferable to round to increments of 1000, 100 or 10. If 3200 mm is considered excessive, round to

3120 mm or 3150 mm, unless item will no longer fit in the Work.

5. Round to the nonoffending direction (always left to right). For example, 1990 BOCA 514.7 requires 36 inches (914 mm) of unobstructed width for pedestrian walkways. The left most digit is 9, representing 900 mm which would offend the code. The nonoffending direction is higher, so round to 1000 mm.
6. General Metric Conversion Factors for Area, Length, Volume and Mass:

Quantity	From Inch-Pound Units	To SI units	Multiply By
Length	foot (ft)	m	0.304 8
		mm	304.8
	inch (in)	mm	25.4
Area	square foot (ft2)	m2	0.092 903 04
	square inch (in2)	mm2	645.16
Volume	cubic foot (ft3)	m3	0.028 316 8
	cubic foot (ft3)	L(1000 cm3)	28 316.85
	gallon (gal)	L(1000 cm3)	3.785 41
	cubic inch (in3)	mm3	16 386.064
Mass	pound (lb)	kg	0.453 592

1.03 ENGINEERING DATA

A. As a general rule produce all engineering calculations in metric. Because some of the calculation software is not available in metric, calculations may be executed in inch-pound units and the relevant output data converted to metric. This is particularly true for structural calculations and electrical short circuit and voltage drop calculations.

B. Civil Engineering:
   1. General metric rules for Civil Engineering:
      a. Express slope in nondimensional ratios. The vertical component is Indicated first and then the horizontal. For example, a rise of one meter in four meters is expressed as 1:4. The units that are compared should be the same (meters to meters, millimeters to millimeters).
      b. For slopes less than 45 deg, the vertical component should be unitary (i.e., 1:20). For slopes over 45 deg, the horizontal component should be unitary (i.e., 5:1).
      c. Measure plane angles in surveying (cartography) in

degrees (deg), minutes (') and seconds (") rather than the metric radian.

d. Contour intervals will be every half-meter (0.500 m or 500 mm).

e. Express elevation references in meters.

2. Use these metric units for Civil Engineering:

Quantity	Unit	Symbol
Length	kilometer	km
Area	hectare (10 000 m2)	ha
	square kilometer	km2
Mass (weight)	metric ton (1000 kg)	t
Rate of flow	liters/second	L/s
	cubic meters/second	m3/s

3. Use these Civil Engineering Conversion Factors:

Quantity	From Inch-Pound Units	To SI Units	Multiply By
Area	acre	hectare (ha)	0.404 687
	square yard	square meter (m2)	0.836 127 36
Length	mile	kilometer (km)	1.609 344
	yard	meter (m)	0.914 4
Volume	cubic yard	cubic meter (m3)	0.764 555
	acre foot	cubic meter (m3)	1 233.49
Rate of Flow	gallons/minute	liters/second (L/s)	0.063 090
	cubic feet/second	cubic meters/second (m3/s)	0.028 316 8

C. Structural Engineering:

1. General metric rules for structural engineering:

a. Use separate units for mass and force.

b. Use the kilogram (kg) as the base unit for mass, which is the unit quantity of matter independent of gravity.

c. Use the newton (N) as the derived unit for force (mass times acceleration, or kgm/s2). Do not use the unit "kilogram- force" (kgf).

d. Do not use the joule to designate torque or moment, use newton meter (Nm).

e. Use the pascal (Pa) as the unit for pressure and stress. The term "bar" is not a metric unit and should not be used.

f. Structural calculations should be Indicated in MPa or kPa.

2. Use these metric units for structural engineering:

Quantity	Unit	Symbol
Mass	metric ton (1000 kg)	t
Mass/unit length	kilogram/meter	kg/m
Mass/unit area	kilograms/sq meter	kg/m2
Mass density	Kilograms/cubic meter	kg/m3
Force	newton	N
	kilonewton	kN
Force/unit length	newtons/meter	N/m
	kilonewtons/meter	kN/m
Pressure, stress, modulus of elasticity	pascal	Pa
	kilopascal	kPa
Bending moment, torque moment of force	newton meter	Nm
	kilonewton meter	kNm
Moment of mass	kilogram meter	kgm
Moment of inertia	millimeter 4	mm4
Section modulus	cubic millimeters	mm3

3. Use these Structural Engineering Conversion Factors.

Quantity	Units	Units	Multiply By
Mass	kip	metric ton	0.453 592
Mass/unit length	plf	kg/m	1.488 16
Mass/unit area	psf	kg/m2	4.882 43
Mass density	pcf	kg/m3	16.018 5
Force	lb	N	4.448 22
	kip	kN	4.448 22
Force/unit length	plf	N/m	14.593 9
	klf	kN/m	14.593 9
Pressure, stress, modulus of elasticity	psf	Pa	47.880 3
	ksf	kPa	47.880 3
	psi	kPa	6.894 76
	ksi	MPa	6.894 76
Bending moment, torque, moment of force	ft-lb	Nm	1.355 82
	ft-kip	kNm	1.355 82
Moment of mass	lbft	kgm	0.138 255
Moment of inertia	in4	mm4	416 231
Section modulus	in3	mm3	16 387.064

D. Mechanical Engineering:
   1. General metric rules for Mechanical Engineering:
      a. Use the joule (J) as the unit for energy, work and quantity of heat. It is equal to a newton meter (Nm) and a watt second (Ws). It replaces a large number of inch-pound units.

b. Use the watt (W) as both the inch-pound and metric unit for power and heat flow. It replaces horsepower, foot pound-force per hour, Btu per hour, calorie per minute, and ton of refrigeration.
c. Express moisture movement by the terms "vapor permanence" and "vapor permeability".
d. The inch-pound unit "perm" represents the degree of retardation of moisture movement. The lower the value, the greater the retardation.

2. Use these metric units for Mechanical Engineering:

Quantity	Unit	Symbol
Capacity	liter	L
Airflow	meter/second	m/s
Volume flow	cubic meter/second	m3/s
	liter/second	L/s
Temperature	degrees Celsius	degC
Force	newton, kilonewton	N, kN
Pressure	pascal	Pa
	kilopascal	kPa
Energy,work	kilojoule, megajoule	kJ, MJ
Rate of heat flow	watt, kilowatt	W, kW
Heat release	kilowatt per sq meter	kW/m2
Steam flow rate	kilogram per second	kg/s
Heat flux	watts per sq meter	W/m2
Mass density	kilograms per cubic meter	kg/m3
Thermal conductivity	watts per meter kelvin	W/mK
Specific volume	cubic meters per kilogram	m3/kg
Rotational frequency	revolutions per minute	rpm
Heating value, solid	megajoules per kilogram	MJ/kg
Heating value, gas	megajoules per cubic meter	MJ/m3
Permanence	nanogram per second.square meter.pascal	ng/sm2Pa

3. Use these Mechanical Engineering Conversion Factors:

Quantity	From Inch-Pound units	To SI units	Multiply by
Power	ton (refig)	kW	3.517
	hp (electric)	W	745.700
	Bth/h	W	0.293.071
	boiler hp	kW	9.81
Heat flux	Btu/h ft2	W/m2	3.152.481
Rate of heat			

flow	Bth/h	W	0.293 071 1
Thermal conductivity (k value)	Btuin/hft2	W/m K	.1442
Thermal conductance (U value)	Btu/hft2degF	W/m2K	5.678 263
Thermal Resistivity (r value)	hft2degF/Btuin	mK/W	6.933 464
Thermal Resistance (R value)	hft2degF/Btu	m2K/W	0.176 11
Specific heat capacity, specific enthrophy	Btu/lbdegF	kJ/kgK	4.186 8
Specific energy, latent heat	Btu/lb	kJ/kg	2.326
Volume rate of flow	ft3/h	mL/s	7.866
Volume rate of flow	cfm	L/s	0.471 947 4
Velocity, speed	ft/min	m/s	0.00508
	ft/s	m/s	0.3048
Temperature	degF	degC	5/9(degF-32)
Energy, work, quantity of heat	kWh	MJ	3.6
	Btu	J	1.055 056
Rate of flow	gpm	L/s	0.063 1
	gph	ML/s	1.05
Pressure	psi	kPa	6.895
Inch of water		Pa	248.8
Inch of water per 100 FT of pipe		Pa/m	8.163
Foot of water		kPa	2.99
Foot of water per 100 FT of pipe		kPa/m	0.0981
Permanence	Perm	ng/sm2Pa	57.2

E. Electrical Engineering:

1. General metric rules for Electrical Engineering:

a. Use the candela (cd) as the unit for luminous

intensity. It replaces candle and candlepower.

b. Use the lux (lx) as the unit for illuminance. It replaces lumen per square foot and footcandle.

c. Express luminance in candela per square meter (cd/m2). It replaces candela per square foot, footlambert, and lambert.

2. Use these units for Electrical Engineering:

Quantity	Unit	Symbol
Frequency	hertz	Hz
Power	watt, kilowatt	W, kW
Energy	kilowatt hour	kWh
Electric current	ampere	A
Electric potential	volt, kilovolt	V, kV
Resistance	ohm	ohm
Luminous intensity	candela	cd
Luminance	candela per sq meter	cd/m2
Luminous flux	lumen	lm
Illuminance	lux	lx

3. Make no unit value changes for Electrical Engineering except for illuminance and luminance. The units are neither English "inch pound" nor metric, but rather are the same value for each system.

Quantity	IP units	SI units	Value
Power, radiant flux	W	W	1 (same unit)
Frequency	Hz	Hz	1 (same unit)
Electric current	A	A	1 (same unit)
Electric potential	V	V	1 (same unit)
Resistance	ohm	ohm	1 (same unit)
Luminous intensity	cd	cd	1 (same unit)
Luminous flux	lm	lm	1 (same unit)

4. Use these Electrical Engineering Conversion Factors:

Quantity	From Inch-Pound units	To SI units	Multiply by
Luminance	lambert	cd/m2	3 183.01
	cd/ft2	cd/m2	10.753 9
	footlambert	cd/m2	3.426 26
Illuminance	footcandle	lx	10.763 9

1.04 CONSTRUCTION DOCUMENTS

A. Scales:

1. Produce all Drawings with metric drawing scales which are expressed in non-dimensional ratios.
2. There are nine (9) base scales: 1:1 (full size), 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000.
3. Three others have limited usage: 1:2 (half size), 1:25, 1:250.
4. Draw floor plans at 1:100 which is very close to 1/8 IN scale.

B. Dimensioning:
1. Use only unit of measurement on the Drawings for all disciplines except Civil Engineering.
2. Do not use any dual dimensioning, except for soft metric conversions.
3. For Civil Drawings only, state in meters (m), expressed to the third decimal where required.
4. Do not use centimeters for dimensioning.
5. Eliminate the unit symbol on all Drawings. All dimensions are Indicated in millimeters unless specifically noted otherwise by Government.
6. Whole numbers always indicate millimeters; decimal numbers taken to three places always indicate meters.

C. Metric Module:
1. Contract may use a metric module to facilitate drawings and dimensioning. Where modules are used, the recommended basic metric module is 100 mm, which is similar to the 4 inch module used in building construction. The multimodules and submodules, in preferred order, are:

   6000, 3000, 1200, 600, 300, 100, 50, 25, 20, 10 and 5.

D. Specifications:
1. Specification requirements: State the dimensional references in metric, in millimeters (mm), with no dual dimensioning.
2. Use domestically produced hard metric products.

E. Shop Drawings:
1. For shop drawings: Submit all product data and shop drawings using metric units. Dual dimensioning is acceptable on product data. Shop drawings shall be dimensioned in millimeters.

END OF SECTION

SECTION 01980

GENERAL METRIC ABBREVIATIONS

PART 1 - GENERAL

1.01 UNITS OF MEASUREMENT

A (amp)	ampere(s), area
AIC	amps interrupting capacity
AFF	above finish floor
AWG	American Wire Gauge
C	Celsius
cm3	cubic centimeter
cd	candela
cm3/s	cubic centimeter(s) per second
cm	centimeter(s)
cm2	square centimeter(s)
cm/s	centimeter(s) per second
cps	cycle(s) per second
CU	cubic
Db	decibel(s)
Db/m	decibel/meter
DbmV	decibel millivolts
DEG	degree(s) (angular)
øC	degree(s) Celsius
FV	face velocity
g	gram(s)
GA, ga	gage, gauge
GHZ	gigahertz
GR	grains
ha	hectare
HD	head
HR, h	hour(s)
Hz	hertz
J	joule
K	kelvin
k value	thermal conductivity (W/mK)
k	kilo
kg	kilogram(s)
kg/ha	kilogram/hectare
kg/m	kilogram/meter
kg/mm	kilogram/millimeter
kHz	kilohertz

kJ	kilojoule
km	kilometer
km/h	kilometer/hour
kNm	kilonewton meter
kPa	kilopascal(s)
km2	kilogram(s) per square meter
kV	kilovolt(s)
kVA	kilovolt ampere(s)
kVAR	kilovars
kW	kilowatt(s)
kWh	kilowatt-hours
L	liter(s), length
L/h	liters/hour
L/ha	liters/hectare
L/m	liters/meter
L/s	liters/second
LIN	linear, lineal
lm	lumen
Lm	linear meter(s)
L/m	liter(s)/meter
Lpf	liters per flush
L/s	liters/second
lx	lux
M	mega
m	meter
m2	square meter(s)
m3	meters cubed
mA	milliamps
MCM	thousand circular mils
MHz	megahertz
mHz	millihertz
min	minute(s), minimum
m/h	meter(s)/hour
mL	milliliter
m/L	meter(s)/liter
mL/s	milliliter/second
mm	millimeter(s)
MPa	megapascal
m/s	meter(s)/second
MVA	megavoltamperes
N	newton
n	nano (10□&a-50V-9□&a+50V)
Pa	Pascal
PCE	pyrometric cone equivalent
PPM	parts per million
RH	relative humidity

RSI	thermal resistance (m2K/W)
RMS	root mean square
rpm	revolutions per minute
rps	revolutions per second
s	second
SSU	saybolt seconds universal
t	ton
t/ha	tons/hectare
U value	thermal conductance (1 divided by total R value) (W/m2K)
mV	microvolts
V	volt(s), volume, velocity
VAC	volt(s), AC
VDC	volt(s), DC
W	watt(s)
W/m	watts/meter

END OF SECTION

SECTION 05505

UNISTRUT CHANNEL SUPPORT SYSTEM

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Manufacturer shall have been active in metal framing business for at least five years and shall maintain a quality assurance program that will permit manufacturer to submit mill test reports for material furnished to assure that material meets specification criteria.
   1. Specifications for Design of Cold Formed Steel Structural Members: AISI.
   2. Manual of Steel Construction: AISC.
   3. Resistance welding: AWS C1.1-66.
   4. Welding sheet steel in structures: AWS D1.3-80.

B. Design criteria:
   1. Support structure: Arrangement and minimum sizes as indicated, a universal grid system that will provide continuous support channels of spacing indicated in direction noted for each space. For equipment support systems that require higher loadings, see drawings. System to allow attachment of equipment support rails at any point without drilling or welding.
      a. Support channel spacing: 1200 mm OC maximum.
      b. Equipment support rails: Provided with equipment specified in other sections.
   2. Ceiling anchorage: Attach to structure as indicated by direct attachment to structural framing. At concrete floor and roof framing, provide continuous embedded channels (Unistrut P3270) centered at the bottom of each joist and beam.
   3. Loading: Size members, fastenings and anchors to support a concentrated load of 680 kg at any point within support system. Concentrated load is maximum that will be encountered by positioning of equipment at extremities of support system (maximal load configuration).
   4. Safety factor: Provide support structure for a minimum safety factor of 3 based on ultimate strength under static loading conditions. Do not allow structure to deflect more than 1/720 span in either plane (vertical or horizontal) when maximal loading conditions are applied.
   5. Engineering calculations: Structural calculations sealed by professional engineer registered in State of Maryland to verify design.
      a. Based on maximal loading conditions with specified

safety factors for configurations and spacings indicated.

b. Confirm or determine member, fastening and anchor sizes.
   (1) Size anchor bolts for minimum 150 percent of calculated pull-out load.
   (2) Base anchor bolt selection on independent test report results for pull-out strength for project substrate material and conditions.
   (3) Attach copy of independent test report to calculations.

c. Designate and size members where grouped struts are required if single strut member cannot support specified load.

C. Allowable tolerances:
   1. Provide supporting framework plumb and true.
   2. Assure that mounting surfaces of support structure are horizontal within 1 mm in 600 mm and within 1.6 mm in 5400 mm length.
   3. Elevation of one rail mounting surface to other within 1.6 mm in 600 mm length of rails.

1.02 SUBMITTALS

A. Shop drawings:
   1. Indicate plan layout, elevations, fastening details and anchoring methods.
      a. Include model numbers of each component and methods to fit components together.
      b. Show coordination with work specified under other sections.
         (1) Comply with requirements for coordination drawings specified in Section 01042.
         (2) Show UCSS on coordination drawings.
      c. Include and differentiate fabrication and field assembly details, and indicate extent of both.
      d. Provide plans at 1:50 scale and details at 1:4 scale.

B. Product data:
   1. Catalog data: Properties of section, parts details.
   2. Manufacturer's installation instructions.

C. Samples: Not required for COTR review.

D. Project information:
   1. Manufacturer's qualifications.
   2. Manufacturer's quality assurance program description.
   3. Mill test reports.
   4. Certified engineering calculations.

E. Contract closeout information:
    1. Certification by manufacturer that installation complies with manufacturer's requirements.
    2. Address of nearest stocking dealer.

1.03 JOB CONDITIONS

A. Field measurements:
    1. Take field measurements to assure that support system can be installed without interference with structural framing, mechanical systems, plumbing, or other obstructions.
    2. Correct interferences with work of other sections.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Support system:
        a. Base:
            (1) Unistrut.
        b. Optional:
            (1) B-Line Systems.
            (2) Thomas & Betts, Superstrut.
            (3) Hilti.
    2. Neoprene grommet:
        a. Base:
            (1) Technical Manufacturing Corporation (Barry Controls).
    3. Support system manufacturer must have a service office within a 800 km radius of project, which has been functioning with full time personnel for a minimum of 5 years prior to offer date.
    4. Other manufacturers desiring approval comply with Section 01640.

B. Framing material: ASTM-A570/A570M Grade 33 or ASTM-A446/A446M Grade A, Z275.

C. Finish:
    1. Framing members and fittings: Corrosion resistant acrylic enamel paint, electro-deposited and baked-on.
        a. Color: Federal Standard 595 color number 14109 (dark limit V-), Perma-Green.
    2. Embedded application: Galvanized per ASTM-A525, G90.
    3. Hardware: Electrogalvanized per F.S.QQ-Z-325A; Type 1 Class 3.

D. Neoprene grommets:
    1. Barry Controls, Type WB.
        a. I.D.: 10 mm.
        b. Maximum load: 250 N.

E. Anchor bolts: ASTM-A449 or ASTM-A687, high strength.
    1. Sized for minimum 150 percent of pull-out loads calculated by structural engineer.

F. Welding:
    1. Welders: Certified within last 12 months in compliance with American Welding Society (AWS) Code.
    2. Materials and methods: ANSI/AWS D1.1.

PART 3 - EXECUTION

3.01 PREPARATION

A. Embedments:
    1. Coordinate with installers of substrates with embedments for support system anchorage.
        a. Provide embedments in advance of substrate construction.
        b. Verify location and positioning of embedments placed in substrate for accurate anchorage of universal channel support system.

B. Mechanical and electrical systems:
    1. Coordinate with installers of mechanical and electrical systems specified in Divisions 15 and 16, to avoid interference of mechanical and electrical lines, devices, hangers and other components with universal channel support system.

C. Partitions and casework:
    1. Coordinate with installers of partitions and casework to assure accurate interface with universal channel support system.
        a. Fixed partitions: See Division 9 including but not limited to Sections 09110 and 09250.
        b. Panelized Wall System: See Section 10620.

3.02 INSTALLATION

A. Install equipment support structure in accordance with approved shop drawings.

B. Interrupt support system structures along building lines of expansion or vibration control joints.
    1. Provide independent fully supported structures between

expansion or vibration control joints.

C. Provide field cuts of members with oil cooled band saw or rotary blade saw.
   1. Remove oil before installation from members cut by oil cooled band saw.
   2. Remove burrs before installation from edges of members cut by rotary blade saw.
   3. Ease cut edges of members before installation.

D. Weld only joints indicated on drawings for welding.

E. Configure system for maximum demountability and flexibility.

END OF SECTION

SECTION 10270

ACCESS FLOORING (AF)

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Provide system capable of supporting following minimum loads, with no permanent set:
   1. Concentrated load of 455 kg on any 645 mm2 of floor panels, with maximum deflection between pedestals of L/300.
   2. Overturning moment of 113,000 mN.m and axial load of 22,000 N for each pedestal without panels or other supports in place.
   3. Concentrated load of 890 N at center of span for each stringer.
   4. Rolling loads in accordance with Ceilings and Interior System Construction Association (CISCA) "Recommended Test Procedures for Access Floors" for CISCA path A or B that produces the greater top surface deflection:
      a. Wheel 1 rolling load: 455 kg applied for 10 passes with maximum 1 mm deformation.
      b. Wheel 2 rolling load: 303 kg applied for 10,000 passes with maximum 1 mm deformation.
   5. Under floor support structural design shall be stamped by a licensed structural engineer.

B. Tolerances:
   1. Squareness tolerance of plus/minus 0.13 mm, measured on diagonal on top of panel.
   2. Flatness tolerance of plus/minus 0.51 mm, measured on diagonal on top of panel.
   3. Tolerances apply before edging is applied.

C. Fire resistance requirements: Materials incombustible or fire retardant treated.

D. Electrical conductance:
   1. Provide solid copper grounding jumper from grid system to room reference ground.
   2. Provide floor covering material meeting requirements of NFPA-99 for conductive flooring.

1.02 SUBMITTALS

A. Shop drawings:
   1. Pedestal and panel layouts.
   2. Standard and abutment details.

B. Product data:
    1. Provide pedestal base templates to steel subframe supplier.

C. Samples:
    1. Full range of colors of floor finish material for selection.
    2. Pedestal set in adhesive with proposed anchors or fasteners.

D. Project information: Not required for COTR review.

E. Contract closeout information:
    1. Maintenance data.
    2. Manufacturer's certification that system has been installed in accordance with requirements of this Section.
    3. Extra material.

1.03 JOB CONDITIONS

A. Verify field dimensions.

B. Verify levelness of subfloor.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Access flooring:
        a. Base:
            (1) Tate Access Floors.
        b. Optional:
            (1) Interface AR.
    2. Other manufacturers desiring approval comply with Section 01640.

B. Pedestals:
    1. Manufacturer's standard, metal construction.
    2. Base not less than 100 x 100 mm or 100 mm diameter.
    3. Steel or aluminum head.
    4. Vertical adjustment by threaded column with positive locking elevating nut.
    5. Capable of supporting 2270 kg without deformation.
    6. Height as required.
    7. Galvanize steel components.
    8. Provide conductive pedestal gasket with aluminum mesh screen for installation on pedestal head for sound deadening and grounding.

9. Provide wider base flanges for pedestals in areas exceed 300 mm heights as recommended by manufacturer to maintain lateral stability.
10. Provide perimeter pedestals where system abuts walls and adjacent floors.

C. Grid systems:
1. Galvanized steel or aluminum stringers, interlocking with pedestal heads to form grid pattern supporting edge of each floor panel, with pedestal under each panel corner.
2. Galvanize steel components.
3. Removable grid with stringers "bolted" to pedestal heads to create stable grid without exposed fasteners.
4. Stringers with resilient top coating or film.
5. Grounding system.

D. Floor panels (AF-1):
1. All steel welded construction filled internally with non-compressive cementitious core material, 600 mm x 600 mm.
a. Weight: 430 Pa.
b. Ultimate load: 18.2 kN.
2. Chemically clean steel, bonderize, and apply baked enamel finish.
3. Faced both sides with minimum 0.6 mm galvanized steel bonded to core.
4. Seal panel edges with metal.
5. Secure vinyl lip around panel perimeter to meet flush with finish flooring.

E. Floor covering:
1. Static dissipative resilient tile (SRVT): Refer to Section 09660.
2. Factory application: Finish tops of floor panels with floor covering material, laid flush to each panel edge, bonded to bearing surface.
3. Colors and patterns: See Section 09000.

F. Perforated floor panels (AF-2):
1. Manufacturer's 600 x 600 mm baked enamel finished steel floor panel with air flow perforations.
2. Reinforce panel if required to carry rated load.
3. Provide a minimum of 90 000 mm2 of free area per panel.
4. Locate as indicated.

G. Aluminum floor panels (AF-3):
1. Manufacturer's 600 x 600 mm aluminum, unperforated.
2. Reinforce panel if required to carry rated load.
3. Provide all aluminum pedestal and stringer grid system

where aluminum floor panels are indicated.

H. Closures:
1. 2 mm thick aluminum.
2. Accurately scribe and fit to subfloor, columns, walls, etc.
3. Set and seal with mastic if enclosing plenum.
4. Provide wherever floor system does not meet building walls or columns.

I. Panel lifting device: Double, suction type.
1. Provide one per laboratory room.

J. Base: Specified in Section 09660.

2.02 EXTRA MATERIAL

A. Extra floor panels:
1. Upon completion of work, deliver extra floor panels of same size, pattern and color as used on job to COTR for use in repair and maintenance work.
2. Furnish panels in original wrappings, properly marked.
3. Provide quantity equal to at least 2 percent of quantity installed of floor panels (AF-1).
4. Provide quantity equal to at least 10 percent of quantity installed of perforated floor panels (AF-2).

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Examine area where access flooring is to be installed.

B. Correct unsatisfactory conditions.

C. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

A. Install floor system under supervision of manufacturer or authorized representative, rigid, free of vibration, rocking, rattles, squeaks, and other objectionable defects.

B. Layout floor panels to minimize number of cut panels at floor perimeter.
1. Scribe panel assemblies at perimeter to provide fit with no voids greater than 3 mm where panels abut vertical and horizontal surfaces.

a. Tie back perimeter panels at edges with sheet metal screws through side of stringer to panel.
b. At perimeters with horizontal surfaces, provide minimum 75 mm wide aluminum transition sill centered over joint.
(1) Screw attachments at 450 mm OC maximum.
(2) Miter corners at turns.

2. Calk voids and perimeter if floor is a plenum.

C. Make cutouts required in floor panels.
1. Trim with rubber or plastic edging and provide foam rubber pad for sealing and protection of cables.
2. Verify locations, numbers and sizes.
3. Provide additional support as required if cutouts lessen panel strength.
4. Provide foam rubber pads for sealing and protection of cable penetrations.

D. At concrete subfloor: Locate each pedestal and complete necessary subfloor preparation:
1. Vacuum clean subfloor.
2. Set pedestals in adhesive and mechanically fasten to subfloor as recommended by manufacturer to provide full bearing.
3. Perform minor subfloor grinding or filling to provide satisfactory bearing.
4. Mechanically anchor to substrate.
a. Provide minimum 2 fasteners for each pedestal base plate.

E. At tubular steel subframe: Locate each pedestal and complete all necessary subframing preparation:
1. Clean subframing.
2. Attach set pedestals to subframing with screws as recommended by manufacturer to provide full bearing.
3. Perform minor subframing grinding or filling to provide satisfactory bearing.

F. Vacuum subfloor area as installation proceeds.

G. Level installed access flooring to within 3 mm over entire area and within 2 mm in any 3000 mm distance.

H. Edge cut panels with manufacturer's standard trim, to fit panels to perimeter or obstructions.
1. Seal cut edges to prevent dusting.

3.03 ADJUST AND CLEAN

A. After completion of installation, vacuum entire floor.

B. Cover entire floor with reinforced paper or plastic, and cover walkways and door openings with minimum 5 mm thick masonite.
   1. Fasten edges of temporary coverings.

C. Maintain and repair damages to protective covering until directed to remove.

D. Replace damaged or stained components.

E. Prior to final inspection, clean and wax.

END OF SECTION

SECTION 10620

PANELIZED WALL SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide prefabricated demountable metal panelized wall system for office partitions if Offer Option #4 is included in the project work.

B. Components shall include but not limited to the following:
   1. Wall panels complete with ceiling and base trim.
   2. Door frames complete with mortising for hinges and other hardware specified in Sections 08000 and 08700, to include wood doors specified in Section 08211.
   3. Electrical cutouts where indicated for concealed wiring boxes and devices specified in Division 16.

1.02 QUALITY ASSURANCE

A. American National Standard Institute:
   1. ANSI/BIFMA-X5.6.
      a. Comply with shelf loading criteria specified.

B. American Society for Testing and Materials:
   1. ASTM-E84.
   2. ASTM-E90.
   3. Comply with surface burning characteristics and Sound Transmission Coefficient (STC) criteria specified.

C. Installer qualifications:
   1. Installation shall be provided by manufacturer or by installer approved in writing by manufacturer.
   2. More than 5 years experience in the installation of panelized wall system similar to the type specified, including at least 5 projects of similar or greater size.

D. Training program:
   1. Manufacturer shall provide full day training in demounting, reinstallation, maintenance and repair procedures for Government's maintenance personnel.

1.03 SUBMITTALS

A. Shop drawings:
   1. Complete fabrication and installation drawings indicating attachment to all adjacent surfaces, panel layouts, accessories and anchoring methods, including

coordination with doors, hardware and electrical work.

B. Product data:
   1. Manufacturer's catalog data for system provided under this section.

C. Samples:
   1. Finish colors.

D. Project information:
   1. Shelf loading test report.
   2. Surface burning characteristics test report.
   3. STC test report.
   4. Installer qualifications.

E. Contract closeout information:
   1. Report of completed training program for Government's maintenance personnel.
   2. Manufacturer's maintenance manuals.

1.04 PRODUCT DELIVER, STORAGE AND HANDLING

A. Deliver prefabricated metal partition components in protective containers, cartons or crates.

B. Damaged components not repaired to match undamaged components in all respects shall be replaced to the satisfaction of the COTR.

1.05 JOB CONDITIONS

A. Field measurements:
   1. To the extent practical, take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting of the Work.
   2. Where exact pre-fabrication field measurements are not practical, make provisions for field fittings of equal quality to factory fabrications.

B. Coordinate access and cutouts for electrical work with requirements indicated on the drawings and specified in Division 16.

C. Verify suitability of substrates to accept installation.
   1. Correct defects.

D. Installation assumes responsibility for performance.

1.06 PRECONSTRUCTION CONFERENCE

A. Hold preconstruction conference, directed by Contractor

personnel, prior to beginning of wall system installation to discuss following:
1. Contract Document requirements.
2. Office plans.
3. Approved shop drawings.
4. Wall system manufacturer's specifications and details.
5. Other requirements.
6. Available on site storage.

B. Minimum attendance:
1. COTR representatives.
2. Contractor representatives.
3. Wall system manufacturer's representatives.
4. Wall system installation supervisor.
5. Ceiling manufacturer's installation supervisor.
6. Ceiling installation supervisor.
7. Electrical installation supervisor.

C. Review the following materials at conference:
1. Installation drawings.
2. Manufacturer product data.
3. Samples of proposed materials.
4. Project schedule.
5. Other information deemed pertinent for sound and secure application.

D. Conference shall review specifications, details, application requirements and preliminary work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Panelized wall system:
a. Base:
(1) Clestra Hauserman.
b. Optional:
(1) Transwall Corporation.
2. Other manufacturers desiring approval comply with Section 01640.

B. Panelized wall system construction: Steel faced modular width panels with vertical delineation reveal between panels.
1. Total thickness: 59 mm.
2. Finish on all exposed metal surfaces: Electrostatically applied and oven baked polyester enamel.
a. Color: See Section 09000.

3. Height: Floor to ceiling.
    a. No horizontal splices or joints.
4. System to permit 2, 3 or 4 way extensions without removal of previously installed panels or floor track.
5. System to provide minimum 50 mm vertical adjustment in overall height to accommodate floor and ceiling irregularities.
6. Panel intersections shall have vertical feature strips holding panels continuously together without clips.
7. Panel unit construction shall include:
    a. Integral slotting at 38 mm OC for mounting work surfaces and storage compartments on either side of panel, including side-by-side mounting.
    b. Integral screw leveling mechanism for setting panels without use of shims.
    c. Two separated concealed wireways.
8. System to permit installation on top of finished flooring, raised flooring or carpeted flooring without use of floor fasteners.
9. System to include one-piece continuous steel ceiling channel for installation to underside of suspended ceiling without use of destructive fasteners.

C. Panel system components: Minimum 0.37 mm thick cold-formed leveled steel faces enclosing sound absorbing fiberglass filler.
1. Standard modular panel size: 1000 mm wide by 2700 mm high.
2. Integral concealed slotted vertical edges for mounting wall-hung components.
3. Integral screw leveling capability with leveler mechanism concealed behind steel base cover.
4. Each panel unitized to include screw-leveled, panel-attached, spring-loaded floor track with integral sound seals.
    a. Unitized base: Formed steel, 100 mm high.
    b. Base cover: Flush with panel face, independently removable from each side.
5. Ceiling channel: One-piece continuous formed steel with continuous factory-installed resilient light and sound seal.
    a. Overlapping to panel face.
    b. Sized to allow concealed specified vertical adjustment.
6. Panel units joined together by vinyl delineation insert.
    a. Provides continuous light and sound seal.
    b. Contains flexible outer member to provide access to slots in use and to cover slots not in use.
    c. Insert flush with panel face at corridor partitions: Slots not intended to be used.

d. Insert recessed from panel face at demising partitions within offices: Allowing slots to be used.

7. Door frames: Formed steel with continuous resilient sound seal at jambs.
   a. Provides vertical adjustment to compensate for floor and ceiling irregularities.
   b. Mortised and reinforced for hardware.
8. Filler partitions to fixed walls or columns: Similar construction as panel units.
   a. Fit into wall channel at abutting fixed construction.
   b. Wall channel: Containing continuous factory-installed light and sound seal and not utilizing destructive fasteners when attaching to fixed construction.
9. Metal facings for gypsum wallboard fascias: Matching panel faces in all respects.
   a. Configurated as indicated on drawings.
   b. Concealed secure fastenings to fascia framing.

2.02 PERFORMANCE REQUIREMENTS

A. Certified test data from independent testing laboratories.

B. Shelf loading: Withstands load of 525 N/m on each of 5 shelves suspended from panel, in accordance with ANSI/BIFMA-X5.6.

C. Surface burning characteristics: Flame spread of 10 or less, and smoke developed of 10 or less, in accordance with ADTM-E84.

D. STC rating: Minimum 38, in accordance with ASTM-E90.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelized wall system without permanent fastenings to finished flooring.
   1. Installation to allow for future changes without need to patch flooring material at removals.

B. Scribe and neatly fit panels to fixed building conditions.

C. Install system under manufacturer's approved direct supervision.

D. Provide accurate cutouts for electrical devices that

penetrate wall system.

1. Cutouts shall be formed and sized to allow full coverage by electrical fixtures or cover plates specified in Division 16.

E. Repair any nicks and scratches with touch-up paint in matching color and gloss, to the satisfaction of the COTR.

END OF SECTION

SECTION 09000

ROOM FINISH AND COLOR SCHEDULE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Unless otherwise indicated, finishes shall match corresponding finishes of existing like materials.

B. Where finish color is not indicated, submit full range samples of manufacturer's standard colors for selection by Architect.

END OF SECTION

SECTION 09110

NON-LOAD BEARING WALL FRAMING SYSTEMS

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Wherever a fire resistance classification is indicated for walls or partitions, provide studs and accessories of type tested and listed for construction indicated.

B. Installation in accordance with ASTM-C754.

C. Studs: ASTM-C645.

D. Galvanizing: ASTM-A525.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
1. Manufacturer of listed products.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Non-load bearing framing components:
a. Base:
(1) Unimast.
b. Optional:
(1) National Gypsum.
(2) Domtar Gypsum.
(3) Dietrich Industries.
(4) Dale/Incor.
(5) Clark Steel Framing Systems.
2. Other manufacturers desiring approval comply with Section 01640.

B. Metal studs, screw type: Roll formed channel studs and

tracks.
1. Thickness: 0.9 mm.
    a. At jambs of openings: Two 0.9 mm studs.
2. Sizes: As indicated.
3. Flanges: Minimum 32 mm wide.
4. Galvanized: ASTM-A525, Z180.

C. Furring channels:
1. 0.5 mm, screw type.
2. ASTM-A525, Z180.
3. Hat shaped sections.

D. Wire ties: 1.2 mm, soft annealed, galvanized.

E. Fasteners for runners: Power driven type, to withstand minimum 85 kg shear when driven.

F. Closure: When continuous vapor barrier is required, provide continuous 0.9 mm galvanized closure to tape vapor barrier to.

G. Shaft wall framing: C-H shaped studs and U or J shaped tracks.
1. Thickness: 0.9 mm.
2. Size: 65 mm wide.
3. Galvanized: ASTM-A525, Z180.
4. Shaft wall assembly with gypsum wallboard and insulation, Section 09250:
    a. Fire-resistance rating: 2 hours in accordance with ASTM-E119.
    b. Structural properties: Withstand minimum 49 kg/m2 design loading applied transiently and cyclically without deflection exceeding 1/120 of partition height.
    c. Sound transmission class: STC 47 in accordance with ASTM-E90.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine supporting structure and conditions under which system will be installed.

B. Correct conditions detrimental to proper installation.

C. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

A. Provide continuous runner tracks sized to match studs.
   1. Align runners accurately at both floor and top.
   2. Secure runner tracks to structure not over 600 mm on center.
   3. Secure at corners and ends.

B. Where partitions abut horizontal or vertical structural elements, Provide slip or cushion type joint between partition and structure.

C. Where partition is fire or smoke rated, extend to structure above, with fire and smoke resistant joint treatment; see Section 07270.

D. Space studs maximum 400 mm on center.
   1. Provide additional studs at corners, partition intersections and terminations of partitions, and at both sides of control joints.

E. Positively attach studs to runners with 10 mm self tapping pan head screws or stud clinching tool on both flanges of each stud, top and bottom, or as required by fire resistance design.

F. At openings Provide 2 full length studs, back to back, at each jamb.
   1. For wall areas above and below openings, cut track to length, split flanges and bend webs at ends.
   2. Overlap and screw attach to jamb studs.
   3. Install cut to length intermediate studs between jamb studs at head and sill sections at same spacing as full length studs.
   4. To provide for control joints at openings, install additional stud, maximum 13 mm from jamb studs.
   5. Do not fasten extra stud to track or jamb stud.
   6. Securely attach jamb studs to door frames.

G. Install screw type metal furring channel system directly attached to walls, as indicated.
   1. Install channels at maximum 400 mm OC.
   2. Provide additional framing at openings, cutouts, corners and control joints.
   3. Fasten to masonry walls with cut nails.
   4. Fasten to concrete with power driven fasteners.
   5. Space fasteners not more than 600 mm OC, staggered on opposite flanges of hat channels.

H. Align stud openings to facilitate running of wires and conduit.

I. Provide snap on framing clips for structural steel members in accordance with manufacturer's recommendations.
   1. When sprayed fireproofing is being used, install clips on steel before spraying is performed.

J. Horizontally stiffen partitions where studs run over 4200 mm without lateral support.
   1. Use continuous 19 mm furring channels spaced not over 1370 mm OC vertically.
   2. Run channels through stud knockouts and wire tie to each stud or secure as recommended by manufacturer.

K. Coordinate installation with UCSS work specified in Section 05505.

L. Construct chase wall partitions with double row of runners and studs.
   1. Provide stud or runner cross braces horizontally between stud rows at maximum 1220 mm on center both ways.
   2. Attach brace web to webs of studs with minimum 2 screws each.

M. Coordinate installation with gypsum wallboard work specified in Section 09250.

END OF SECTION

SECTION 09250

GYPSUM WALLBOARD (GWB)

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. ASTM Standards:
1. ASTM-C36: Gypsum Wallboard.
2. ASTM-C442: Gypsum Backing Board and Coreboard.
3. ASTM-C475: Joint Treatment Materials for Gypsum Wallboard.
4. ASTM-C557: Adhesives.
5. ASTM-C630: Water Resistant Gypsum Backing Board.
6. ASTM-C840: Application and Finishing of Gypsum Board.
7. ASTM-C1002: Drywall Screws.
8. ASTM-C1047: Accessories for Gypsum Wallboard and Gypsum Veneer Base.
9. ASTM-E84: Surface Burning Characteristics of Building Materials.
10. ASTM-E90: Sound Transmission Testing.
11. ASTM-E119: Fire Tests of Building Construction.
12. ASTM-B749: Lead.

B. Gypsum Association:
1. GA-216 Recommended Specifications.

C. Fire resistant materials and assembly standards:
1. Provide materials, accessories and application procedures which have been tested in accordance with ASTM-E119.
2. Listed by UL, or other approved testing laboratory, for type of construction and rating indicated.

D. Radiation shielding test:
1. After completion of installation; when radiation generating equipment is in place, have test performed by qualified physicist.
2. Administer and complete testing, including coordination of items forming part of leakage.
3. Test result required: No radiation leakage.
4. Perform corrective work.
5. After corrective work is performed, retest as required until successful results are obtained.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:

1. Materials.
2. Manufacturer's installation instructions.

C. Samples: Not required for COTR review.

D. Project information:
1. Certification that sound insulation thickness and density is suitable for wall system STC rating required.
2. Certification that materials meet or exceed requirements of referenced standards.
3. Radiation shielding test report, signed by physicist typically engaged in testing and certification of radiation shielding.

E. Contract closeout information: Not required for COTR review.

1.03 JOB CONDITIONS

A. Coordinate work under this section with work under other sections to allow time for correct installation of the work under all sections.

B. Assure that areas to receive gypsum wallboard installation and finishing are maintained between 10 and 22 degC.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Gypsum wallboard and accessories:
a. Base:
(1) USG.
b. Optional:
(1) National Gypsum.
(2) Domtar Gypsum.
(3) Georgia Pacific.
2. Foam tape:
a. Base:
(1) Norton Performance Plastics.
b. Optional:
(1) Gasket Dynamics.
(2) Williams Products.
3. Insulation, sound:
a. Base:
(1) Owens Corning Fiberglas.
b. Optional:
(1) Schuller International.

(2) Certain Teed.

4. Suspended ceiling system:
   a. Base:
      (1) USG.
   b. Optional:
      (1) Chicago Metallic.
      (2) Armstrong World Industries.
      (3) National Gypsum.
5. Sound sealants:
   a. Base:
      (1) Pecora.
   b. Optional:
      (1) Tremco.
      (2) Sonneborn.
6. Reveal channels:
   a. Base:
      (1) Pittcon Industries.
   b. Optional:
      (1) Gordon.
      (2) USG.
7. Lead products:
   a. Base:
      (1) A&L Shielding.
   b. Optional:
      (1) Ameray.
      (2) Radiation Protection Products.
      (3) Ray Bar Engineering.
      (4) Willard Industries.
8. Prefabricated metal ceiling fascia and wall caps:
   a. Base:
      (1) Pittcon Industries.
   b. Optional:
      (1) Custom Enclosures, Inc.
      (2) Chicago Metallic Corporation.
9. Other manufacturers desiring approval comply with Section 01640.

B. Gypsum wallboard (GWB):
   1. Furnish in maximum available lengths, consistent with installation requirements, bevel edged, square ends.
   2. Regular board:
      a. 16 mm thick.
      b. Use where other types are not required.
   3. Fire rated board (Type X):
      a. 16 mm thick, one hour rated.
      b. Use for fire rated walls, fire rated ceilings and joint backing at fire rated ceilings.
   4. Gypsum shaft wall liner panel, Type X: 25 x 600 mm.
   5. Gypsum wallboard, lead lined (LLGWB):
      a. Minimum 1.5 mm thick lead sheet laminated to 16 mm thick gypsum wallboard.

b. 1220 mm wide x manufacturer's standard lengths, with lead edge flanges.

6. Foil back gypsum wallboard (FBGWB):
   a. 16 mm thick, with aluminum foil on back surface.
   b. Use on inside of exterior walls.
7. Moisture resistant gypsum wallboard (MRGWB):
   a. Moisture resistant: 16 mm thick.
   b. Use fire rated type in fire walls.
   c. Provide at toilet rooms, janitor closets, showers, and other wet areas where finish is paint or high build glazed coating.
8. Cementitious backer board (CBB):
   a. 16 mm thick, aggregate portland cement board.
   b. Install vapor retarder prior to installation of cementitious backer board in wet or other areas of high and constant humidity.
   c. Provide as substrate for ceramic tile in toilet rooms, showers, and other wet areas.

C. Backing for control and expansion joints:
   1. Fire rated board.

D. Joint Compound: ASTM-C475. As recommended by wallboard manufacturer.

E. Joint Tape: As recommended by wallboard manufacturer.

F. Adhesive: As recommended by wallboard manufacturer.

G. Gypsum wallboard accessories: ASTM-C1047 galvanized steel for general use, zinc for wet and exterior areas.
   1. Corner bead:
      a. Manufacturer's standard with perforated flanges.
   2. Trim bead:
      a. Manufacturer's standard.
   3. Control or expansion joints:
      a. Manufacturer's standard.

H. Screws:
   1. Self-tapping, bugle head, length to penetrate framing member minimum 16 mm.
   2. Type S for gypsum wallboard to metal and type G for gypsum wallboard to gypsum wallboard.

I. Sealants and caulking:
   1. Except as specified for sound caulking, see Section 07900.

J. Foam tape:
   1. Base: PVC, 13 x 6 mm, with pressure sensitive adhesive; Norton Norseal.

2. Optional: EPDM, 13 x 6 mm, with pressure sensitive adhesive; Gasket Dynamics Cellular Rubber.

K. Insulation, sound:
1. Commercial sound blanket, ASTM-C665, Type I.
2. Thickness and density required to achieve STC indicated for sound rating of wall system.

L. Caulking, sound:
1. Base: Pecora AC-20-FTR Acrylic Latex.
2. Optional: Tremco Acoustical Sealant.
3. Synthetic rubber-based material conforming to ASTM-C919:
a. Minimum 90 percent solids.
b. Non-bleeding.
c. Non-staining.
d. No oil migration.
e. Slightly tacky at 71 degC after 50 days.

M. Suspension wire: Soft annealed, galvanized.
1. Diameter: Minimum 2.6 mm.

N. Tie wire: Soft annealed, galvanized.
1. Diameter: Minimum 2.3 mm.

O. Carrying channels: Cold rolled steel, galvanized.
1. Depth: 38 mm.
2. Flanges: Minimum 11 mm wide.
3. Thickness: Minimum 1.5 mm.

P. Furring channels and metal studs: See Section 09110.

Q. Metal furring channel ceiling system.
1. Suspension wire.
2. Tie wire.
3. Carrying channel.
4. Furring channel.
5. Provide trim pieces to trim out exposed gypsum wallboard edges at light penetrations.

R. Firestopping: See Section 07270.

S. Sealer for moisture resistant gypsum wallboard.
1. Manufacturer's standard compound.
2. Use at joints, cut edges and screw penetrations.

T. Reveal channels:
1. Pittcon model numbers:
a. 6 mm wide: SWR-025-050.
b. 20 mm wide:
(1) Wall condition: SWR-075-050.

(2) Door jamb condition: STR-075-050.
c. 25 mm wide: SWR-100-050.
d. 50 mm wide: SWR-200-050.
(1) Wood insert.
2. Sizes and profiles indicated on drawings.
3. Provide matching end-closures at reveal terminations.

U. Prefabricated metal ceiling fascia and wall caps:
1. Aluminum: Alloy 3003 H-14.
a. Minimum thickness: 2 mm.
b. Finish: Factory painted, white.
c. Form to profile indicated.
(1) True radius curves at ceiling fascia.
(2) Smooth untextured face.
d. Butt joint members.
(1) Hairline seams.
(2) Concealed splice plates.
e. Concealed corner and edge transitions with gypsum wallboard:
(1) Flange and other forms to receive wallboard.
(2) Allowing concealment by taping and spackling when finishing wallboard.
f. Complete with concealed clips and other accessories for installation indicated on drawings.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Examine supporting structure and conditions under which wallboard is to be installed.
1. Vapor barrier substrates: Obtain COTR written approval before covering with gypsum wallboard.

B. Correct unsatisfactory conditions.

C. Coordinate with UCSS work specified in Section 05505.

3.02 INSTALLATION - GENERAL

A. Erect wallboard vertically with edges over supporting members.

B. Secure to each support or framing member with screws.

C. Bring boards into contact but do not force into place.

D. Fit neatly and carefully.

E. Stagger edge joints on opposite side of partition so they occur on different framing members.

F. Proceed with attachment from center of board toward ends and edges.

G. Make cuts neatly.
   1. Cutouts at outlet boxes to produce joints around boxes of less than 5 mm for sound Caulking.
   2. Provide for 6 mm wide joint between channel edge trim and wallboard for sound Caulking.

H. Provide sound insulation in walls to top of partition where sound rated walls are indicated.
   1. Provide as necessary to achieve sound rating.
   2. Pack spaces around electric boxes and other penetrations to maintain full sound reduction.
   3. Provide sound Caulking material for rating required.
      a. Apply 2 continuous beads to bottom and top substrates before installing floor and ceiling runners.
      b. Fill wallboard joints around outlet boxes, and butter sides and back of boxes fully.
      c. Fill joint between channel edge trim and wallboard, and tool to cove profile.
      d. Apply continuous beads on horizontal legs of angle trim, and on edges of ceiling boards laid on trim, to seal joint but not ooze out and be exposed to view.

I. Erect tile backer board per manufacturer's instructions.

J. Install reveal channels as recommended by manufacturer.

3.03 INSTALLATION - SINGLE LAYER SYSTEM

A. Set screws between 10 to 13 mm from edges.
   1. Space maximum of 300 mm OC at edges and in field of board.
   2. Where wallboard butts at wall/ceiling juncture, hold screws back 150 mm from edges.
   3. Use closer screw spacing if required by UL.

B. Drive screws so head rests in slight dimple without cutting face paper or fracturing core.

3.04 INSTALLATION - TWO LAYER SYSTEM

A. Space screws in base layer maximum of 300 mm OC at edges and in field of board.

B. Screw apply finish layer.

C. Stagger joints not less than one support from first layer.

3.05 INSTALLATION - RADIATION SHIELDING

A. Install in accordance with manufacturer's recommendations and UL requirements.

B. Screw lead lined wallboard to studs.
   1. Space screws 205 mm OC at edges and 305 mm OC in field.
   2. Install nominal 50 mm square lead cap crimped over screw points penetrating lead lined wallboard.

C. Install 50 mm wide strip of sheet lead behind joints.
   1. Install at perimeters of door and other opening frames.
   2. Overlap lead minimum 25 mm.

D. Where lead is penetrated or interrupted by installed items, including, but not limited to, electric boxes, plumbing and trench ducts; line back, bottom, top and sides of item with equivalent lead thickness to maintain shielding integrity.

E. Perform corrective work to achieve complete radiation isolation, including repair or replacement of finishes.

3.06 INSTALLATION - SHAFTWALL

A. Install shaft walls in compliance with UL and Gypsum Association requirements.

B. Provide shaft wall systems which permit entire erection procedure from outside of shaft.

C. Provide special metal runner angles and channels, and studs or splines spaced in accordance with manufacturer's requirements.

D. Provide number, type and thickness of wallboard layers including air spaces and insulation as required to achieve indicated ratings for fire resistance and sound reduction.

E. Comply with requirements for thickness of metal and thickness of wall, for heights of wall indicated.

F. Use maximum practical board lengths.

G. Bring boards into contact but do not force into place.

3.07 INSTALLATION - CEILING

A. Provide in compliance with manufacturer's recommendations.
   1. Furring ceiling support system.
   2. Gypsum wallboard.

B. Provide required items to support and trim out neatly flush or recessed mechanical and electrical items.

3.08 CONTROL JOINTS

A. Install control joints to provide following maximum unjointed lengths or areas:
   1. Partitions and soffits: 9000 mm maximum straight run.
   2. Frames:
      a. Single door: Latch side of jamb from head of opening to top of partition.
      b. Pair of doors: Each side of jamb from head of opening to top of partition.
      c. Pair of doors, cross corridor: Not required.
      d. Cased opening: Each side of jamb from head of opening to top of partition.
      e. Window opening: Each side of jamb from head of opening to top of partition.
   3. Ceilings: 15 000 mm with perimeter relief, maximum 9000 mm without perimeter relief in one direction, and at change of direction or irregular shapes.
   4. Ceiling area: Maximum 235.0 m2, with perimeter relief, maximum 85.0 m2, without perimeter relief.

B. Calk control joints behind base flush.
   1. Use color to match base color as closely as possible.

C. Provide suitable backing material to maintain required rating where control or expansion joints occur in fire or sound rated assemblies.

D. Provide corner bead where partition or ceiling abuts structural element or dissimilar wall or ceiling.

3.09 WALLBOARD FINISHING

A. Perform Level 4 finishing in accordance with ASTM-G840.

B. Securely attach continuous corner beads to external corners in accordance with manufacturers installation instructions.

C. Where wallboard abuts dissimilar surfaces securely attach continuous trim beads in accordance with manufacturers

directions.
1. Where bead abuts exterior metal window frames or other metal components, separate from other material by use of foam tape.
2. Install accessories.

D. Apply joint treatment compound to full height of partitions in accordance with manufacturer's directions.

E. Fill joints, screw heads and internal corners with compound.

F. After irregularities have been eliminated:
1. Apply a thin skim coat of joint compound over entire surface of board and joints.
2. Exercise care to avoid laps or tool marks which might indicate through paint.

G. At corner transitions with prefabricated metal ceiling fascia or prefabricated metal wall cap, tape and spackle to conceal exposed flange and create monolithic appearance after painting.

H. Have wall primed by painter.

I. After painter has applied primer to wallboard surfaces, repair and refinish areas which indicate defects.

J. If wallboard is damaged or surfaces are roughened, repair or remove and replace surfaces to satisfaction of COTR.

3.10 CEMENTITIOUS BACKER BOARD FINISHING

A. Seal entire surface of backerboard with thinned ceramic tile mastic to manufacturer's recommendations.

B. Embed joint tape over joints and treat fasteners with approved joint compound.

C. Flat trowel minimum two coats until surface is smooth and free of voids.
1. Do not apply ready-mix compounds.

END OF SECTION

SECTION 09660

RESILIENT TILE (RVT), RESILIENT BASE (RB)
AND STATIC DISSIPATIVE RESILIENT TILE (SRVT)

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Tile standard: ASTM-F1066.

B. Static coefficient of friction test: ASTM-D2047.

C. Construct sample inside and outside corner.
   1. Include minimum 1220 mm straight base each direction from corner.
   2. If not acceptable construct additional corners.
      a. Stress whitening and cracking will not be acceptable.
      b. Color and height variation will not be acceptable.
   3. Sample corners constitute standard of quality for actual construction.
   4. Maintain sample corners during construction.
   5. Remove when directed.
   6. Sample corners may be built into permanent construction provided sample area is readily identifiable during construction.
   7. Do not proceed with base installation until sample corners are approved by COTR.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
   1. Materials.

C. Samples:
   1. Full range of colors of each type of tile, accent/ feature strips, and stair tread edging strips required for color selection.
   2. Sample of base and stair tread.
   3. Sample corners: See Quality Assurance.

D. Project information:
   1. Manufacturer's installation instructions.

E. Contract closeout information:
   1. Maintenance data.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers indicating name, brand, color and pattern.

B. Store at minimum 21 degC for 72 HRS before installation.

1.04 JOB CONDITIONS

A. Maintain work spaces at 21 degC 72 HRS prior, during, and 72 HRS after installation.

B. Protect adjacent work from damage.

C. Install after wall finishes.

D. Install prior to carpet and acoustical material.

E. Schedule installation to minimize accumulation of air contaminants that cannot be removed prior to occupancy.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Resilient tile (RVT): Vinyl.
        a. Base:
            (1) Armstrong World Industries, Inc.
        b. Optional:
            (1) Azrock Industries.
            (2) Kentile Floors.
            (3) Mannington Commercial Resilient.
            (4) Tarkett, Inc., Hardwood Div., North America.
    2. Resilient base (RB): Rubber.
        a. Base:
            (1) Johnsonite.
        b. Optional:
            (1) Mercer Products.
            (2) Kentile Floors.
            (3) Mannington Commercial Resilient.
            (4) Vinyl Plastics.
            (5) National Floor Products.
            (6) Armstrong World Industries, Inc.
    3. Static dissipative resilient tile (SRVT): Vinyl.
        a. Base:
            (1) Forbo Industries.
        b. Optional:
            (1) Armstrong World Industries.
    4. Stair treads (STRD):
        a. Base:

(1) Nora Rubber Flooring.
b. Optional:
(1) Johnsonite.
(2) Roppe.
5. Other manufacturers desiring approval comply with Section 01640.

B. Resilient tile (RVT):
1. Vinyl, 3 mm thick, 305 mm square.
2. Static coefficient of friction: Minimum 0.6.
3. Color: See Section 09000.

C. Static dissipative resilient tile (SRVT):
1. Vinyl, 3 mm thick, 300 mm square.
2. Electrical resistance: ASTM F-150, 6 to the 10th to 8 to the 10th ohms.
3. Static generation: Less than 100 volts per AATCC-134 at 20 percent R.H. when tested on conductive footwear.
4. Static decay: 5,000 volts to zero in less than 0.2 seconds per Federal Test Method 4046 and 101C.
5. Static coefficient of friction: Minimum 0.6.
6. Colors and patterns: See Section 09000.

D. Resilient base (RB), except at carpet:
1. Rubber top set, coved type.
2. 3 x 100 mm, 6 mm wide at bottom.
3. Field formed external and internal corners.
4. Provide continuous rolls, minimum 29 m long.
5. Color: See Section 09000.

E. Resilient base (RB) at carpet:
1. Rubber top set, straight type.
2. 3 x 100 mm.
3. Field formed external and internal corners.
4. Provide continuous rolls, minimum 29.0 m long.
5. Color: See Section 09000.

F. Stair treads (STRD):
1. Rubber, consisting of tread cut from tile and front and back nosings.
2. Tile, 1000 mm x 1000 mm, cut to fit tread form and dimensions.
a. Thickness: Minimum 4 mm.
b. Pattern: Raised round discs, minimum 0.5 mm high and nominal 27 mm diameter.
c. Cut with pattern parallel to front nosing.
3. Front and back nosings:
a. Thickness: Minimum 3.7 mm.
b. Square, 45 mm face with maximum 50 mm wide exposed top surface.

4. Color: As indicated in Section 09000.
5. Coefficient of friction: Minimum 0.60, ASTM-D2047.
6. Critical radiant heat flux: Class 1, ASTM-E648.
7. Flame spread index: Maximum 75, ASTM-E84.
8. Smoke density: Maximum 450, ASTM-E662.

G. Leveling compound: As recommended by manufacturer compatible with adhesives.

H. Adhesives and primers: As recommended by manufacturer.

I. Accent/feature strips: 3 mm thick, 25 mm wide plain color homogeneous vinyl with backing.
1. Color: See Section 09000.

J. Edging strips: Beveled vinyl plastic of solid color.
1. Colors to match predominate color of adjacent floor tile, as selected by COTR.

2.02 EXTRA MATERIAL

A. 5 percent of amount installed of RVT-1, RVT-2, SRVT-1, RVT-3 and RVT-4.

B. 5 percent of length installed of each color and type of base.

C. Component materials for 2 extra stair tread assemblies.

D. Provide materials in clearly labeled containers.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verify substrates are clean, free from moisture, or materials which may affect adhesion.

B. Carefully examine surfaces for defects and irregularities.

C. Installation constitutes acceptance of surfaces.

3.02 PREPARATION

A. Fill cracks, joints, etc., in floors with water resistant non crumbling patching compound.

B. Trowel level.

C. Where resilient flooring abuts other finish flooring

materials and finished surfaces do not align but are within 3 mm, feather leveling compound for approximately 300 mm so finished surfaces will align.

D. Where resilient flooring abuts other finish flooring materials and finished surfaces do not align in excess of 3 mm; provide edging strips unless separated by a threshold or edging material is included with other finish flooring.

3.03 INSTALLATION

A. Do not start until work under other Sections is complete.

B. Coordinate with floor, wall and ceiling work specified under other Sections.
   1. Extend resilient flooring fully under casework, removable equipment, demountable partitions and other items not permanently fixed in place.

C. Apply primer and adhesive as recommended by manufacturer.

D. Lay in patterns indicated.
   1. Alternate tile 90 degrees if pattern is directional.
   2. Bond tile to floor, flush, tight, and in true alignment with adjacent tiles and with finished surface.
   3. Fit neatly into breaks and recesses, against walls, around pipes, and other obstructions.
   4. Provide edging strips where tile edge is exposed or where flooring terminates.
   5. Lay out tile to avoid less than 1/2 tile at permanent walls.
   6. Perform cutting or drilling of tile as required.

E. Where tile color changes or floor finish material changes to sheet vinyl, install accent/feature strips in door openings directly under door when in closed position.

F. Roll entire floor surface with rubber faced roller, minimum 100 kg, maximum 600 mm wide, to ensure adhesion of floor surface before adhesive has set and cured.

G. Install stair treads in adhesive recommended by tread manufacturer.
   1. Roll to assure adhesion.
   2. Cut to fit without seams in tile surface.

H. Install base after wall material has dried out thoroughly.
   1. Provide base at intersections of floor and vertical surfaces in areas scheduled to receive base, where

intersection is exposed to view.
2. Set base straight and true.
3. Fit into breaks and recesses.
4. Scribe to trim at doors and door frame.
5. Make joints tight.
6. Install with top and bottom edge in firm contact with wall and floor.
7. Provide corners as recommended by manufacturer.

3.04 ADJUST AND CLEAN

A. Immediately after application and rolling, remove surplus adhesive.

B. Damp mop entire floor.

C. Clean floors in accordance with manufacturer's recommendations.

D. Leave floors smooth and clean.

E. Protect with non-staining building paper as may be necessary to prevent dirt and damage.

F. Protect traffic areas with fiberboard or plywood.

G. Prior to final walk through:
1. Wash, wax and buff floors and base.
2. After thorough cleaning, apply two coats of wax recommended by flooring manufacturer.
3. Buff after each coat.

END OF SECTION

SECTION 09900

PAINTING (PNT)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definitions:
   1. "Paint" and "painting" refer to field applied coatings.
   2. Mechanical work (and equipment): Specified under Division 15.
   3. Electrical work (and equipment): Specified under Division 16.

B. Work specified under this Section.
   1. Interior surfaces in finished rooms or spaces, unless indicated not to be painted or indicated to be painted under other Sections.
   2. Mechanical and electrical work:
      a. Interior mechanical and electrical equipment not completely factory finished.
      b. In finished rooms and spaces with finished ceilings: Exposed ductwork, piping, insulated piping, conduit, busways, raceways, and associated accessories.

1.02 QUALITY ASSURANCE

A. American Society for Testing and Materials:
   1. ASTM-D3134 for gloss ratings.

B. American Woodworking Institute:
   1. AWI Architectural Woodwork Quality Standards, Section 1500 for transparent finishing of wood.

C. Steel Structures Painting Council (SSPC) for preparation of metal substrates.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
   1. Manufacturer's data for each paint type to be applied indicating conformance to Specifications.
      a. Name of material.
      b. Contents by volume.
      c. VOC data.
      d. Application instructions.

C. Samples:
   1. Manufacturers complete range of colors for selection or verification.
   2. Gloss samples.
   3. 300 x 300 mm sample of all colors.

D. Project information:
   1. Letter stating substrate moist content is acceptable.

E. Contract closeout information:
   1. Maintenance data.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in original labeled containers.

B. Protect from freezing or damage.

C. Keep storage neat and clean.

D. Repair damage to surroundings.

E. Remove rags and waste from building daily.

F. Avoid danger of fire.

1.05 JOB CONDITIONS

A. Install when temperature and humidity conditions approximate conditions that will exist when building is occupied. Maintain conditions after installation.

B. Install prior to application of adhesively applied flooring and wall covering, carpet and acoustical material.

C. Schedule installation to minimize accumulation of air contaminants that cannot be removed prior to occupancy.

D. Air out construction with 100 percent outside air.
   1. Do not recirculate prior to occupancy.
   2. Ventilate during installation. Seal return air ducts and use direct exhaust to outdoors.

E. Maintain schedule indicating when painter will complete respective coats of paint for various areas.

F. Keep schedule current as job progress dictates.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
   1. Provide paint as product of one manufacturer unless specified material is unavailable from selected manufacturer.
   2. Paints, stains, coatings, and associated series designations specified in this Section are Sherwin Williams products, unless noted otherwise, with the associated series designations specified in this Section to establish material and level of quality.
   3. Paints:
      a. Base:
         (1) Sherwin Williams Co.
         (2) PPG Industries, Inc.
      b. Optional:
         (1) ICI Paint Stores.
         (2) MAB Paints and Coatings.
         (3) Benjamin Moore.
         (4) Tnemec Co., Inc.
         (5) Diamond Vogel Paints.
         (6) Duron, Inc.
   4. Stains:
      a. Base:
         (1) Sherwin Williams Co.
         (2) PPG Industries, Inc.
      b. Optional:
         (1) ICI Paint Stores.
   5. Other manufacturers desiring approval comply with Section 01640.

B. Paints and stains: As specified in paragraphs "Paint Systems: Exterior" and "Paint Systems: Interior".
   1. Use best quality by approved manufacturers.
   2. Colors: As indicated in Division 15 and Division 16.
      a. COTR may select accent colors from entire range of manufacturer's colors, including deep colors.
      b. COTR may select custom colors for painting of equipment and mechanical or electrical systems, for safety or identification purposes.
      c. COTR may require that one or more walls in a room or space be painted a contrasting accent color, except in janitor's and electric closets and other small miscellaneous rooms and spaces.
   3. Following system schedules are listing of surfaces and type of paint to be applied.
   4. Finish coats shall have a gloss rating of 15 to 25 at 60 degree angle per ASTM-D3134, except where the following finishes are specified:

a. Eggshell or flat: Rating of 5 to 15.
b. Semi-gloss: Rating of 25 to 65.
c. Gloss: Rating of greater than 65.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine surfaces carefully for defects which might prevent satisfactory results.

B. Commencing of work in a specific area constitutes acceptance of surfaces, and responsibility for performance.

3.02 PREPARATION - GENERAL

A. Assure that surfaces are clean and dry.

B. Assure that surfaces are free of foreign materials which will affect adhesion or appearance.

C. Remove mildew and neutralize surface.

D. Eliminate efflorescence before painting.

E. Paint when substrate moisture is within paint manufacturer's acceptable limits.

3.03 PREPARATION - PREVIOUSLY PAINTED SURFACES

A. Wherever previously painted work is cut, patched, or added to, touch up to match new work as closely as possible.
1. Check compatibility of new coating to previously painted surfaces by applying test patch. Allow to dry and test adhesion before continuing painting work.

B. Put previously painted work scheduled for repainting in condition to provide good adhesion and to receive paint.
1. Wash thoroughly all surfaces to be repainted with abrasive kitchen cleaner or sand to manufacturer's recommendations.
2. Remove all residue from cleaning and abrading procedures.
3. Spot prime bare areas.

C. Where a wall or ceiling is disturbed and patched, repaint entire wall or ceiling.

D. On surfaces to be refinished remove hardware, accessories,

plates, surface mounted lighting fixtures, and similar items which are not to be coated, or provide protection during preparation and coating operations.

3.04 MATERIAL PREPARATION

A. Mix and prepare materials per manufacturer's specifications.

B. Stir, agitate or blend materials to produce a mixture of uniform density as required for application of materials.

3.05 PREPARATION - WOOD

A. Sandpaper smooth, then dust.

B. After priming coat has dried, seal knots, pitch and resinous sapwood.

C. Putty nail holes and minor defects, to match wood color.

3.06 PREPARATION - FERROUS METAL SURFACES AND HOLLOW METAL

A. Follow requirements of SSPC SP1 and SP3.

B. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.

C. Touch up damaged shop coats.

D. For surfaces with touched up shop coat, omit first coat.

3.07 PREPARATION - GALVANIZED METAL SURFACES AND NONANODIZED ALUMINUM

A. Follow requirements of SSPC SP1.

3.08 PREPARATION - GYPSUM DRYWALL

A. Repair minor irregularities left by finishing of drywall.

B. Exercise care to avoid raising nap of paper.

C. Apply prime coat.

D. Employ a skilled drywall finisher to repair and refinish any areas which indicate defects after application of primer.

E. Reprime refinished areas.

3.09 PREPARATION - CONCRETE AND MASONRY WALLS

A. Repair minor defects.

B. Sand or stone-finish outside corners to produce eased edges for finishing.

C. Remove oil from concrete by washing with xylol.

D. Block filler:
   1. Apply to level out substrate.
   2. Apply in 2 coats applied at right angles to each other.
   3. Provide complete cover with manufacturers recommended coating system.

E. Squeegee finish top coat of filler.

F. Obtain COTR's approval of finish preparation.

3.10 PREPARATION - CONCRETE FLOORS

A. Repair minor defects.

B. Flush clean with water.

C. Apply Tnemec 409 Pre-Kote/Cleaner in accordance with manufacturer's specifications.

3.11 APPLICATION - GENERAL

A. Paint surfaces as specified in paragraphs "Schedule - Interior Paint Systems" and "Schedule - Exterior Paint Systems".

B. Provide complete coverage and hide.
   1. Paint systems are to cover.
   2. When color or undercoats indicate through, apply additional coats at no additional cost until paint film is of uniform finish and color.

C. Employ only skilled mechanics.

D. Mix and apply as recommended by manufacturer.

E. If COTR so directs, do not apply succeeding coats until COTR has an opportunity to observe previous coat.

F. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.

G. Upon completion of painting, carefully replace removed items and remove protection.

H. Apply materials under adequate illumination.

I. Evenly spread and smoothly flow on for full, smooth cover.

J. Assure that coats are dry before recoating.

K. Touch up suction or hot spots in drywall, concrete block, and concrete before painting.

L. Touch up abraded areas of shop prime coats before subsequent coats are applied.

M. Back prime wood trim with penetrating sealer.

3.12 APPLICATION - INTERIOR

A. Finish door edges same as faces of doors.

B. Finish closets, semi-exposed surfaces behind grilles, etc., to match nearest adjoining surfaces.

3.13 SURFACES NOT TO BE PAINTED

A. Anodized aluminum, stainless steel, chromium plate, glass, copper, bronze or similar materials.

B. Moving parts of valves, operating units, mechanical and electrical parts, such as valve and damper operators, sending devices, motor and fan shafts.

C. Code labels, such as UL, FM.

D. Equipment identification or rating plates.

E. Items having complete factory finish with the exception of electrical panels, control cabinets, and similar surfaces in finished areas.

3.14 PROTECTION AND CLEANUP

A. Protect adjacent work against damage by painting and finishing work.

B. Clean, repair or replace, and repaint damaged work as directed by COTR.

C. Provide "WET PAINT" signs.

D. Remove temporary protective wrappings, after completion of operations.

E. Clean paint spattered surfaces.

F. Use care not to damage finished surfaces.

G. Remove any surplus materials, scaffolding and debris.

H. Leave areas broom clean.

3.15 IDENTIFICATION OF RATED PARTITIONS

A. Provide identification on partitions indicated on drawings as having a required fire or smoke rating.
   1. Identification: Same as indicated on drawing legend.
   2. Location: 3050 mm on center, both sides of partition:
      a. Above ceilings in spaces with ceilings.
         (1) Above access panels with hard ceilings.
      b. 300 mm below underside of structure above, in spaces without ceilings, if visible from 1.5 m above floor with finished work.
         (1) If not visible from 1.5 m above floor at location 300 mm below underside of structure: As directed by COTR.
   3. Lettering: 50 mm helvetica, painted with aid of stencils.
   4. Color: Red.

3.16 SCHEDULE - INTERIOR PAINT SYSTEMS

A. Concrete and concrete block walls: (Semi-gloss finish).
   1. First coat: Latex block filler, PrepRite Block Filler; B25W25.
   2. Second coat: Latex Semi-Gloss Enamel, ProMar 200; B31W200 Series.
   3. Third coat: Latex Semi-Gloss Enamel, ProMar 200; B31W200 Series.

B. Concrete ceilings: (Eggshell finish).
   1. First coat: Latex Wall Primer, PrepRite 200; B28W200.
   2. Second coat: Latex Eg-Shel, ProMar 200; B20W200 Series.
   3. Third coat: Latex Eg-Shel, ProMar 200; B20W200 Series.

C. Concrete floors, and concrete and concrete block wall below access flooring:
   1. First Coat: All Weather Epoxy; B62W40/B60V70, reduced 12 percent with R7K54.

2. Second Coat: All Weather Epoxy; B62W40/B660V10, package consistency.

D. Gypsum wallboard in other spaces: (Eggshell finish).
   1. First Coat: Latex Wall Primer, PrepRite 200; B28W200.
   2. Second coat: HealthSpec Low Order Eg-Shel Enamel.
   3. Third coat: HealthSpec Low Order Eg-Shel Enamel.

E. Other not galvanized metals: (Semi-gloss finish).
   1. First coat: Acrylic, DTM Acrylic Primer/Finish; B66.
   2. Second coat: ProClassic Waterborne Acrylic Semi-Gloss.
   3. Third coat: ProClassic Waterborne Acrylic Semi-Gloss.

F. Galvanized metals: (Semi-gloss finish).
   1. Clean with Great Lakes "Clean-n-Etch".
   2. First Coat: ProClassic Waterborne Acrylic Semi-Gloss.
   3. Second Coat: ProClassic Waterborne Acrylic Semi-Gloss.

G. Pipe and duct insulation: (Semi-gloss finish).
   1. First coat: Latex Wall Primer, PrepRite 200.
   2. Second coat: Metalatex Semi-Gloss; B42 Series.
   3. Third coat: Metalatex Semi-Gloss; B42 Series.
      a. Colors: Section 15190.

H. Wood, painted, exposed: (Semi-gloss finish).
   1. First coat: PrepRite Classic Interior Primer; B28W101.
   2. Second coat: ProClassic Waterborne Interior Semi-Gloss Enamel.
   3. Third coat: ProClassic Waterborne Interior Semi-Gloss Enamel.

I. Wood, concealed: (Flat finish).
   1. First coat: PrepRite Classic Interior Primer; B28W101.
   2. Second coat: Latex Wall Paint, flat ProMar 200.
   3. Third coat: Latex Wall Paint, flat, ProMar 200.

J. Wood, transparent finish:
   1. First coat: Wood filler for open grain wood only.
   2. Second coat: Semi-transparent wood stain; A48 Series.
   3. Top coats: Equal to AWI Finish System No.5, catalyzed polyurethane, premium grade.

END OF SECTION

SECTION 07270

FIRESTOPPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide firestopping including but not limited to:
   1. Between edge of floor slab and curtainwall.
   2. At floor level in stud walls that bypass floors.
   3. At top of wall below structure in coordination with vibration isolation requirements.
   4. At building expansion joints in walls, floors and floor-to-floor structural elements.
   5. At mechanical, electrical and plumbing penetration openings which are left in fire assemblies.
   6. Other penetrations, voids and openings in fire and smoke assemblies, walls, floors and perimeters.

B. Provide fire-safing insulation to fill the void between the interior face of the building enclosure assembly and the edge of the floor slab to the complete depth of the floor slab (101.6 mm minimum thickness) with aluminum foil facing upward to complete an impervious vapor retarder.

1.02 QUALITY ASSURANCE

A. Fire-safing performance criteria:
   1. Fire-safing insulation shall be rated noncombustible as defined by NFPA Standard 220 when tested in accordance with ASTM-E136. Melt point shall exceed 1,093.33 degC.
   2. Fire-safing insulation shall be NFPA Class A material and shall have a burning characteristic Flame Spread of 25 and a Smoke Developed of 5 when tested in accordance with ASTM-E84.
   3. Fire-safing insulation shall be 3 hour tested under simulated field conditions, in accordance with ASTM-E119 and ASTM-E814.
   4. Fire-safing insulation shall have a "RSI" value (1/U) of 2.82 m2K/W for 101.60 mm thickness when tested in accordance with ASTM-C518.
   5. UL Standard 1479.

B. UL Fire Resistance Directory Volume II: Fire and temperature ratings for assemblies shall be equal to or exceed corresponding ratings of floor or ceiling or wall penetrated and not less than required by applicable codes listed on the Fire Protection Plan Drawings.

C. Materials used in Cleanroom Building 215 shall be acceptable for cleanroom construction.

1.03 SUBMITTALS

A. Shop drawings:
1. Indicating UL system, materials, anchorage, installation methods and adjacent construction for all penetrations in fire assemblies.

B. Product data:
1. UL report with illustration of system and system number for all conditions and assemblies.
2. Fire and temperature rating data.
3. Certification that components are asbestos free.
4. Manufacturer's installation instructions for all conditions and assemblies.

C. Samples: Not required for COTR review.

D. Project information:
1. Data substantiating compliance with specified requirements.
2. Certification that firestopping is compatible with adjacent construction.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Forming material:
a. Base:
(1) Any manufacturer UL listed for system used. See UL "Building Materials Directory".
2. Fill, void or cavity materials:
a. Base:
(1) Any manufacturer UL listed for systems used. See UL "Building Materials Directory".
3. Firestop sealant:
a. Base:
(1) Any manufacturer UL listed for systems used. See UL "Building Materials Directory".
4. Other manufacturers desiring approval comply with Section 01640.

B. Forming material:
1. Inorganic mineral fibers and binders formed into

semi-rigid blankets.
2. ASTM-E84 flame spread: Maximum 25.
3. ASTM-E119 and ASTM-E814 tested as component of assembly.
4. Thickness and density as required to maintain fire rating of assembly.
5. Retainer: Minimum 0.9 mm, Z180, galvanized steel closure.

C. Fill, void or cavity materials:
1. UL listed as component of "Through-Penetration Firestop System".

D. Forming materials:
1. UL listed as component of "Through-Penetration Firestop System".

E. Firestop sealant:
1. UL listed as component of "Through-Penetration Firestop System".
2. Seal all joints, seams and perimeter interfaces with fire and smoke sealant compound which has been tested in accordance with ASTM-E814 to achieve an impervious vapor retarder.

F. Firestop sealer:
1. UL listed as component of "Through-Penetration Firestop System".

G. Curtainwall system:
1. UL listed materials as components of "Glass Curtainwall Fire Containment System".

H. Fire-safing insulation:
1. Materials complying with the fire-safing performance criteria.

PART 3 - EXECUTION

3.01 FORMING OR PACKING MATERIALS

A. Provide in accordance with manufacturer's instructions, to maintain fire separations per UL listing.

B. Remove or leave in place in accordance with UL system.

3.02 FILL, VOID OR CAVITY MATERIALS

A. Provide in accordance with manufacturer's instructions, to maintain fire separations per UL listing.

3.03 FIRESTOP SEALANT OR SEALER

A. Provide in accordance with manufacturer's instructions, to maintain fire separations per UL listing.

3.04 OTHER COMPONENTS

A. Provide other components, like cover plates, retainers, fittings, etc., in accordance with manufacturer's instructions, to maintain fire separations, per UL listing.

3.05 CURTAINWALL FIRESTOPPING

A. Provide in accordance with manufacturer's instructions to maintain fire separation specified.

3.06 FIRE-SAFING

A. Install the fire-safing insulation of required size on 1.52 mm thick galvanized steel safing clips spaced as needed, 457.2 mm on center maximum, in safe-off area between building enclosure assembly and floor slabs (101.6 mm minimum thickness), leaving no voids.

3.07 RESPONSIBILITY

A. Provide a system, or combination of systems which, when installed, will maintain required fire separation.

B. System must provide the fire (F) and temperature (T) ratings as required by applicable codes.

C. Materials and work performed under this section shall be compatible with adjacent work performed under other sections.
   1. System shall not affect performance and installation of adjacent construction.

D. Contractor's option:
   1. Contractor may close large openings using same type of construction as adjacent floor, ceiling or wall assembly to maintain fire separations.
   2. Final closure between assembly and penetrating element must be accomplished using UL systems as indicated above.

E. Perform patching and repair of firestopping systems damaged by work performed under other sections.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definition:
   1. Words "caulk" and "caulking" mean sealant work.
   2. "Interior wet areas" means toilets, showers, and similar areas where sealant is subject to moisture.

B. Seal joints which will permit penetration of moisture or air, unless sealing work is specifically required under other sections.

C. Work included: Provide sealants as follows:
   1. Flashing reglets and retainers.
   2. Exterior wall joints, above and below grade, for each building enclosure assembly, and between building enclosure assembly and adjacent construction.
   3. Masonry control joints, exterior and interior and between masonry and other materials.
   4. Flooring joints.
   5. Isolation joints.
   6. Joints between paving or sidewalks and building.
   7. Joints at penetrations of walls, floors and decks by piping and other services and equipment not requiring firestopping.
   8. Exterior and interior perimeters of exterior and interior door and window frames, louvers, grilles and other framed openings.
   9. Between cabinets, casework, countertops and back splashes where adjacent to walls.
   10. Joints between dissimilar materials, to provide visually acceptable closures.
   11. Solidly bed thresholds at exterior doors.
   12. Other joints where sealant is specified in other sections.
   13. Other joints where caulking, sealant or compressible sealant is indicated on the drawings.

D. Provide sealant work including but not limited to joint cleaning, priming, bond breaking, adhering, masking, and providing backer rods and fillers for complete assemblies.

E. Work of this section excludes:
   1. Sealants in pavements: See Sections 02513 and 02521.
   2. Sealants for firestopping in fire rated assemblies: See Section 07270.

3. Glazing sealants: See Sections 07820, 08800 and 08902.
4. Factory installed sealants within system assemblies where sealant is specified in that section.

1.02 QUALITY ASSURANCE

A. Sealant materials:
1. Sealant specification: ASTM-C920 Type S or M, Grade NS, minimum Class 25.
2. Sealant testing: ASTM-C510; ASTM-C711; ASTM-C719 Class 25, Grade N; ASTM-C792; ASTM-C793; ASTM-C794; and ASTM-C910.
3. Silicone sealant and substrate testing: ASTM-G26, ASTM-C794 and ASTM-D2203.
4. Sealant use: ASTM-C1193.
5. Compressible sealants: ASTM-C509.
6. Compatibility of materials and work performed with adjacent construction, including but not limited to joint substrates, waterstops, waterproofing and other interfacing materials.
a. Manufacturers' field representative to test sealant materials on project for each condition to verify compatibility before installation.

B. Install qualifications:
1. Approved by manufacturer.
2. More than 10 years experience in the installation of sealants of the types specified.

1.03 SUBMITTALS

A. Shop drawings:
1. Details of each condition and type of application of exterior sealant.

B. Product data:
1. Manufacturer's literature and adhesion and other specified test results indicating compliance of sealant materials with quality assurance requirements.

C. Samples:
1. Cured sample of each color for color selection.

D. Project information:
1. Certification of installer qualifications by manufacturers.
2. Silicone sealant certifications and test reports.
3. Field representative reports and other data specified to be submitted.

E. Contract closeout information:

1. Warranties for each type of sealant.

1.04 JOB CONDITIONS

A. Perform sealant work under this section only when ambient temperature is 5 degC or higher.

B. Perform sealant work when joint substrates and weather conditions are dry.

C. Apply only to joints free of material which may inhibit bond.

D. Apply to cementitious materials only when thoroughly cured and dry:
1. Cure concrete at least 28 days.

1.05 WARRANTIES

A. Provide written warranties that sealant work will remain free of defects for period specified for each type of sealant:
1. Failure of watertightness or air tightness constitutes defect.
2. Remove defective work and materials and replace with new work and materials.
3. Repair other work damaged as a result of defective sealant work at no additional expense to Government.
4. Each warranty signed by manufacturer, installer and Contractor.
5. Period of warranties:
a. Silicone sealants: 20 years.
b. Polyurethane sealants: 10 years.
c. Other sealants: 5 years.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Polyurethane sealants:
a. Base:
(1) Tremco.
b. Optional:
(1) Mameco.
(2) Pecora.
(3) Sonneborn Building Products.
(4) Sika.
2. Silicone sealants:
a. Base:

(1) Dow Corning.
b. Optional:
(1) Pecora.
(2) Tremco.
(3) General Electric.
3. Compressible sealant:
a. Base:
(1) Polytite Manufacturing.
b. Optional:
(1) W. R. Grace.
(2) Emseal.
4. Premolded compressible Filler:
a. Base:
(1) Williams.
b. Optional:
(1) Polytite.
(2) Everlastic.
5. Other manufacturers desiring approval comply with Section 01640.

B. Sealants - General:
1. Provide colors specified in Section 09000 or, where not specified, provide custom colors matching color of materials being sealed.
2. Where sealant is not exposed to view, use manufacturer's gray color.
3. Use non-sag sealant in vertical and horizontal joints.
4. Before use of any sealant, investigate its compatibility with surfaces, fillers and other materials in joint system.
5. Use only compatible materials.
6. Obtain sealants from manufacturers who will provide manufacturers' field service representatives at project site for purpose of advising and instructing installers.
7. Sealants specified to be "optionally" provided at particular joints may be provided at those locations instead of sealants specified to be provided, at the Contractor's option.
8. Provide sealant of each general type (silicone, polyurethane) by a single manufacturer.

C. Silicone, two-part, non-acid-curing elastomeric sealant.
1. ASTM-C920 properties:
a. Type M.
b. Grade NS.
c. Class 25 with additional joint movement capability to withstand increase and decrease of 50% of joint width at time of installation as tested in accordance with ASTM-C719 under maximum cyclic movement.

d. Exposure Use T.
e. Joint Substrate Uses M and O as applicable to joint substrates indicated.
f. Cured Shore A hardness of 25 to 30.

2. Provide for exterior and interior expansion, contraction and isolation joints at traffic surfaces, except where compressible sealant is indicated.
3. Provide for other exterior joints at traffic surfaces.
4. Provide for interior joints at cleanroom traffic surfaces.
5. Optionally provide for other interior joints at traffic surfaces.

D. Silicone, one-part, non-acid-curing, low modulus elastomeric sealant.
1. ASTM-C920 properties:
a. Type S.
b. Grade NS.
c. Class 25 with additional joint movement capability to withstand increase and decrease of 50% of joint width at time of installation as tested in accordance with ASTM-C719 under maximum cyclic movement.
d. Exposure Use NT.
e. Joint Substrate Uses A, G, M and O as applicable to joint substrates indicated.
f. Cured Shore A hardness of 15 to 20.
g. Ultimate elongation of minimum 1200%.

2. Provide for exterior and interior expansion, contraction and isolation joints at non-traffic surfaces, except where compressible sealant is indicated.
3. Provide for other exterior joints at non-traffic surfaces.
4. Provide for joints at the interior of exterior wall, window and door assemblies.
5. Provide for interior joints at cleanroom non-traffic surfaces.
6. Optionally provide for other interior joints at non-traffic surfaces except:
a. Joints at ceramic tile surfaces or "interior wet areas".
b. Joints of 4.75 mm or less width.

E. Additional requirements for silicone weather sealants:
1. Contractor shall provide certification from sealant manufacturer that the sealant manufacturer has reviewed all sealant details and finds the details suitable for the purpose intended and compatible with the surfaces with which they are in contact.
2. The sealant manufacturer shall submit certification of

compatibility that all substrate materials in contact with the sealants are compatible with the sealants as tested after 21 days constant exposure to ultraviolet light in accordance with ASTM-G26 followed immediately by adhesion tests in accordance with ASTM-C794.

3. The sealant manufacturer shall provide written certification that the silicone sealant will not stain any adhered adjacent materials for a period of 20 years from the date of acceptance and shall also provide test results that have been performed on substrate materials in accordance with ASTM-D2203.
4. The sealant manufacturer shall provide written certification that the silicone sealant intended shall maintain its full strength and adhesion characteristics through the full shelf life, up to the last day.

F. Polyurethane, two-part, non-sag elastomeric sealant.
   1. ASTM-C920 properties:
      a. Type M.
      b. Grade NS.
      c. Class 25.
      d. Exposure Use T.
      e. Joint Substrate Uses A, M and O as applicable to joint substrates indicated.
      f. Cured Shore A hardness of 20 to 40.
   2. Optionally provide for interior joints at traffic surfaces except:
      a. Expansion, contraction or isolation joints.
      b. Joints in cleanrooms.

G. Polyurethane, multi-part, non-sag elastomeric sealant.
   1. ASTM-C920 properties:
      a. Type M.
      b. Grade NS.
      c. Class 25.
      d. Exposure Use NT.
      e. Joint Substrate Uses A, G, M and O as applicable to joint substrates indicated.
      f. Cured Shore A hardness of 20 to 40.
   2. Optionally provide for interior joints at non-traffic surfaces except:
      a. Expansion, contraction or isolation joints.
      b. Joints in cleanrooms.
      c. Joints at ceramic tile surfaces or "interior wet areas".
      d. Joints of 4.75 mm or less width.

H. Silicone, one-part, mildew-resistant elastomeric sealant.
   1. ASTM-C920 properties:
      a. Type S.

b. Grade NS.
c. Class 25.
d. Exposure Use NT.
e. Joint Substrates Uses A, G and O as applicable to joint substrates indicated.
f. Cured Shore A hardness of 25 to 30.

2. Provide for interior joints at non-traffic ceramic tile surfaces and "interior wet areas", except expansion, contraction or isolation joints.
3. Optionally provide for other interior joints at non-traffic surfaces except:
   a. Expansion, contraction or isolation joints.
   b. Joints of 4.75 mm or less width.

I. Synthetic rubber sealant:
1. Solvent-release-curing pigmented synthetic rubber formulated for sealing interior joints of 4.75 mm or less width.
2. Provide for interior joints of 4.75 mm or less width at non-traffic surfaces except:
   a. Expansion, contraction or isolation joints.

J. Joint cleaner, primer, bond breaker: Recommended by sealant manufacturer and suitable for purpose intended.

K. Sealant backer rod:
1. Rod stock of polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material compatible with sealant and recommended by sealant manufacturer to:
   a. Control joint depth.
   b. Break bond of sealant at bottom of joint.
   c. Provide proper shape of sealant.
   d. Suitable for other intended purposes.

L. Sealant, compressible:
1. Provide width of material twice joint width.
2. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing agent.
3. Concealed compressible sealant: Coated on front face with non-reactive release agent that acts as bond breaker, Polytite-B.
4. Exposed compressible sealant: Coated on front face with an elastomeric membrane, color as selected, Polytite-R.
5. Provide where indicated at expansion, contraction or isolation joints.

M. Adhesive for compressible sealant: Recommended by sealant manufacturer and suitable for intended purpose.

N. Premolded compressible filler:
1. Closed cell expanded neoprene.
2. Oil and solvent resistant.
3. Compatible and suitable for intended purpose.
4. Williams Neoprene Type NN1.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean joint substrates.
1. Remove dust, dirt, oil, grease, water repellents, waterproofing, water, frost and paint, except for permanent protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer.
a. Porous joint substrates: Clean concrete, masonry and other porous substrates by brushing, grinding, blasting, mechanical abrading, acid washing or combination of these methods to produce sound substrates capable of optimum bond with sealant.
(1) Remove loose particles by vacuuming or blowing out with oil-free compressed air.
(2) Remove laitance and form release agents from concrete.
b. Non-porous substrates: Clean metal, glass and other non-porous substrates with chemical cleaners or by other means to remove residues capable of interfering with adhesion of sealant.

B. Where finish coating or covering is to be applied to surface (e.g., paint, wall covering, glazed coating), wait until such coating or covering has been applied and dried or cured at least 24 hours before installing sealant.

3.02 INSTALLATION

A. Make joints water and air tight.

B. Prime joint surfaces.
1. Limit application to surfaces to receive sealants.
2. Mask off adjacent surfaces with non-staining, non-absorbent masking tape compatible with sealant and surfaces.

C. Make depth of sealant not more than one-half width of joint, but in no case less than 6 mm.

D. Subcaulk joints without suitable backstop, to proper depth.

E. Provide correctly sized backer rods.

F. Apply bond breaker as required or recommended by sealant manufacturer.

G. Tool sealants using sufficient pressure to fill voids.

H. Upon completion, leave caulking smooth and even.

I. Provide compressible sealant to position at indicated depth.
   1. Take care to avoid contamination of sides of joint.
   2. Protect side walls of joint (to depth of caulking).
   3. Install with adhesive faces in contact with joint sides.

J. Install to completely fill voids.

K. Application of sealants:
   1. Sealants shall be used in strict accordance with the sealant manufacturer's printed instructions. Sealants shall be applied only by mechanics specially trained or experienced in their use.
   2. Prior to the application of sealants, completely remove all foreign matter which may be deleterious to the adhesion of the sealants.
   3. Properly prepare substrate surfaces.
   4. Comply with the printed instructions of sealant manufacturer regarding joint size, limitations, backer rod, mixing, cleaning, surface preparation, priming and application. A primer shall be used, unless the sealant manufacturer advises to the contrary and the sealant manufacturer provides certification that the use of a primer will reduce sealant performance. Sealant shall not be applied when any moisture is present on the substrates or when the surface temperature is below 5 degC.
   5. Care shall be exercised to insure against "Three Surface Adhesion". Bond breakers shall be provided where required.
   6. All adjoining surfaces shall be masked to maintain a clean and neat appearance. Sealing compounds shall be dry positive compression tooled to fill the joint and provide a smooth finish surface and shall be similar in appearance to an extruded product (gasket-like in appearance and configuration).
   7. The sealant manufacturer, along with its distributors, agents and brokers, shall maintain an environmental condition during shipping and storage that shall not be detrimental to the silicone sealants integrity or

shelf life. Contractor shall maintain a nondetrimental environmental condition when handling or storing the sealant.

END OF SECTION

SECTION 06000

CARPENTRY

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Lumber grading rules and species:
   1. US Department of Commerce, PS 20-70.
   2. Western Wood Products Association (WWPA).
   3. Southern Forest Products Association (SFPA).

B. Plywood grading rules and recommendations:
   1. For softwood plywood: US Department of Commerce PS 1-83.
   2. For hardwood plywood: US Department of Commerce PS 51-71.
   3. American Plywood Association (APA).

C. Factory marking:
   1. Identify type, grade, moisture content, inspection service, producing mill, and other qualities.
   2. Marking may be omitted if certificate of inspection is provided for each shipment.
      a. Mark each piece of fire retardant treated material.

D. Standards for fire hazard classification for fire retardant treated material: Underwriters' Laboratories, (UL) BPVV-723 and American Wood Preservers Institute (AWPI).
   1. Test method: ASTM-E84.

E. Preservative and pressure treatment standards: American Wood Preservers Association (AWPA).
   1. Provide continuous monitoring of production and kiln temperatures by third party inspection agency to assure that production methods are same as those used on elevated temperature strength test specimens. Indicate compliance in factory marking.

F. Workmanship finish carpentry: Architectural Woodwork Institute (AWI) Premium Grade Standards.

1.02 SUBMITTALS

A. Shop drawings:
   1. Finish carpentry.

B. Product data:

1. Certification of preservative or fire retardant treated material.
2. AWI Certification for all plywood products.

C. Samples:
1. Finish carpentry materials, color and finish.

D. Project information:
1. Independent laboratory test results for fire retardant treated material.

E. Contract closeout information: Not required for COTR review.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store in dry, weathertight, ventilated spaces.

B. Do not bring items into building until receiving spaces have humidity controlled to between 25 percent and 65 percent.

C. Stack to provide air circulation.

D. Store and protect materials in areas where moisture content can be maintained.

E. Time delivery and installation to avoid delaying progress of other work.

F. Handle treated material and repair damage in accordance with AWPA M-4.

1.04 JOB CONDITIONS

A. Drawings indicate type, arrangement, and location of items of finish carpentry.

B. If variations from arrangement or profile indicated are required notify COTR.

C. Make such variations at no added expense to COTR.

D. Contractor is responsible for fitting to recesses, including trim pieces, fillers and closures.

1.05 LOCATIONS OF TREATED MATERIALS

A. Provide preservative treated material at the following locations:
1. Members used outside buildings.

2. Members exposed to the exterior.
3. Members exposed to the earth or otherwise located below finished grade.
4. Members within exterior wall assemblies.
5. Members that are part of the roof structure.
6. Members that are used for the principle mechanical fastening or anchoring of roofing or parapet assembly components.

B. Provide fire retardant treated material at the following locations:
1. Members within building including members exposed to the interior and members within partitions and other fully interior assemblies.
2. Blocking, cants and other non-structural members within roofing or parapet assemblies.
a. Not used for the principle mechanical fastening or anchoring of roofing or parapet assembly components.

PART 2 - PRODUCTS

2.01 MATERIALS - ROUGH CARPENTRY

A. Acceptable manufacturers:
1. Preservative treated fire retardant and preservative treated lumber:
a. Base:
(1) Hoover Treated Wood Products, Inc.
b. Optional:
(1) Hickson Corporation.
(2) Chemical Specialties, Inc.
2. Other manufacturers desiring approval comply with Section 01640.

B. Lumber for framing, blocking, nailers, furring, grounds, and similar members:
1. Comply with dry size requirements of PS-20, Douglas fir WWPA No.3, or SFPA No.2.
2. Thoroughly seasoned, well fabricated materials of longest practical lengths and sizes.
3. Free of non-correctable warp.
4. Discard material which would impair quality of work.

C. Plywood:
1. PS1, exterior type, A-C Grade.
2. Provide MDO-EXT-APA Plywood, as indicated.

D. Preservative treated material:
1. Treated lumber standard: AWPA C-2.

2. Treated plywood standard: AWPA C-9.
3. Preservative treatment standard: AWPA P-5.
4. Kiln dry to 15 percent moisture content.
5. Where possible, precut material before treatment.
6. Use salt preservative treatment on material used in conjunction with roofing systems.

E. Fire retardant treated material:
1. Treated lumber standard: AWPA C-20.
   a. Kiln dry to 19 percent moisture content.
2. Treated plywood standard: AWPA C-27.
   a. Kiln dry to 15 percent moisture content.
3. Maximum flame spread rating: 25, ASTM-E84.
4. Use treatment which will not bleed through or adversely affect bond of applied finish.
5. Use Type A fire retardant chemical formulation to produce treated lumber and plywood with following properties after installation.
   a. No reduction in bending strength, stiffness and fastener holding capacities under elevated temperatures and humidity conditions, based on independent laboratory tests under simulated conditions.
   b. No form of degradation due to acid hydrolysis or other causes related to manufacture or treatment.
   c. No corrosion of metal fasteners in contact with treated lumber or plywood.
6. Provide UL (BPVV) label or certificate for each piece of fire retardant treated material.

F. Anchorage and fastening materials: Proper type, size, material and finish for application, suitable for purpose intended, and that will not exhibit any type of degradation whatsoever during its intended use.

G. Additional requirements for fire retardant treated material for blocking, cants and other non-structural members within roofing or parapet assemblies:
1. Members shall be of proper dimension for use.
   a. Roofing assembly manufacturer shall submit certification that members are suitable for purposes intended and compatible with all surrounding materials, in addition to label or certificate of fire retardant treatment.
2. Members shall be non-combustible treated fire retardant wood complying as tested in accordance with the following:
   a. ASTM-D2898.
   b. ASTM-D3201.
   c. ASTM-ES20 for softwood plywood.
   d. ASTM-E160.

e. ASTM-E69.

3. Members shall be kiln dried after treatment to achieve maximum moisture content of 15 percent when tested in accordance with ASTM-D3201.
4. Use treatment which will not bleed through or adversely affect bond of applied surfacing.
5. Use fire retardant chemical formulation to produce treated material with following properties after installation:
   a. No reduction in bending strength, stiffness and fastener holding capacities under elevated temperatures and humidity conditions, based on independent laboratory tests under simulated conditions.
   b. No form of degradation due to acid hydrolysis or other causes related to manufacture or treatment.
   c. No corrosion of metal fasteners in contact with treated material.
6. Provide UL (BPVV) label or certificate for each piece of fire retardant treated material.

2.02 MATERIALS - FINISH CARPENTRY

A. Acceptable manufacturers:
   1. Plastic laminate:
      a. Base:
         (1) Formica Corporation.
      b. Optional:
         (1) Nevamar Corp.
         (2) Wilsonart International.
   2. Hanging track reveals:
      a. Base:
         (1) Pittcon Industries.
      b. Optional:
         (1) Gordon, Inc.
         (2) USG Corp.
   3. Other manufacturers desiring approval comply with Section 01640.

B. Plywood exposed:
   1. AWI Grade I.
   2. Species: Rift-cut cherry.
      a. Hardwood Plywood and Veneer Association (HPVA) HP-1 AA face grade.
      b. Smooth texture.
   3. Veneer or particle core.
   4. Fabricate with Type II (waterproof) adhesive.
   5. Minimum 6 mm thick solid hardwood edges, grade to match panel veneer.
   6. Plywood panel veneer: Book matched and sequence matched.

7. Factory finish: AWI Premium Grade System No.5, Catalyzed Polyurethane.

C. Hardwood: Solid, S4S, Rift-cut cherry.

D. Plywood panel fasteners: Concealed metal fastener bars with stainless steel trim:
   1. Finish: Type 304 stainless steel.
      a. ASTM-A480 No.4 satin finish.

E. Plastic laminate: NEMA LD-3, Type GP-50, 1.27 mm thick, Style D, Grade HP, Class 1.
   1. Color and finish: Section 09000.
   2. Fabrication: Fed. Spec. L-T-41.
      a. Solid, one piece to within commercial size limitations, uniform thickness, straight edges, flat faces, free of warp and twist.
      b. Edges and cutouts: Sealed against moisture.
      c. Joints: Located to be inconspicuous.
      d. Corners: Mitered.

F. Hanging track reveals:
   1. Pittcon Model numbers:
      a. SWR-050-HT.
      b. SWC-050-HT.
   2. Modify top flange for profiles indicated on the drawings.
   3. Alloy 6063T5 aluminum.
   4. Finish: Factory prime painted.
   5. Accessories: Deliver to COTR, do not install.
      a. Tack strip insert.
      b. 200 spring clip hanging hooks.
      c. 200 aluminum hanging inserts and set screws.
      d. 100 m spool of flexible hanging wire.

G. Tackboards:
   1. Vinyl fabric laminated to face to cork sheet that is pressure laminated to backing board.
   2. Vinyl fabric: Fed Spec., CCC-W0408, Type II, mildew resistant, flame spread of 25 or less per ASTM-E84, washable with integral color throughout, color FAB-1 in Section 09000.
   3. Cork sheet: MIL-C 15116, ground natural cork compressed with resinous binder, minimum 6 mm thick.
   4. Backing board: Exterior grade plywood or hardboard, minimum 6 mm thick.

2.03 FABRICATION - FINISH CARPENTRY

A. Finish plywood panel edges to match exterior surfaces.

B. Assemble without use of exposed fasteners.

C. Dado and glue hardwood edging in place.

D. All plywood panels to be removable.

PART 3 - EXECUTION

3.01 PREPARATION - ROUGH CARPENTRY

A. Verify measurements, dimensions and drawing details before proceeding.

B. Coordinate location of furring, nailers, blocking, grounds and similar supports for attached work.

C. Examine conditions under which work is to be installed.

D. Before proceeding with work under this section, correct unsatisfactory conditions.

3.02 INSTALLATION - ROUGH CARPENTRY

A. Attach work under this section securely by anchoring and fastening as indicated or required to support applied loading.
   1. Provide washers under bolt heads and nuts.
   2. Nail plywood in accordance with APA recommendations.
   3. Countersink nail heads.
   4. Fill holes with matching filler.

B. Set work under this section to required levels and lines, plumb, true.

C. Cut and fit accurately.

D. Make connections tight.
   1. Use common wire nails or screws for general work.
   2. Use finishing nails for finish work.
   3. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
   4. Install fasteners without splitting wood; predrill as required.
   5. Do not drive treaded friction type fasteners.
   6. Tighten bolts and lag screws at installation and retighten as required.
   7. Use galvanized nails and fasteners.

E. Provide wood grounds, nailers, or blocking as required for

attachment of other work under this section and work under other sections including surface applied items.

F. Form to shapes indicated.

G. Provide wood blocking between studs at height of door stop, behind stop, at every door opening.

H. Grounds: Dressed, key bevelled lumber minimum 38 mm wide of thickness required to bring face of ground even with finish material.

I. Remove temporary grounds when no longer required.

J. Install wood furring plumb and level with closure strips at edges and openings.

K. Shim as required.

L. Field treat cuts and holes in preservative and fire retardant treated material in accordance with AWPA Standard M-4.

M. Provide roofing nailers as indicated:
1. Match height of nailers to insulation.
2. Anchor nailers to resist force of 111 kg/m.
3. Use minimum of 3 anchors for each nailer, with 13 mm vent spaces nominally 600 mm OC.

3.03 INSPECTION - FINISH CARPENTRY

A. Examine areas to receive work.

B. Correct unsatisfactory conditions.

C. Start of work constitutes acceptance of responsibility for performance.

3.04 INSTALLATION - FINISH CARPENTRY

A. Set items in proper location, assemble, level, neatly fit, and secure in place.

B. Display wall:
1. Install rails and stiles plumb and square.
a. Prepare for field applied stain finish.
2. Install hanging reveal track in top rails.
a. Prepare for field applied paint finish.
3. Fit as indicated, including:
a. Removable panels.
b. Tackboards.

3.05 INSTALLATION - PLYWOOD PANELING

A. Factory finish premium grade paneling.

B. Apply two coats of sealer to back of paneling before installation.

C. Install grounds on wall as indicated to receive paneling.

D. Install concealed clip bars and trim:
   1. Vertical members continuous.
   2. Horizontal members continuous between verticals.
   3. Perimeter: Continuous with mitered corners.

E. Install factory finished panels with grain and color blended panel-to-panel.
   1. Grain direction shall match panel-to-panel.
   2. Color blending shall be provided to the satisfaction of the COTR.

3.06 PREPARATION FOR FINISH

A. Set nails.

B. Fill holes.

C. Sand smooth before application of finishes.

D. Leave ready for finishing.

3.07 ADJUST AND CLEAN

A. Promptly remove debris, dirt and rubbish.

B. After installation, adjust operating parts.

C. Leave items in perfect operating condition.

D. Remove and replace rejected work.

E. Provide temporary coverings to protect installed work.

END OF SECTION

SECTION 11460

UNIT KITCHENS (UK)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide factory fabricated unit kitchens complete with cabinets, sink-top and sink, and undercounter refrigerator.

1.02 QUALITY ASSURANCE

A. Manufacturer's qualifications:
   1. More than 5 years experience in the manufacture of unit kitchens of the type specified as one of its principal products.
   2. At least 10 installations of unit kitchens with requirements similar to the product specified.

B. Warranty:
   1. Provide written, minimum 5 years warranty on the refrigeration system.
   2. Warranty signed by the unit kitchen manufacturer.

1.03 SUBMITTALS (See Division 1)

A. Shop drawings:
   1. Fabrication and installation drawings including connections to utility services.

B. Product data:
   1. Manufacturer's standard catalog data for unit kitchens provided under this section.

C. Samples:
   1. Before fabrication, three samples of baked enamel color for approval of appearance.

D. Project information:
   1. Certification of manufacturer's qualifications.

E. Contract closeout information:
   1. Warranties.
   2. Manufacturer's operating and maintenance manuals.

PART 2 - PRODUCTS

2.01 UNIT KITCHENS

A. Acceptable manufacturers:
    1. Base:
        a. Dwyer Products Corp.
    2. Optional:
        a. Cervitor Kitchens Incorporated.
    3. Other manufacturers desiring approval comply with Section 01640.

B. Partially and fully recessed unit kitchen assemblies:
    1. Unit kitchens #1 (UK-1):
        a. Components:
            (1) Base cabinets.
            (2) Sink-top and sink.
            (3) Removable undercounter refrigerator.
    2. Unit kitchen #2 (UK-2):
        a. Components:
            (1) Base and wall cabinets, with backwall shield.
            (2) Sink-top and sink.
            (3) Upright refrigerator/freezer.
            (4) Electric cooking surface.
            (5) Undercounter dishwasher.
    3. Depths: 635 mm at sinktop, and 673 mm including base cabinet door pull projection.
    4. Heights:
        a. Sink-top above finished floor.
        b. Clear above sink-top, below shelf or wall cabinets.
        c. Countertop above finished floor, where located over undercounter refrigerator or undercounter dishwasher.

C. Cabinets:
    1. Cabinet construction:
        a. Cabinet doors and drawer fronts 22-gauge textured steel, reinforced and sound-deadened.
        b. Sides of cabinets shall be constructed of 22-gauge steel.
        c. Wall cabinets shall be constructed with flush double bottoms.
    2. Cabinet finish:
        a. Baked enamel finish.
        b. Color: Custom color as selected by COTR.
    3. Recessed base:
        a. Recess depth: 75 mm.
        b. Height: 100 mm.
    4. Base cabinet:
        a. Depth: 620 mm.
    5. Wall cabinets:
        a. Depth: 330 mm.
    6. Hardware:
        a. Drawer guides: With nylon rollers providing a positive stop.

b. Hinges: Concealed, self closing and adjustable.
c. Shelves: Rolled fronts, adjustable.
d. Pulls: Eurostyle flush pulls.

D. Sink-top and sink:
1. Sink-top:
a. Sink-top shall be standard post-forming, self-edge grade finish high pressure laminate meeting or surpassing N.E.M.A. standards and Federal specifications.
b. Particle board shall be grade ANSI-1-M-3 with density of 45 pfc, internal bond 100 psi, screw holding of 250 pounds (face), and screw holding of 225 pounds (edge).
2. Backsplash and upturned sink-top ends.
a. Height: 100 mm.
b. End and top depth: 40 mm.
3. Sink assembly:
a. Polished chrome faucet with dual wrist-blade handles.
b. Sink bowl: 16 gauge (type 304) chrome/nickel stainless steel drop-in type, polished to a No. 4 brushed-satin finish.
(1) Nominal 300 x 450 mm bowl.
(2) 152 mm deep at units #UK-1.
(3) 165 mm deep at unit #UK-2.
c. Drain and strainer: 90 mm.

E. Removable undercounter refrigerator:
1. Capacity: 0.17 m3.
2. Fan cooled condenser.
3. Interior light.
4. Push-button defrost.
5. Seamless interior.
6. Frozen food storage compartment.
7. Wired for 115-volt, 2-wire, 60-cycle AC.
8. Door faced and trimmed to match base cabinet finish and color.

F. Upright refrigerator/freezer:
1. Capacity: 0.34 m3.
2. Frost-free.
3. Interior light.
4. Seamless interior.
5. Freezer compartment.
6. Icemaker.
7. Wired for 115-volt, 2 wire, 60 cycle AC.
8. Door faced and trimmed to match base cabinet finish and color.

G. Electric cooking surface:

1. Two burner units.
2. Safety switches.
3. Signal lights.
4. Install sink-top/countertop extension.
5. Wired for 208 Volt.

H. Undercounter dishwasher:
1. 610 mm wide unit.
2. Hard wired: 120-volt.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit kitchens in accordance with manufacturer's instructions at locations Indicated on Drawings.

B. Connect sinks, garbage disposals, refrigerators, microwave ovens, cooking surfaces and dishwashers to utility services.

3.02 ADJUSTMENTS AND CLEANING

A. Test and adjust items of equipments for satisfactory operation.

B. Adjust hinges for proper door alignment and operation.

C. Repair damages, remove debris and clean exposed surfaces.

END OF SECTION

SECTION 11724

METAL INSULATED WALL PANELS AND DOORS (MIP)

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Metal insulated wall panels shall be UL listed and meet requirements of FM Class I for Building Materials.

B. Manufacturers must have minimum five installations of similar design.

1.02 SUBMITTALS

A. Shop drawings:
   1. Complete installation drawings of all temperature control labs.
      a. Indicate panel layouts, and anchoring methods.
      b. Indicate arrangement and size of components.
      c. Indicate all locations of mechanical and electrical penetrations.

B. Product data:
   1. Manufacturer's literature.

C. Samples:
   1. Finishes.

D. Project information:
   1. Manufacturer's qualifications.
   2. Certification of compliance with UL and FM requirements.

E. Contract closeout information:
   1. Operating and maintenance data.
   2. COTR instruction report.
   3. Warranty.

1.03 WARRANTY

A. Written warranty signed jointly by fabricator, installer and Contractor, agreeing to repair or replace work performed under this section which fails.
   1. Failure includes defects in materials, workmanship, air tightness of assembly, calking, glazing or other defects in system which affects its ability to perform as airtight envelope.
   2. Warranty period: 5 years.

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. Acceptable products:
    1. Metal Insulated Wall Panels:
        a. Base:
            (1) Tafco.
        b. Optional:
            (1) Aluma Shield.
            (2) Kolpak.
            (3) W.A. Brown

B. Sheet metal for insulated wall panels:
    1. 0.85 mm thick Z275 galvanized steel facings.

C. Insulation:
    1. Rigid polyurethane or polyisocyanurate foam.
    2. Density no less than 40 kg/m3.
    3. Thermal conductivity k-value not to exceed 0.0175 W/mk.
    4. Shear strength no less than 182 kPa.
    5. Tensile strength no less than 170 kPa.
    6. Compressive strength no less than 92 kPa.
    7. 95 percent closed cell structure.
    8. Flame spread of 25 or less and smoke developed of 450 or less in accord with ASTM-E84.
    9. Core thermal properties:
        a. Withstand humidity aging at 72 degC and 100 percent relative humidity for duration of seven days with a volume increase not greater than 7.3 percent in accordance with ASTM-D2161.
        b. Withstand heat aging at 95 degC for duration of 28 days with volume expansion not to exceed 1.8 percent in accordance with ASTM-D2161.
        c. Withstand cold aging at -28 degC for duration of 28 days with volume loss not to exceed 0.3 percent in accordance with ASTM-D2126.

D. Insulated wall panels:
    1. Interior and exterior metal pan skin and rigid polyurethane or polyisocyanurate foam core without internal wood or metal structural members.
        a. Minimum 100 mm thick, except provide 25 mm thick panels where indicated to extend panel coverage over structural members.
    2. Interchangeable panels in modular widths 1200 mm or as indicated.
        a. All panels will be removable without dismantling of adjacent wall.

3. Panel edges formed with continuous tongues and grooves with continuous flexible vinyl gasket on tongue edge.
    a. Panel edges will be sealed with metallic tape to prevent shedding.
4. Panel locking devices spaced at a maximum of 1150 mm OC.
    a. Panel locking devices consist of a cam-action hooked locking arm engaging a steel rod set in the adjacent panel.
    b. Locking arm and steel rod shall be housed in steel pockets, set into panel and anchored through panel with 50 mm steel straps.
    c. Locking wrench shall be supplied as part of the room.
5. Reinforce metal panel skin at anchors.
6. Corner panels formed 90 degree angled panels.
7. All panels to meet Factory Mutual Standard No. 4480.
8. Factory cut and reinforce all openings for mechanical and electrical penetrations.
9. Finish: Baked polyester.
10. Color: Match existing.

E. Temperature control doors and frames:
1. Door:
    a. In-fitting flush mounted design.
    b. Insulated with 100 mm poured-in-place rigid polyurethane or polyisocyanurate.
    c. Thermoplastic gasket with magnetic steel core seal, on top and both sides of door.
    d. Dual blade, rubber wiper gasket on bottom of door.
2. Door panel:
    a. 1.8 mm "U" channel reinforced steel frame around perimeter of opening.
3. Frame: 130 mm, inside and outside casing, constructed of 1.5 mm minimum galvanized steel.
4. Hardware:
    a. Satin finish aluminum.
    b. Minimum three hinges per door leaf, self-closing, spring loaded type with stainless steel pin and delrin cam-type bearing.
    c. Surface mounted flush bolts (inactive leaf).
    d. Aluminum threshold with thermal break.

F. Insulated doors and frames:
1. Door:
    a. Hollow metal 45 mm thick with minimum 1.2 mm galvanized face sheets and flush top closures with joints welded filled and ground.
    b. Insulated with 45 mm poured-in-place rigid polyurethane or polyisocyanurate insulation.
    c. Thermoplastic gasket with magnetic steel core

seal, on top and both sides of doors.
d. Dual blade, rubber wiper gasket on bottom of door.
e. RIS value (Thermal resistance in metric units) of 1.9 m2/k/W.

2. Frame: 75 mm, inside and outside casing, constructed of 1.5 mm minimum galvanized steel.
3. Hardware:
a. Satin finish aluminum.
b. Minimum two hinges per door, self-closing, spring loaded type with stainless steel pin and delrin cam type bearings.

G. Insulated window:
1. Complete extruded aluminum framing system and glazing.
a. ASTM-B221, 6063-TS alloy.
2. Include sills, mullions, division bars, anchors and accessories.
3. Use no through metal connectors.
4. Provide system to receive 25 mm insulating glass.
5. Structural thermal barrier:
a. Poured in place rigid polyurethane or polyisocyanurate.
b. Self adhering to aluminum members.
6. Finish:
a. Color: Match existing.
b. Minimum 70 percent Kynar resin 0.025 mm thick.

H. Fasteners:
1. Non-magnetic 300 series stainless steel which will not cause electrolytic action or corrosion.
2. Provide Phillips flat head screws where exposed.
3. Finish exposed fasteners to match panel finish.

I. Sealants:
1. See Section 07900.
2. Use exposed sealants of color to match aluminum finish.
3. Provide sealants and calking required as work of this section.

J. Glass:
1. 25 mm insulating unit complying with Glass Type 6.
2. Provide as work of this section.

K. Brackets, anchors and reinforcements:
1. 300 series stainless steel.

L. Trim:
1. Galvanized steel with finish and color to match adjacent insulated wall panel facings.
2. Shape and size as indicated on drawings.

M. Composite insulation strips:
    1. 75 mm wide x 10 mm thick in 2 layers:
        a. 5 mm thick 30 Durometer neoprene.
        b. 5 mm thick medium density closed cell sponge neoprene foam.

N. Shim strips:
    1. 95 mm wide x 5 mm thick 50 Durometer neoprene.

2.02 FABRICATION

A. Fabrication - general:
    1. Combine all products under responsibility of prefabricated room manufacturer.
    2. Provide all components indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 13001

CLEAN ZONE GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section specifies the general requirements for every person who performs any work or function within the defined boundaries of the Clean Zone.

B. The objective of this Section is to provide a controlled clean environment within which all mechanical, electrical, cleanroom systems, and process piping will be installed.
   1. This clean environment shall be maintained from the initial construction stage through final cleanroom certification.
   2. All products brought into the Clean Zone shall meet minimum cleanliness standards on both interior and exterior surfaces.
   3. Personnel cleanliness levels and construction protocol standards shall be established and monitored for each construction stage.
   4. Active contamination controls will be enforced consistent with each construction stage.
   5. The required level of cleanliness will be monitored using spot checks at prescribed locations.

1.02 DESCRIPTION

A. Cleanrooms as specified in this section and as indicated on the drawings shall be constructed by a Cleanroom Contractor responsible for compliance with the documents.
   1. The Cleanroom Contractor shall provide a Clean Zone Director for the duration of all construction and start-up activities covered by this section.
   2. The Contractor shall employ and pay for the services of a qualified cleanroom testing and certification contractor (Certifying Agency) as a subcontractor to perform services specified in Section 13003.
   3. This subcontractor shall be independent from the Cleanroom Contractor, system manufacturer and the installer.
   4. Clean Zone Director shall have a minimum ten years experience in the construction of cleanrooms.
   5. Clean Zone Director shall have completed a minimum of two projects dealing with submicron wafer technology under Class M3.5 or better.
   6. Clean Zone Director shall have full authority over all construction procedures and personnel in the Clean

Zone Area.

7. Clean Zone Director shall initiate weekly meetings to be attended by all contractors installing equipment in Clean Zone.
   a. Clean Zone Director shall keep minutes of all meetings, establish the agenda and maintain coordination between trades working in the Clean Zone.
8. Clean Zone Director shall log and document all staged construction events.
9. Clean Zone Director shall organize and lead protocol training sessions required to assure compliance with the documents and construction requirements.
10. Clean Zone Director shall, or shall coordinate, all cleaning procedures, testing and balancing and commissioning procedures specified in the documents.

1.03 CLEAN ZONE BOUNDARIES

A. Clean Zone includes cleanrooms scheduled in Section 13003, and remote rooms for cleanroom support equipment, bounded by and inclusive of:
   1. Top of isolation floor slab below.
   2. Bottom of structural slab above.
   3. Perimeter walls on all sides.

1.04 CLEAN ZONE CONSTRUCTION STAGES

A. Milestones for scheduling construction stages include:
   1. Stage 1 - Building Shell Enclosed.
   2. Stage 2 - Clean Zone Perimeter Boundaries Enclosed.
   3. Stage 3 - Cleanroom Walls, Floors, and Ceiling Assembly Completed.
   4. Stage 4 - Ceiling HEPA Filters Installed.
   5. Stage 5 - Certification Tests Completed.

1.05 DEFINITIONS

A. Refer to Federal Standard 209E for a complete list of definitions appropriate to cleanrooms.
   1. Specific words and phrases used within these Contract Documents are defined below for easy reference.

B. As-Built Facility: Cleanroom which is complete and ready for operation, with all services connected and functional, but without production equipment or personnel within the room.

C. At-Rest Facility: Cleanroom which is complete and has production equipment installed and operating, but without personnel within the room.

D. Basement: A defined utility area bounded by the building slab-on-grade below, the bottom of the cleanroom structural floor slab above, and the perimeter boundary walls on all sides, including all spaces, products, and utilities within.

E. Certifying Agency: The cleanroom testing and certifying firm or agency retained by the Contractor to assist and verify Acceptance and performance of all cleanroom systems. Also referred to as the Quality Assurance Agency.

F. Classes of Cleanliness: Statistically allowable number of particles of a given size per cubic foot volume of air. For this project, the concentration and size of particles shall meet the requirements of Federal Standard 209E, measured at 0.5 micrometers.

G. Cleanroom: A defined clean area or room in which the concentration of airborne particles is controlled to specified limits. For this project, that shall be defined as the space bounded by the cleanroom structural floor slab below, the cleanroom filtered ceiling grid above, and the perimeter cleanroom walls on all sides, including all spaces, products, and utilities within.

H. Clean Zone: A defined clean area in which the concentration of airborne particles is controlled to specified limits. For this project, that shall be defined as the building space described in Article, Clean Zone Boundaries, bounded by and inclusive of top of isolation floor slab below, bottom of structural slab above, and the perimeter fire/separation/boundary walls on all sides, which encompass any and all cleanrooms of any cleanliness classification, as well as any remote special rooms for cleanroom support equipment, including all spaces, products, and utilities within.

I. Clean Zone Construction Stage: See Stage.

J. Clean Zone Director: The person vested with authority by the Cleanroom Contractor to supervise all construction personnel working within the Clean Zone and ensure requirements of the Contract Documents are met in completion of the Clean Zone construction, including all spaces, products, and utilities within.

K. Fan Attic: A defined clean area bounded by the existing top of the concrete recirculation air support structure and the bottom of the building roof membrane above, and

the perimeter fire/separation/boundary walls on all sides, including all spaces, products, and utilities within.

L. Interstitial: A defined clean area bounded by the plane of the cleanroom filtered ceiling below, the bottom of the fan attic floor above, and the perimeter fire/separation/boundary walls on all sides, including all spaces, products, and utilities within.

M. Office Clean: A standard of cleanliness commonly maintained in finished commercial office spaces, with no visible residues of dirt, dust, oil, grease, or debris, on the floor, walls, or work stations, as normally achieved by cleaning, wiping, and vacuuming.

N. Operating Facility: Cleanroom in normal operation with all services functioning and with production equipment and personnel present and performing their normal work functions within the room.

O. Products: Materials, equipment, physical items, and packaged systems.

P. Quality Assurance Agency: The quality assurance cleanroom certifying firm or agency retained and paid for by the Contractor to spot check and verify proper cleanroom construction and performance.

Q. Stage: The phase or degree of construction completion that mandates specific activities, training, security clearance, dress and work protocol, cleaning procedures, work habits, and system performance, all as defined in Section 13002.

R. Staging area: Controlled room or defined area in the building, including enclosed access routes to the Clean Zone, where products to be installed during a workday are unpackaged, cleaned and otherwise made ready for installation that same day in the cleanroom.

1.06 DESIGN CRITERIA

A. Design criteria:
   1. FED-STD-209E for cleanliness classes in cleanrooms and clean zones.
   2. ASHRAE Handbook: Fundamentals.
   3. Institute of Environmental Science (IES) recommended practices:
      a. IES-RP-CC001: HEPA and ULPA Filters.
      b. IES-RP-CC006.2: Testing Cleanrooms.
   4. NFPA 318 for standard for the protection of

cleanrooms.

1.07 SUBMITTALS

A. Shop drawings:
   1. Complete shop drawings indicating construction limits and details of Clean Zone.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
   1. Clean Zone Director's resume.
   2. Checklists of requirements for reviewing procedures and work performed.

E. Contract closeout information: Not required for COTR review.

1.08 PRECONSTRUCTION CONFERENCE

A. Preconstruction conference, directed by Clean Zone Director, will be held prior to beginning of Cleanroom installations. Meeting agenda will include, but not limited to:
   1. Contract Document requirements.
   2. Scheduling.
   3. Cleanroom drawings.
   4. Partition manufacturer's specifications and details.
   5. Ceiling manufacturer's specifications and details.
   6. Access floor system manufacturer's specifications and details.
   7. HVAC system manufacturer's specifications and details.
   8. Piping and plumbing requirements.
   9. Life safety requirements.
   10. Available on site storage.
   11. Protection from damage by other trades.
   12. Testing, balancing and commission protocol.
   13. Installation drawings.
   14. Manufacturer product data.
   15. Samples of proposed materials.
   16. Warranties.
   17. Project schedule.
   18. Other information deemed pertinent for sound and secure application.

B. Attendance is required for:
   1. Contractor's superintendent.
   2. Modular partition manufacturer's representative.
   3. Modular partition installation supervisor.

4. Ceiling manufacturer's representative.
5. Ceiling installation supervisor.
6. Access floor system manufacturer's representative.
7. Access floor system installation supervisor.
8. HEPA filter manufacturer.
9. Mechanical installation supervisor.
10. Sheet metal installation supervisor performing ductwork.
11. Sprinkler installation supervisor.
12. Electrical installation supervisor.
13. Plumbing and piping installation supervisors.
14. Other trades working within the Clean Zone or whose work may effect cleanroom construction.

C. Minimum two weeks prior to conference forward pertinent information to COTR for review.

D. Conference shall review specifications, details, application requirements and preliminary work.

1.09 PRE-ENCLOSURE CONFERENCE

A. Prior to construction of Clean Zone areas, Clean Zone Director shall call meeting to coordinate and clarify all requirements regarding staging area.

B. Attendance is required for all participants in Preconstruction Conference.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Clean Zone components shall be delivered with an approved protective covering and packaged to prevent transit and construction dust from contaminating the surfaces.
1. Return any material or equipment to the manufacturer for recleaning and repackaging where the original shipping protective wrap is torn or defective.
2. Stripping of packaging shall be done inside the designated equipment staging room outside the cleanroom.

B. Materials must be sealed in their original unopened packages.

C. Open ends of all ducts and pipes shall be sealed with moisture-proof barrier until product is being connected during installation.

D. Products and components shall be stored in such manner as to prevent damage or intrusion of foreign matter.
1. Conspicuously mark "Rejected" on any materials which

have been damaged, and remove them from the job site.

E. Use extreme care when handling components to prevent damage.

F. Products shall be stored within the building in controlled space designated by the Contractor.

G. Products shall not be stored in the staging area in excess of that used in one day's work.

H. Contaminated materials must not be stored in the staging areas or Clean Zone.

1.11 QUALITY ASSURANCE

A. Review the procedures and work performed on a continuous basis to verify compliance with these requirements.
   1. Prepare checklists of requirements as basis for reviewing procedures and work performed.

B. Provide training for new personnel during construction before they are allowed to work in Clean Zone.

C. Weekly reports shall be submitted to the COTR that summarize the following activities:
   1. Cleanup crew operations for the previous week.
   2. Clean Zone particle counts for each day of the previous week.
   3. Updated list of visitors entering the Clean Zone for the previous week.
   4. Inventory list of tools, equipment, materials, and other items entering the Clean Zone for the previous week.
   5. Updated list of construction workers authorized and cleared for entry into the Clean Zone for the upcoming week.

D. Factory test logs shall be submitted for all equipment and products used within the Clean Zone to fully document the name of the quality control inspector, test date, original performance and test data logs, corrective action required, and final certified performance and test data logs.

E. Test data logs shall be included with each shipment for every item that is included therein, enclosed inside waterproof clear plastic jackets suitable for placing in a standard three-ring binder.

F. Every product shall include the final certified

performance and test data information indicated on a permanent nameplate, decal, or sticker located for easy viewing.

G. A qualified technical supervisor shall be furnished by all manufacturers whose Clean Zone products require field application, assembly, or installation by workers who are not direct employees of the manufacturer.

H. Technical supervisor shall observe field conditions, quality of surface finishes, and other field conditions essential to acceptance and use of the finished product.

I. During subsequent work activities by the installing workers, the manufacturer's technical supervisor shall provide periodic, timely inspection and counseling to ensure system complies with factory requirements.

J. Technical supervisor shall submit a written report to the Cleanroom Contractor listing tasks performed, observations, and finished results.

K. Take particle counts within the Clean Zone on a random schedule at least twice each week.
   1. Maintain particle count records and submit as part of monthly status reports.

PART 2 - PRODUCTS

2.01 CLEANROOM SYSTEMS

A. Acceptable Clean Zone Contractors:
   1. Cleanrooms:
      a. Base:
         (1) Clestra Cleanroom Comp-Aire.
         (2) Performance Contracting.
   2. Other Clean Zone Contractors desiring approval comply with Section 01640.

B. Architectural elements:
   1. Modular partitions:
      a. Prefinished relocatable panels with integral structural framing and supports, doors, windows, gaskets, sealants and accessories as specified in Section 13066.
   2. Access floor:
      a. Manufacturer's static dissipative raised access flooring system as specified in Section 13070.
   3. Flow-through grid system:
      a. Manufacturer's integral modular ceiling system as specified in Section 13064.

4. Flushlight grid system:
    a. Manufacturer's recessed lighting and HEPA filter assembly as specified in Section 13064.
5. Steel framing:
    a. Manufacturer's steel support system as specified in Section 05505.

C. Mechanical elements:
1. HVAC systems:
    a. Recirculating AHU system including ductwork, plenums, piping, dampers, coils, sound attenuators, mounting, connection to filters and connection to make-up AHU system.
    b. Floor panels.
    c. HEPA filters.
    d. Ceiling return registers.
    e. Air Handling Units specified in Section 15861.
    f. Sound Attenuators specified in Section 15880.
    g. Grilles and registers specified in Section 15880.

2. Piping systems:
    a. Process chilled water from valved connections.
    b. Process chilled water to lab and heat exchangers.
    c. Valves specified in Section 15100.

3. Plumbing systems:
    a. Ultra pure water from valved loop.
    b. Indirect waste to floor drain.
    c. Indirect solvent waste to holding tanks.
    d. Gases from valved loop.
    e. Ultra pure water, indirect waste to and from lab equipment.

4. Fire Suppression systems:
    a. Sprinkler heads, run-out from branches.
    b. Branches from cross mains.

D. Electrical elements:
1. Lighting:
    a. Flush mounted integral with ceiling system.
    b. Light fixtures in chases.
2. Grounding of raised floor system.
3. Installation of branch circuits including wiring, conduit and disconnects in cleanroom and chases.
4. Panelboards in chases.

PART 3 - EXECUTION

3.01 JOB CONDITIONS

A. Cleanroom Contractor to furnish, install and maintain temporary envelope around cleanroom construction.

B. Provide continuous and uninterrupted staging areas and enclosed access routes to Clean Zone.

C. Construct temporary gowning areas for all personnel involved in cleanroom construction.
   1. Construct gowning areas to be upgraded for each stage of operations as construction proceeds.

D. Provide separate temporary staging area for equipment and equipment storage.

E. Temporary cleanroom meeting Class M4.5 standards is required for field fabrication, storage, cleaning, and assembly of cleanroom walls, ceilings and floors, and for storage of HEPA filters prior to installation.
   1. Temporary cleanroom shall be provided and maintained by Cleanroom Contractor.

3.02 TEMPORARY CLIMATE CONTROL

A. Clean Zone Director shall assure that positive pressure within Clean Zone of 0.012 kPa continuously until permanent makeup air system is activated and the building has reached Class M4.5.

B. Provide, or have furnished, temporary fans with 30 percent prefilters and 99.99 percent HEPA filters operating with 100 percent outside air.
   1. Provide sufficient fans for minimum six air changes per hour.
   2. Replace prefilters and HEPA filters every 30 days minimum.
   3. Assure that emergency backup power is available to maintain Clean Zone climate control.

C. Temporary flooring, partitions and doors:
   1. Provide products that are water resistant, sealed against particle gathering or release, airtight and suitable for function intended.
   2. Provide sufficient weatherstripping on doors to prevent passage of air outside of Clean Zone.

END OF SECTION

SECTION 13002

CLEANROOM PROTOCOL

PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

A. Refer to Section 13001 for Clean Zone General Requirements.

1.02 DESCRIPTION

A. Perform all special cleanroom cleaning as specified in this section in addition to cleaning specified elsewhere.

B. Cleanroom areas include rooms and associated spaces identified in the Schedule of Required Classifications in Section 13003.

1.03 QUALITY ASSURANCE

A. Supervise cleaning procedures and provide competent technicians to conduct all the work.

B. Cleanroom cleaning supervisor shall have a minimum of 3 years uninterrupted experience, devoted exclusively to cleaning of cleanroom facilities.

C. Use cleaning products which are compatible with surface to be cleaned, and which will cause no damage to adjacent materials.

1.04 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
1. Submit qualifications and references of proposed cleanroom cleaning contractor, supervisor, and personnel.
2. Submit product data for cleaning materials and program of cleaning procedures.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS

A. Wipe-down fabric:
   1. Lint-free "Techni-Cloth", "Miracle-Wipes", and Tech-Wipes".

B. Wipe-down liquid:
   1. EKC "Lab Clean".
   2. "Floor Clean".
   3. "Glass Clean".
   4. Allied Chemical, WRS-200.

C. See subarticle 3.02, A through E, for other generic product requirements.

PART 3 - EXECUTION

3.01 CLEANROOM CLEANING - GENERAL

A. Vacuum all spaces which will be concealed by subsequent construction as the work progresses.

B. Clean all dirt from structural members, decking, etc., before proceeding with other construction.

C. Operate recirculating fan units, without HEPA-Filters installed, for at least 24 hours continuously before final cleaning.

D. Remove construction debris promptly.

E. Shovels, brooms, dustpans, mops and buckets may be used during Stage 1 cleaning.
   1. Minimize need for brooms and sweeping tools during Stage 2 cleaning, and primarily use wet mopping and vacuum cleaning for floor cleaning.
   2. Where surfactants are needed, use only non-ionic type.

F. Use 99.99 percent HEPA filtered vacuum cleaner during Stage 3 and later cleaning.
   1. Output filter shall be tested at least weekly with a particle counter to assure minimum Class M3.5 performance.

G. Beginning during Stage 2 cleaning, provide positive pressurization to prevent infiltration of contamination from surrounding areas.

1. During welding, grinding and other construction operations requiring additional measures to remove contaminates, provide negative pressure ducted smoke removal fans.

H. The following materials shall not be used in cleanroom construction:
   1. Masking tape.
   2. Duct tape.
   3. Lubricants, pastes and fluxes containing ionic contaminants.
   4. Freons, aerosols and spray products.
   5. Salt, soap and other materials containing sodium, potassium or other heavy metals.

I. Contractor performing work shall be responsible for cleaning their own tools, cleaning their construction materials, and removing their construction debris.
   1. Contractor shall provide minimum one cleaning person for every ten or less of their workers on the job.

3.02 BASIC CLEANROOM PROTOCOL

A. Adhere to following protocol after general construction within cleanrooms is complete.

B. Materials not permitted:
   1. Ordinary paper pads, notebooks, manuals, or writing paper.
   2. Ordinary writing pencils, pens, erasers, crayons, or chalk
   3. Any type of wood.

C. Notes and records shall be kept on lint-free paper, plastic sheet, using ball point pens or other suitable nondust generating materials.
   1. Drawings, Specifications, and other instructions shall be covered with plastic film or other lint-free, nondust generating materials.

D. Maintain a complete set of tools, ladders, and material handling devices for use only within confines of clean room areas.
   1. This equipment shall remain in cleanroom to avoid unnecessary transfer of contamination.

E. Provide handtrucks, dollies, and other rolling devices which are equipped with nonlubricated bearings for use within cleanroom.

F. Personnel shall wear cleanroom gowns while within confines

of cleanroom.
1. Gowns and gowning procedures shall be as approved by Clean Zone Director.

3.03 FINAL CLEANROOM CLEANING

A. Throughout area prior to certification, but after general construction is complete, perform following final cleaning:
   1. Clean cleanroom areas as follows with the vacuuming and wiping down of surfaces occurring in the order of ceiling areas first, walls second, and floors last.
      a. Vacuum light fixtures inside and out, H.E.P.A. filter protective grids, ceiling channels and angles, automatic fire sprinklers and escutcheons and ceiling tiles, using portable or central vacuum system with maximum 0.2 micron size filter and discharge to the building exterior.
      b. Vacuum wall surfaces, including furnishings, hardware, etc.
      c. Vacuum exposed surfaces of process piping, drain lines, interior and exterior of ductwork, electrical raceways, including interior, utility rack framing, and all connections to process equipment.
      d. Vacuum floors in cleanrooms, including integral coved base and reducer strip, floor penetration coverings, etc.
      e. Final wipe-down: After vacuuming of cleanroom areas has been completed, wipe down hard surfaces including glazing, using wipe-down fabric soaked in wipe-down liquid.

B. Completed work areas shall be subjected to certification testing to confirm conformance to specified cleanliness standards.
   1. Reclean areas not conforming to whatever extent necessary to reach certification.

3.04 CLEANROOM PROTOCOL SUMMARY

A. Stage 1:
   1. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
      a. Work: Dirty: Concrete, major structural steel, grinding, welding, gas torch cutting, heavy piping, insulation piping and ductwork, interstitial sprinkler piping, ductwork, plumbing and air handlers.
         (1) An "office-clean" environment shall exist and be maintained.
      b. Garments: No special requirements.

c. Cleaning: Daily trash removal and floor sweep (all zones).

2. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
   a. Work: After completion, initial wipe down and vacuum from top structure down.
   b. Trash removed daily and floors vacuumed daily.
   c. Smoking, spitting, eating, or drinking not allowed.
   d. Gas powered or fume and particulate-emitting equipment not allowed inside building.
   e. An "office-clean" environment shall exist and be > maintained.

B. Stage 2:
   1. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
      a. Work: Semiclean: Cleanroom perimeter established, firewalls constructed, controlled staging area and erected entry/gowning area, commence clean rough-in of clean supply and return ductwork, catwalks, electrical, ceiling support steel, sprinkler pipe, below floor trench piping.
      b. Garments: Clean construction boots.
      c. Cleaning: Continuous trash removal and floor sweep removed from Class M3.5 areas.
      d. Maintain "Office Clean" environment.
   2. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
      a. Work: After completion, vacuum and "coarse clean" from structure down all building elements.
      b. Garments: Clean booties.
   3. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
      a. Work: Begin 24 hour per day pressurization with makeup air handler, make-up air handler and recirculation air handler blowdown.
   4. Zone: Cleanroom, Fan Attic, Subfloor:
      a. Work: After pressurization and blowdown, COTR shall have the opportunity to observe interstitial spaces and confirm that an "office clean" environment exists.
      b. Provide a "final" coarse cleaning from structure down for those areas not complying with "office clean" environment.
      c. Garments: Clean booties.
      d. Cleaning: Daily damp mopping.

C. Stage 3:
   1. Zone: Cleanroom, Fan Attic, Interstitial, Subfloor:
      a. Work: Clean: Controlled gowning area, access flooring, ceiling grid, and cleanroom wall partitions.
      b. Garments: Clean smock jacket, clean booties and headgear.

c. Cleaning: Continuous trash and debris removal, vacuuming, and wipe down of all surfaces.

2. Zone: Cleanroom:
   a. Work: After completion, provide clean zone initial washdown from interstitial elevation down.
   b. Garments: Full-length suit, clean booties and headgear (first level only).

D. Stage 4:
1. Zone: Cleanroom, Subfloor:
   a. Work: Clean: HEPA filters materials cleaned, continuous cleaning, i.e., wipedown, vacuum and trash removal.
   b. Garments: Clean smock jackets, booties and headgear.
   c. Cleaning: Equipment, tools and clean booties.
2. Zone: Cleanroom, Subfloor:
   a. Work: After completion, provide a cleanroom final washdown of all surfaces within cleanroom.
      (1) Provide a black and white felt rubdown test when complete.
   b. Garments: Full-length suit, knee high boots and headgear (first level only).

E. Stage 5:
1. Zone: Cleanroom:
   a. Work: Test and certification.
   b. Garments: Full-length suit, knee-high boots, and headgear.
   c. Cleaning: Equipment, tools, and materials cleaned before entering.

END OF SECTION

SECTION 13003

CLEANROOM CERTIFICATION

PART 1 - GENERAL

1.01 CONDITIONS AND REQUIREMENTS

A. Refer to Section 13001 for Clean Zone General Requirements.

B. Refer to Section 13002 for cleanroom cleaning procedures.

1.02 DESCRIPTION

A. Employ and pay for the services of a qualified Cleanroom Testing and Certification Contractor (Certifying Agency), as a subcontractor to perform specified service. The Cleanroom Testing and Certification Contractor shall be independent from the cleanroom contractor, system manufacturer and installer. Cleanroom Testing and Certification shall be a separate activity from other services which may be offered by this contractor. Employment of the independent subcontractor shall in no way relieve the Contractor's obligation to perform work of Contractor's Contract.

B. Provide certification that the completed construction of the rooms scheduled below complies with the air cleanliness classification required in accordance with Federal Standard 209E "Clean Room and Work Station Requirements, Controlled Environment".

C. Use test methods for characterizing the performance of cleanrooms in accordance with the Institute of Environmental Sciences IES-RP-CC006.2, "Testing Cleanrooms". Refer to Part 3 of this section for specific tests required and the acceptance criteria.

1.03 QUALITY ASSURANCE

A. The Testing and Certification Contractor shall supervise all tests and shall provide competent test technicians to conduct all tests in the presence of the COTR's authorized representative. The test technician shall:
   1. Have a minimum of four years uninterrupted service, devoted exclusively to the Testing and Certification of Cleanroom Facilities.
   2. Or shall be under the direct supervision of the above described person.

B. The tests must be performed under the observation of the COTR. The tests shall be performed after initial operating and balancing adjustments have been completed by the Contractor to the satisfaction of the COTR. Provide a copy of the Air Balancing report to the Testing and Certification Contractor to satisfy requirements that the facility is ready for "Cleanroom Certification" testing.

C. Instrumentation to be used shall be in accordance with the descriptions given in each test procedure, and shall have a demonstrated accuracy and sensitivity suitable for the test procedure. All instruments shall be properly calibrated according to the manufacturer's recommendations and so certified by Cleanroom Testing and Certification Contractor at the time of the test.

1.04 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information:
   1. Submit qualifications and references of the proposed testing laboratory, supervisor, and personnel.
   2. Submit program of test procedures and specimen copy of each of the report forms proposed for use.
   3. Submit three copies of a complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each indicating:
      a. Manufacturer and Model Number.
      b. Size, Capacity, and Sensitivity Range.
      c. Serial Number.
      d. Latest Calibration Date and method of calibration employed.
   4. Submit reports of all initial tests and retesting required after corrective measures have been taken.
   5. Submit proposed method of test procedures for Airflow Parallelism and Dispersion Test in Cleanrooms where the Government's process equipment will be in place at the time of the test.
   6. Submit a schedule for performing all tests specified indicating the duration of the testing period for each room indicated in "Schedule of Required Classifications", and indicate total duration for each lab.
   7. After completion and acceptance of all required tests, the Cleanroom Testing and Certification Contractor shall compile all of the test and certification data

and shall submit three copies of the completed report to the COTR. The report submitted shall include a signed and dated certificate, stating compliance with the specified performance criteria.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS - Not applicable.

PART 3 - EXECUTION

3.01 INSPECTION & PREPARATION

A. Prior to the start of Cleanroom Certification Testing, the Testing and Certification Contractor shall verify that the work of the Air and Water Balancing Contractor has been completed. In addition, the Testing and Certification Contractor shall verify that all construction Contract work has been completed within the clean space. Prior to doing any Airborne Particle Monitoring, clean the Cleanroom to the satisfaction of the Testing and Certification Contractor.

3.02 TEST PROCEDURES - GENERAL

A. The Testing and Certification Contractor shall report the location of all sample points on an accurate grid diagram which represents the actual ceiling layout.

B. Discrepancies with acceptance criteria shall be promptly reported to the COTR for defect resolution strategy.

C. Observe all temperature and humidity sequencing testing by the Air Balancing Contractor.

D. Coordinate the schedule of all work to be done with the COTR to accommodate phased completion.

3.03 ON-SITE PRE-INSTALLATION TESTING OF HEPA FILTERS

A. Test each HEPA filter individually for leaks by full DOP challenge and scan with an aerosol photometer of either linear or logarithmic readout type. Perform testing in a suitably isolated and clean area.

B. Each filter shall be clamped into a holding fixture which provides complete access to the downstream face of the filters and upstream plenum for supplying the air and test

smoke mixture to the filter. The upstream plenum shall have two sample ports, one on each side and the 100 percent reading shall be taken at the lower of the two to assure sufficient concentration.

C. Filter shall be tested at an average flow rate equal to operating design flow rate within +20 percent. A shielded hot-wire anemometer (0.13 m/s-1.5 m/s) face velocity profile, 300 mm downstream of filter face shall establish the average velocity in feet per minute across the face of the filter pack. Velocity shall be uniform within these limits without evidence of "dead spots".

D. Test smoke shall be cold DOP smoke generated by air pressure (140 kpa + 5 kpa) through two, four jet, Laskin type nozzles as per USA Standard N-5.11. The aerosol light scattering droplet size distribution shall be listed in IES-RP-CC006.2.

E. Upstream concentration to the test filter shall be 10□&a-50V-4□&a+50V above the minimum sensitivity of the logarithmic readout photometer, or produce 100 percent reading which will allow the linear readout photometer to be stray - light adjusted to zero on the lowest scale. Measurement shall be taken in the plenum immediately ahead of the test filter. Prolonged exposure of filter to DOP shall be avoided. The least amount of DOP necessary to perform testing shall be introduced.

F. The test instrument shall be an aerosol photometer of sufficient sensitivity to indicate a test smoke concentration of not less than 100 micrograms/liter and a threshold sensitivity of not less than 0.001 micrograms/liter. It shall have a minimum sample flow rate of 0.5 L/s. Probe size shall be dependent upon the actual filter velocity and shall be such that the air flow velocity through the probe is 0.45 m/s +20 percent. (24 mm diameter for 0.24 L/s sample flow rate and 38 mm diameter for 0.6 L/s sample flow rate.)

G. Scanning shall be accomplished by passing the probe over the filter in slightly overlapping strokes so that the entire area of the filter is scanned. A separate pass shall be made around the periphery of the filter and the adhesive bond between the filter pack and the rigid frame. Factory repair patches shall be double checked. The probe shall be a maximum of 25 mm from the filter face. The scanning method shall conform to IES-RP-CC006.2.

H. A leak indicated by a repeatable steady photometer (linear readout type) reading greater than 0.01 percent of the

upstream concentration is defined as a significant leak. For a logarithmic readout photometer, a reading of .01 percent of upstream on the instrument logarithmic calibration chart is defined as a significant leak.

I. Those filters that are found to have leaks after floor testing shall be repaired providing:
   1. The size of the repair(s) is less than 5 percent of the filter face area.
   2. One dimension of any repair is limited to 38 mm maximum. The Testing and Certification Contractor shall keep a daily record of the defective filters found during on-site testing. Those defective filters shall be reboxed immediately, before being repaired, until such time that the problem(s) is identified. The integrity of the filters is the responsibility of the General Contractor.

3.04 SCHEDULE OF CLEANROOM PERFORMANCE TESTING

A. The following tests shall be required for rooms listed in the Schedule of Classifications at the listed operational modes:

I.E.S. SECTION NO.(REF.)	CERTIFICATION TEST	AS BUILT	OPERATING			
4	Air Velocity Uniformity	M3.5	M4.5	*M5.5	M6.5	
5	Final HEPA Filter Installation Leak Test	M3.5	M4.5	M5.5		
6	Airflow Parallelism and Dispersion	M3.5	**M4.5			
7	Room Recovery Test	M3.5	M4.5	*M5.5	*M6.5	
8	Airborne Particle Monitoring	M3.5 M3.5	M4.5 M4.5	M5.5 M5.5	M6.5 M6.5	
11	Room Pressurization	M3.5	M4.5 M4.5	M5.5 M4.5	M6.5 M5.5	M3.5 M6.5
13	Lighting Level and Uniformity	M3.5	M4.5	M5.5	M6.5	
15.2	Temperature and Relative Humidity	M3.5 M4.5	M4.5 M4.5	M5.5 M5.5	M6.5 M6.5	M3.5

15.3 Control Capability

* = These tests shall be made for the sole purpose of providing performance data to the COTR.

** = Airflow Parallelism and Dispersion Tests shall be made at all rooms classified. The tests shall be made for the sole purpose of providing performance data to the COTR.

3.05 SCHEDULE OF ACCEPTANCE CRITERIA

In addition to the general basic cleanliness requirements in Federal Standard 209E, comply with the following criteria:

CERTIFICATION TEST	CRITERIA FOR COTR'S ACCEPTANCE
A. Air Velocity & Uniformity height	Class M3.5: 0.4 M/S +20 percent Class M4.5 +0.35 M/S. Class M4.5 For information only, taken across total room area.
B. Final HEPA Filter Installation Leak Test	Minimum efficiency of filters must be 99.99 percent on 0.3 micron thermally generated particles in accordance with Federal Standard 209E.
C. Airflow Parallelism & Dispersion	Offset in vertical airflow must not exceed 14 degrees.
D. Room Recovery Test	Class M3.5: 30 second recovery. Class M4.5: 4 minute recovery.
E. Airborne Particle	In accordance with Federal Standard Monitoring 209E measured at a workstation height of 860 mm above finish floor. See Schedule of Room Classifications.
F. Room Pressurization	Pressure shall be such that as the cleanliness requirement of the area decreases, the relative pressure decreases (i.e.: Class M3.5 more positive than Class M4.5, and Class M4.5 more positive than Class M5.5, etc.). Minimum acceptable pressure

		differential is 1.2 pa. Indicate room pressure on both sides of wall and pressure differential for each test point in all reporting.
G.	Lighting Level & Uniformity	Class M3.5 & M4.5: 860lx min. for rooms with either white or yellow lighting; 750lx min. for rooms with dual switched white/yellow lighting.
H.	Temperature & Humidity Control Capability	All rooms indicated in "Schedule of Required Classification" shall maintain a temperature of 20 degC+1 degree. Relative humidity in all rooms listed shall be maintained at 35 percent minimum to 40 percent maximum.

3.06 SCHEDULE OF REQUIRED CLASSIFICATIONS

ROOM NO.	NAME	CLASSIFICATION
C0111	ASBESTOS PREP	M3.5
C0105	PARTICLE MANIPULATION	M2.5, M3.5, M4.5, M5.5
C0109	AIR LOCK	M5.5
C0103	OPTICAL MICROSCOPY	M5.5
D0105	SAMPLE PREP	M3.5
G0102	AIR LOCK	M5.5
G0104	INSTITU. SPECT.	M5.5
A0020-1	FINAL SPECIMEN LOAD	M4.5
A0022	MOLECULAR MEAS.MACHINE	M3.5

3.07 FINAL GASKETING LEAKAGE TEST

A. While performing Final HEPA Filter Installation Leak Test, scan ceiling grids for leakage at gasketing, perimeter ceiling angle condition, and at any fixture mounted through the HEPA filters, with particle counter using the same procedures as in the Final HEPA Filter Installation Leak Test. Notify Government Inspector in advance of this Work and allow Inspector to witness test. Report all locations of ceiling grid leakage to Cleanroom Director for immediate defect resolution.

B. Retest all locations of leaks after defects have been corrected.

END OF SECTION

SECTION 13064

CLEANROOM FLOW THROUGH GRID SYSTEM

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. ASTM Standards:
   1. ASTM-B221.
   2. ASTM-B209.
   3. ASTM-A307.
   4. ASTM-A193.
   5. ASTM-A563.

B. American Welding Society, (AWS):
   1. D1.2.

C. Federal Specifications:
   1. FS 209D.

D. Design requirements:
   1. Total dead load of plenum system not to exceed 55 kg/m2.
   2. Plenum shall be capable of supporting a total live load of 50 kg/m2.
   3. Point load of 600 kg at any location or 70 kg loads at 1200 mm OC.
   4. Deflection: limit to L/360 of span.

1.02 SUBMITTALS

A. Shop drawings:
   1. Flow through grid system plans and details.
      a. Framing and support details.
      b. Indicate location of ceiling units and other items requiring coordination with ceiling.
      c. Indicate structural classification of system.

B. Product data: Not required for COTR review.

C. Samples:
   1. Samples of all materials and components proposed for use and sample of finish texture.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Maintenance data.

1.03 JOB CONDITIONS

A. Verify suitability of structure to accept installation.

B. Carefully coordinate ceiling layout with other work which penetrates system.

C. Provide structural bridging to span ducts or other obstructions, and structural headers to reinforce and support deck units at holes through deck.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturer:
   1. Cleanroom Flow through grid system:
      a. Base:
         (1) Gordon Inc.
      b. Optional:
         (1) Laminaire.
         (2) Lepco.
         (3) Meisser & Wurst.
         (4) Texas Technology.
   2. Other manufacturers desiring approval comply with Section 01640.

B. Grid systems:
   1. Aluminum plenum and modular grid system assembly.
      a. 1200 x 600 mm grid unless otherwise indicated on drawings.
   2. Complete with flow-through flush lighting fixtures, filters,filter dampers, fire sprinkler penetrations, structural framing and supports, gaskets, sealants and accessories.
   3. Prefinished aluminum grid with integral gel track.
   4. Prefinished side panels.

C. Dialetric silicone or urethane gel:
   1. Manufacturer's standard.

D. Gaskets:
   1. Cellular urethane foam tape coated one side with aggressive high strength adhesive.
   2. Tape thickness as required.

E. Sealants:
   1. Dow Corning 732 or 999A, or equal product by Pecora or GE Silicones.
   2. Color to match plenum surface.

F. Diffusion screen:
    1. 0.75 mm perforated sheet metal with 23 mm holes staggered at 5 mm centers, 23 percent open.
    2. Paint to match ceiling grid.
    3. Removable from room side of filter without removing filter.
    4. Diffusion screen flush with grid face.

G. Fire sprinkler penetrations:
    1. Seal with manufacturer's standard gel-cup seal plate.

H. Flow-through light fixtures:
    1. Flow-through luminares:
        a. 277 volt, 60 Hz.
        b. Fully recessed, continuous as indicated on the drawings.
        c. Luminares shall be low-heat, high efficiency type suitable for use as continuous raceway.
        d. Fixtures shall bear UL label.
    2. Circuiting to each light fixture to be provided under Division 16.
    3. Ballast shall be integral to fixture.
        a. Comply with VDE0107 for electromagnetic interference, sound rated "A", Class P, 277 volts.
        b. Capable of controlling standard (25 watt) energy saving 915 mm rapid start, T8, 3500 K fluorescent lamps.
        c. See Specification Section 16510 for additional information on ballasts and lamps.
    4. Install amber sleeves with opaque end caps in following photo sensitive areas room CR3L13, CR3L19 and CR3l22.
        a. Sleeves shall be capable of blocking all light from 200 to 500 nanometers at energy levels as low as 20 mj/cm2.
    5. Luminare shall consist of lamp holders, lens, highly polished aluminum reflector and retaining clips.
    6. Luminare lenses shall be flush style eggcrate constructed of white or chrome acrylic.
    7. Lighting systems shall provide minimum 754 lux at 1000 mm from floor in lab bay areas.

I. HEPA Filters Cleanroom:
    1. Filter assembly:
        a. Factory built and assembled.
        b. Ducted supply housing with replaceable filter.
        c. Filter assembly hermetically sealed.
    2. Filter:
        a. Extended surface, 99.99 percent efficient, as certified for 0.3 micron particles in accordance with IES RP-CC-001 for Type C filters.

(1) 100 mm deep mini-pleated, disposable type.
(2) Initial resistance at 0.508 m/s face velocity not greater than 100 Pa.
(3) UL Class 1 listing in UL building materials directory.

3. Filter housing:
   a. Housing and inlet constructed of 1.6 mm aluminum, welded and sealed at all joints and seams to ensure airtight housing.
      (1) 300 mm diameter inlet for 1200 x 600 mm housings.
      (2) 200 mm diameter inlet for smaller than 1200 x 600 mm housings.
   b. Aluminum perimeter and internal channels with welded corners.
   c. Perimeter skirt for fluid sealing system.
   d. Filter sizes to fit modular ceiling system.
   e. Module to include butterfly damper, perforated diffusion plate, filter, white face guard.
   f. Filter shall be replaceable without moving housing from ceiling system.
   g. Damper operated from the room (downstream) side of the unit.
   h. Diffusion plate of 1.6 mm aluminum mounted within housing beneath duct connection.
   i. Face guard of perforated metal. Perforations provide 40 percent free area minimum.

J. Filter Dampers:
   1. Volume control dampers shall be minimum 4 mm aluminum.
   2. Dampers shall be manually adjusted from cleanroom.
   3. Damper operator shall provide continuous linear adjustment.
   4. Dampers for hooded HEPA filters shall be perforated plate at the inlet duct collar.
   5. Damper for standard filters to be side mounted at at upstream side of filter.

K. Hanging clips:
   1. Extruded aluminum and clear anodized after cutting to length capable of supporting a 180 kg concentrated load.
   2. Mount anywhere along grid without interfering with light fixtures or compromising grid integrity.

2.02 FABRICATION

A. Factory weld and grind smooth all grid joints.

B. Reinforce all units for ceiling supported systems.

C. Factory install all sleeves, piping and conduits.
   1. Install pipe with rubber gasket grommets.
   2. Seal fire sprinkler penetrations with manufacturer's standard gel solution.

PART 3 - EXECUTION

3.01 ERECTION

A. Examine all subsurfaces to receive work.

B. Provide all support members and attachments and special dimension closure strips at walls and where otherwise required.

C. Install in accord with manufacturer's recommendations.

D. Place grid system from supporting framework.

E. Level, align and adjust to final position prior to permanent fastening.

END OF SECTION

SECTION 13073

PERFORATED CEILING (PC) AND FLOW
THROUGH GRID SYSTEM

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. ASTM Standards:
   1. ASTM-B221.
   2. ASTM-B209.
   3. ASTM-A307.
   4. ASTM-A193.
   5. ASTM-A563.

B. American Welding Society, (AWS):
   1. D1.2.

C. Federal Specifications:
   1. FS 209D.

D. Design requirements:
   1. Total dead load of plenum system not to exceed 55 kg/m2.
   2. Plenum shall be capable of supporting a total live load of 50 kg/m2.
   3. Point load of 600 kg at any location or 70 kg loads at 1200 mm OC.
   4. Deflection: limit to L/360 of span.

1.02 SUBMITTALS

A. Shop drawings:
   1. Flow through grid system plans and details.
      a. Framing and support details.
      b. Indicate location of ceiling units and other items requiring coordination with ceiling.
      c. Indicate structural classification of system.

B. Product data.

C. Samples:
   1. Samples of all materials and components proposed for use and sample of finish texture.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Maintenance data.

1.03 JOB CONDITIONS

A. Verify suitability of structure to accept installation.

B. Carefully coordinate ceiling layout with other work which penetrates system.

C. Provide structural bridging to span ducts or other obstructions, and structural headers to reinforce and support deck units at holes through deck.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturer:
   1. Perforated ceiling and flow through grid system:
      a. Base:
         (1) Gordon Inc.
         (2) Pace Clean-Pak.
   2. Other manufacturers desiring approval comply with Section 01640.

B. Grid systems:
   1. Aluminum plenum and modular grid system assembly.
      a. 1200 x 600 mm grid unless otherwise indicated on drawings.
   2. Complete with flow-through flush lighting fixtures, filters,filter dampers, fire sprinkler penetrations, structural framing and supports, gaskets, sealants and accessories.
   3. Prefinished aluminum grid with integral gel track.
   4. Prefinished side panels.
   5. Color: See Section 09000.

C. Dialetric silicone or urethane gel:
   1. Manufacturer's standard.

D. Gaskets:
   1. Cellular urethane foam tape coated one side with aggressive high strength adhesive.
   2. Tape thickness as required.

E. Sealants:
   1. Dow Corning 732 or 999A, or equal product by Pecora or GE Silicones.
   2. Color to match plenum surface.

F. Perforated ceiling panel (PC):
   1. 0.75 mm perforated sheet metal with 23 mm holes

staggered at 5 mm centers, 23 percent open.
2. Paint to match ceiling grid.
3. Removable from room side of filter without removing filter in area where filters are scheduled.
4. Ceiling panel flush with grid face.

G. Blank ceiling panel:
1. 0.75 mm sheet metal.
2. Paint to match ceiling grid.
3. Removable from room side of filter without removing filter in area where filters are indicated.
4. Ceiling panel flush with grid face.

H. Fire sprinkler penetrations:
1. Seal with manufacturer's standard gel-cup seal plate.

I. Flow-through light fixtures:
1. Flow-through luminares:
a. 277 volt, 60 Hz.
b. Fully recessed, continuous as indicated on the drawings.
c. Luminares shall be low-heat, high efficiency type suitable for use as continuous raceway.
d. Fixtures shall bear UL label.
2. Lighting circuits shall provide for normal and emergency lighting.
a. Connect fixtures indicated on the electrical drawings to emergency generator.
3. Ballast shall be integral to fixture.
a. Comply with VDE0107 for electromagnetic interference, sound rated "A", Class P, 277 volts.
b. Capable of controlling standard (25 watt) energy saving 915 mm rapid start, T8, 3500 K fluorescent lamps.
c. See Specification Section 16510 for additional information on ballasts and lamps.
4. Luminare shall consist of lamp holders, lens, highly polished aluminum reflector and retaining clips.
5. Luminare lenses shall be flush style eggcrate constructed of white or chrome acrylic.
6. Lighting systems shall provide minimum 754 lux at 1000 mm from floor in lab bay areas.

J. HEPA Filters:
1. Filter assembly:
a. Factory built and assembled.
b. Ducted supply housing with replaceable filter.
c. Filter assembly hermetically sealed.
2. Filter:
a. Extended surface, 99.99 percent efficient certified on 0.3 micron particles per IES

RP-CC-001 for Type C filters.
(1) 100 mm deep mini-pleated, disposable type.
(2) Initial resistance at 0.508 m/s face velocity not greater than 100 Pa.
(3) UL 900 Class 1 listing in UL building materials directory.
(4) Scan test face and perimeter of filter pack for leaks greater than 0.01 percent of the upstream challenge.

3. ULPA filter:
a. Extended surface, 99.999 percent efficient certified on 0.3 micron particles per IES RP-CC-001 for Type D filters.
(1) 100 mm deep mini-pleated, disposable type.
(2) Initial resistance at 0.508 m/s face velocity not greater than 110 Pa.
(3) UL 900 Class 1 listing in UL building materials directory.
(4) Scan test face and perimeter of filter pack for leaks greater than 0.01 percent of the upstream challenge.

4. Filter housing:
a. Housing and inlet constructed of 1.6 mm aluminum, welded and sealed at all joints and seams to ensure airtight housing.
(1) 300 mm diameter inlet for 1200 x 600 mm housings.
(2) 200 mm diameter inlet for smaller than 1200 x 600 mm housings.
b. Aluminum perimeter and internal channels with welded corners.
c. Perimeter skirt for fluid sealing system.
d. Filter sizes to fit modular ceiling system.
e. Module to include butterfly damper, perforated diffusion plate, filter, white face guard.
f. Filter shall be replaceable without moving housing from ceiling system.
g. Damper operated from the room (downstream) side of the unit.
h. Diffusion plate of 1.6 mm aluminum mounted within housing beneath duct connection.
i. Face guard of perforated metal. Perforations provide 40 percent free area minimum.

K. Filter Dampers:
1. Volume control dampers shall be minimum 4 mm aluminum.
2. Dampers shall be manually adjusted from cleanroom.
3. Damper operator shall provide continuous linear adjustment.
4. Dampers for filter housings shall be perforated plate at the inlet duct collar.

5. Damper for standard filters to be side mounted at at upstream side of filter.

L. Hanging clips:
1. Extruded aluminum and clear anodized after cutting to length capable of supporting a 180 kg concentrated load.
2. Mount anywhere along grid without interfering with light fixtures or compromising grid integrity.

2.02 FABRICATION

A. Factory weld and grind smooth all grid joints.

B. Reinforce all units for ceiling supported systems.

C. Factory install all sleeves, piping and conduits.
1. Install pipe with rubber gasket grommets.
2. Seal fire sprinkler penetrations with manufacturer's standard gel solution.

PART 3 - EXECUTION

3.01 ERECTION

A. Examine all subsurfaces to receive work.

B. Provide all support members and attachments and special dimension closure strips at walls and where otherwise required.

C. Install in accord with manufacturer's recommendations.

D. Place grid system from supporting framework.

E. Level, align and adjust to final position prior to permanent fastening.

END OF SECTION

SECTION 13085

ELECTRO-PNEUMATIC CONTROLLED AIR-SPRING
VIBRATION ISOLATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Electro-pneumatic controlled air-springs are used as supports for a vibration isolated concrete floor.

B. Electro-pneumatic controlled air-springs and active vibration isolation controls are Offer Option 3.

1.02 QUALITY ASSURANCE

A. Warranty: The isolation system and controls shall be guaranteed against all defects for one year from the date of acceptance. In the event of a failure, Provide a replacement component at no charge. If the vibration isolation provided by the system should decrease noticeably during the one year warranty period (without any obvious failure) determine the reason for the decrease and adjust or repair the system as required at no charge providing the problem is due to the performance of the system. If the problem is determined to be caused by a something other than the system, standard service rates would apply.

B. The isolators natural frequency in a single degree of freedom system shall be guaranteed to be within +/-15 percent of the values specified. Friction and vibration transmitted by the electro-pneumatic servo valves shall be guaranteed to be less than 1 percent.

1.03 SUBMITTALS

A. Shop drawings: Installation drawings including spring layout and control piping, wiring, and location. Include details for mounting control devices in service module.

B. Product data: Manufacturer's published information of the systems to be provided.

C. Samples: Not required for COTR review.

D. Project information:
1. Review of construction drawings: Review the drawings for the floor being supported and the supports for the springs with regard to possible incompatibilities

between springs and the attachment points. Notify COTR of incompatibilities that are found.

E. Contract closeout information:
1. Maintenance and operating information.
2. Warranty.
3. Acceptance test report.
4. Computer diskettes containing all acceptance test data gathered.

1.04 PRODUCT DELIVERY

A. Deliver material to jobsite in cartons and crates.

B. Inspect for damage prior to installation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Base:
a. Technical Manufacturing Corporation.
2. Other manufacturer's desiring approval comply with Section 01640.

2.02 ELECTRO-PNEUMATIC AIR-SPRING WITH HEIGHT CONTROL

A. Technical Manufacturing Corporation PEPS System or equivalent.

B. The performance of the vibration isolation system will approximate the following:
1. Vertical natural frequency:
a. 1.5 Hz at maximum rated load.
b. 1.75 Hz at 50 percent of maximum rated load.
c. 2.0 Hz at 25 percent of maximum rated load.
2. Horizontal natural frequency 2.5 Hz.
3. Damping - 10 percent of critical, with damping adjustment capability.

C. Vertical to horizontal stiffness ratio - 0.4:1.

2.03 ACTIVE CONTROL PERFORMANCE CHARACTERISTICS

A. Technical Manufacturing Corporation Electro-damp System or equivalent.

B. The active control system shall be installed in parallel with the electro-pneumatic air-spring with height control

to improve the low frequency isolation characteristics. The active control system shall include four active isolators and electronic controller and interconnecting tubing. Each active isolator shall include a triaxial vibration transducer, triaxial electrodynamic force actuator and air spring.

1. The system shall provide active control of vibration in all 6 degrees of freedom.
2. The active vibration control frequency range shall be 0.25 Hz to 25 Hz. Performance outside of this range shall be that of the passive air spring system.
3. The active resonant frequency shall be 0.4 Hz (nominal) in the vertical and horizontal axes with an amplification of less than 1.1.
4. Active vibration isolation shall approximate the following:

    4.1 30 percent at 1 Hz
    4.2 70 percent at 2 Hz
    4.3 90 percent at 5 Hz
    4.4 90 percent at 5 Hz

5. The available force output per isolater per axis shall be 89N peak and 22N continuous.
6. The controller shall operate from 120 volt, 60 Hz wall outlet with a maximum consumption of 750 watts. No other electrical power shall be required.
7. The isolators shall operate off of the air supplied to the air spring system with negligible consumption.

2.04 PRODUCT CONSTRUCTION

A. The isolator body will include a metal housing consisting of a spring chamber and damping chamber in one unit.

B. All tubing shall be color coded plastic with an operating pressure rating of greater than 690 kPa at temperatures of 38 degC or less.

C. Valve to provide damping adjustment capability.

D. Provide variable external orifices with isolators to allow adjustment of vertical natural frequency to 1.3 Hz or less.

E. Provide an oil fog lubricator at the air supply to the system for each vibration isolator system.

2.05 OPERATING CHARACTERISTICS

A. Operating height: As indicated.

B. Internal pressure: 550 kPa at maximum rated load.

C. Over travel protection: An internal safety valve will vent air to protect the isolator from the sudden change in weight.

D. Minimum height: The height of the isolator shall decrease when deflated to permit the isolator to be installed under the ledge of the A-1 concrete inertia slab.

E. The isolators shall be useable in either of the following configurations:
   1. Height control by three mechanical height sensing servo valves.
   2. Height control by an electro-pneumatic height control system.

F. Provide electro-pneumatic height control.

G. When used with mechanical height sensing valves or with electro-pneumatic height control systems, the isolators shall be divided into three sets with the internal pressure and height of each set controlled by one of the servo valves. The height control at each of the three sensing points will be as follows:
   1. High-accuracy electro-pneumatic height control system, with an accuracy of +/-0.005 mm.
   2. Provide hall effect non-contacting sensors. Height sensing potentiometers will not be permitted.

H. The isolation system shall be provided with the number of isolators indicated. The system shall support the total anticipated load of slab weight plus 1.9 kPa with an internal pressure of less than 550 kPa except that system at slab mark "O" shall support the slab weight plus 9 metric tons.

I. A control panel shall be furnished with an air filter, pressure regulator and a minimum of (6) pressure gauges to indicate the regulated pressure and the pressure in each isolator.

J. The distance from the top of the retaining ring the roll plane of the isolators shall not exceed 20 mm.

2.06 INTERFACE TO BUILDING

A. The isolation with electro-pneumatic servo valves shall be able to work with a continuous source of shop air or nitrogen at pressure between 590 kPa and 860 kPa. The

maximum air consumption for the complete isolation system with electro-pneumatic servo valves shall not exceed 28 L/min. under static conditions to 550 L/min. for a few seconds when correcting for large shifts in weight.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine structure, substrates and conditions under which work is to be installed for conditions detrimental to correct and timely completion.

B. Installation constitutes acceptance of responsibility for performance.

3.02 INSTALLATION

A. Provide and grout in setting plates such that the distance from the top of the setting plate to the underside of the slab is equal for all isolators (to plus or minus 0.1 mm).

B. Level and align upon completion of installation.

C. Leave work complete and in proper operating condition.

D. Remove and replace defective work.

E. Manufacturer shall provide a field engineer to supervise installation and testing of the isolation systems.

3.03 ACCEPTANCE TESTING

A. Acceptance testing shall be performed upon completion of the installation compensation and optimization of the system. The natural frequency shall be determined by measuring the transmissibility between the foundation and the top of the mass.
   1. Passive test procedure apply to all isolation systems.
   2. Active test procedure apply to all isolation systems with active control.
   3. These tests shall be performed to indicate the natural frequency and isolation.
   4. Additional testing shall be performed by COTR.
   5. Prior to testing, adjust damping of isolators so that isolators for each mass are balanced and tuned to the configuration of the masses and isolation system.

B. Test procedures:
   1. Passive test:

a. Place two seismic vibration sensors on top of the concrete inertia mass near the center. Using a two channel FFT Spectrum analyzer measure the transfer function between the two signals to verify that the two triaxial sensors have the same calibration and response characteristics. The transfer function should be flat. Repeat for the longitudinal and lateral axes.
b. Relocate one of the triaxial velocity sensors to the top of the pit wall. Where active system is installed set system in STANDBY measure the transfer function (transmissibility) between the inertia mass and the top of the pit wall from 0.5 Hz to 100 Hz in the vertical axis. The transfer function should be the result of 800 line analysis (frequency range 0 to 100 Hz) and at least 50 averages without overlap. This will establish the isolation provided by the passive isolation system.
c. Repeat step b., in the longitudinal axis.
d. Repeat step b., in the lateral axis.
e. At conclusion record and store FFT spectrum data including magnitude, phase and coherence.

2. Active test:
   a. Reset the active controller to OPERATE. Measure the transfer function in the vertical, longitudinal and lateral axes using the same procedure used in step 1.b., above.
   b. Compare the transfer functions obtained in each axis with the controller in STANDBY with the transfer function for the same axis with the controller in OPERATE. The difference in the two transfer functions is the result of the active vibration control.
   c. At conclusion, record and store FFT spectrum data including magnitude, phase and coherence.
3. Height sensing system test:
   a. Install a dial indicator between the floor and the isolated mass at each height sensor for the isolation system. Adjust the dial indicators to mid stroke and set it to 0.
   b. Observe the dial indicator readings for 10 minutes. Note and record the highest and lowest reading.
   c. Add a weight of about 450 N to the top of the mass, note and record the dial indicator readings after the isolation system has corrected for the change in load.
   d. Remove the 450 N weight from the top of the mass, note and record the dial indicator readings after the isolation system has corrected for the change

in load.

C. Data reduction and plotting:
   1. Describe methods and formats.

D. Report:
   1. Describe test conditions.
   2. Describe test activities.
   3. Present data, including a copy of the test procedure, data sheets, FFT spectrums, transfer function plots, and any other applicable information.
   4. Confirm that the active system limits amplification of the existing passive isolation system to no more than 10 dB in the frequency range of 0.5 to 25 Hz and that the active system does not degrade the performance of the passive system by more than 2 dB at frequencies above 25 Hz up to 100 Hz.

END OF SECTION

SECTION 13095
ELECTROMAGNETIC SHIELDED ROOMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Electromagnetic shielding system consists of:
   1. Wall, floor and ceiling shielding.
   2. Supports for shielding.
   3. Doors, door frames and hardware.
   4. Accessories for mechanical and electrical penetrations.
   5. Light fixtures and other electrical devices with associated wiring and switching within the shielding enclosures.

B. Provide separate enclosure for the following rooms to be shielded against acoustic and electromagnetic interference (EMI): Building 218 Room D0017, Low Temperature STM.

C. Refer to inner and outer shielded room drawings at the end of this section.
   1. Final shielded room(s) design shall be produced and approved by the manufacturer.

1.02 QUALITY ASSURANCE

A. Design criteria. The overall acoustic performance of the double wall system shall have an STC rating of a least 70, and a NIC rating of at least 75 with the noise reduction given in the table below or better. Particular attention is to be paid to the lower end of the frequency spectrum for acoustic attenuation.

Sound Noise Reduction, dB Overall Double Wall System:

Octave Band Center Frequencies Hz	63	125	250	500	1K	2K	4K	8K	NIC
Noise Reduction dB	37	52	64	80	93	>93	>93	>93	75

1. Building 218 Room D0017, Low Temperature STM - OUTER ROOM:
   a. Room Size: 6700W x 6900L x 6100H (nominal).
   b. Acoustic Attenuation: STC48 - minimum.
   c. The room shall be constructed with the necessary structural support members to ensure structural integrity and a minimum of flexing to avoid low frequency vibrations in the range of 1-100 Hz.

Sound Transmission Loss, dB Exterior Enclosure Panel:

Octave Band Center Frequencies Hz	63	125	250	500	1K	2K	4K	8K	STC
Sound Transmission Loss dB	31	34	35	44	54	63	62	68	48

Sound Absorption Coefficients Exterior Enclosure Panel:

Octave Band Center Frequencies Hz	125	250	500	1K	2K	4K	NRC
Absorption coefficients	0.56	0.99	1.09	0.97	0.95	0.90	0.95

2. Building 218 Room D0017, Low Temperature STM - INNER ROOM:
   a. Room Size: 4100W x 5200L x 5000H (nominal).
   b. Acoustic Attenuation: STC45 - minimum.
   c. The room shall be constructed with the necessary structural support members to ensure structural integrity and a minimum of flexing to avoid low frequency vibrations in the range of 1-100 Hz. The bottom of the 1420 mm square pit in the A1-slab must be acoustically shielded to the level of the inner room wall system. All materials and fasteners used in the pit must be made of non-magnetic material, see Radio Frequency (RF).
   d. Radio Frequency (RF) Attenuation: NSA 73-2A (minimum).
      1. Attenuation to magnetic field: Minimum performance:
         (a) 50 dB between 10 MHz to 100 MHz.
         (b) 10 dB at 1 KHz.
      2. Attenuation to electric field: Minimum performance:
         (a) 50 dB between 10 KHz to 10 MHz.
      3. Attenuation to plane waves: Minimum performance:
         a. 50 dB at 10 MHz to 100 MHz.
         b. 40 dB at 1 GHz.
   f. As an option, priced separately, increase the room rating to meet the specifications of NSA 65-6.
   g. Minimum resistance between shielding and ground, ungrounded: 1,000 ohms.
   h. Maximum deflection of ceiling: 1/360 of span.

B. Applicable standards:
   1. Method of attenuation measurements for electromagnetic shielding enclosure: MIL-STD-285.
   2. Method of insertion loss measurements for radio frequency filters: MIL-STD-220A.
   3. General specifications for radio frequency shielded enclosures: NSA-73-2A.

4. Standard for safety-electromagnetic interference filters: UL-1283.
5. Test for surface burning characteristics of building materials: ASTM-E84.
6. Recommended practice for laboratory measurements of airborne sound transmission loss of building partitions: ASTM-E90.
7. Standard classification for determining sound transmission class: ASTM-E413.
8. Flame resistance test: Fed. Spec. SS-A-118.
9. NSA 73-2A, NACSIM 5204, National Security Agency Specification for Foil RF Shielded Enclosure, National Security Agency.
10. ASTM-C423.

C. Manufacturer qualifications:
1. Engaged in manufacture and installation of acoustic, electromagnetic or radio-frequency interference shielded enclosures for minimum five years.
2. Manufactured and installed minimum 10 successful acoustic, electromagnetic or radio-frequency interference shielded installations of similar or greater complexity and size.

D. Installer qualifications: Manufacturer shall provide installation.

E. Test instruments:
1. For ground resistance: Relay operating ohmmeter with audio and visual alarm.
2. For magnetic field, electric field and plane wave: MIL-STD-285 and NSA 73-2A requirements.
3. For acoustic: ASTM C423, ASTM E90, and ASTM E413.

1.03 SUBMITTALS

A. Shop drawings:
1. Complete structural design, fabrication and erection drawings, including plans, elevations, typical sections, and details of penetrations, doors and door frames, light fixtures and wiring, and other conditions affecting shielding enclosures.

B. Product data:
1. Manufacturer's standard data for system and components specified.
2. Manufacturer shall furnish certified sound-transmission-loss and sound-absorption test data, per the schedule, and taken in an acoustical laboratory with a reverberation room satisfying applicable portions of ASTM Specifications E90, C 423, and E413.

C. Samples: Not required for COTR review.

D. Project information:
    1. Manufacturer and installer qualifications.
        a. Include list of 10 successful installations.
        b. Include test results from each of the listed installations.
    2. Reports of field quality control testing for each of the rooms.
        a. Certified by manufacturer.
        b. Signed as witnessed by COTR.
E. Contract closeout information:
    1. Warranty.

1.04 JOB CONDITIONS

A. Coordinate with work of other sections providing substrates, finishes, and mechanical and electrical services to shielded rooms: Divisions 3, 9, 15 and 16.
    1. Prior to installation of enclosure:
        a. Parent space shall be enclosed, finished and otherwise prepared to receive shielding work.
    2. Electrical connections to shielded filters.
    3. Ductwork connections to waveguide type RF air vents.
    4. Piping connections to shielded penetrations.
    5. Finished flooring and partitions within enclosure.
    6. Parent space partitions outside of enclosure and associated flooring and ceilings, including return construction at door recesses.
        a. Provide for minimum 25 mm space between enclosure and parent space partitions, except at door recess returns.

1.05 WARRANTY

A. Provide five years warranty against defects in materials and workmanship to retain specified acoustic and electromagnetic shielding characteristics.
    1. Warranty period begins on date of project acceptance.
    2. Warranty signed by manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Electromagnetic interference shielded enclosures:
        a. Base: Industrial Acoustics Company, 1160 Commerce - Avenue, Bronx, New York 10462. Ph: (718) 931-8000. Fax: (718) 863-1138.
    2. Other manufacturers desiring approval comply with Section 01640.

B. Building 218 Room D0017 - Low Temperature STM - OUTER ROOM:

1. Pre-engineered modular wall and ceiling panels inclusive of support framing and fasteners, providing attenuation and other properties as an assembly complying with design criteria.

   a. Sound Transmission Loss, dB Interior Enclosure Panel:

Octave Band Center Frequencies Hz	63	125	250	500	1K	2K	4K	8K	STC
Sound Transmission Loss dB	27	30	32	41	50	59	67	71	45

   b. Sound Absorption Coefficients Interior Enclosure Panel:

Octave Band Center Frequencies Hz	125	250	500	1K	2K	4K	NRC
Absorption coefficients	0.56	0.99	1.09	0.97	0.95	0.90	0.95

2. Wall and Ceiling Panel Construction: The panel wall system must meet or exceed the performance of the "Super-Noise-Lock" panel by the Industrial Acoustics Company. The panel is to be at least 4" thick, with an outside surface of at least 1/4" thick hot rolled solid steel plate, and an inner surface of at least 22 gauge galvanized perforated steel. The panel shall be filled with sheet-rock and acoustic isolation material, which shall be taped and sealed and separated with a spacer. The design weight of the panel shall be at least 15.5 lb/ft2.
   a. Wall, Ceiling and Floor Panels shall be 102mm (4") thick and fabricated of steel face sheets, framing members, and internal reinforcements welded and riveted together to form a rugged, metal-sheathed panel. Each panel shall be damped and filled with sound retardant and absorbing materials that are inert, mildew-resistant, vermin-proof, hydrophobic, and incombustible.
   b. Connecting Panel Joiners for stationary panels shall be fabricated on one length of roll-formed steel designed and sized to prevent noise leakage while acoustically and structurally joining the panels. Steel hardware and trim shall be provided as necessary to form a complete system.
   c. Demountability: The structure shall be designed to permit disassembly without deformation or damage to components. Reassembly shall be accomplished without loss of acoustic or structural integrity and without requiring any replacement parts.
3. Door Construction: The outer room shall have two (2) single leaf acoustical doors with an STC rating that shall

not degrade the overall wall system acoustic performance. The door shall have an STC rating of 61 or better and triple seal. The doors shall have the necessary push/pull hardware with positive locking.

a. Door leaves shall be 63.5mm (2-1/2") thick and fabricated of steel face sheets and internal reinforcements. Face sheets shall be attached or structurally joined only at perimeter. Leaves shall be designed and filled with sound-retardant and absorptive materials that are inert, mildew-resistant, vermin-proof, hydrophobic, and incombustible.
b. Frames may be welded steel construction; however, for this application, it may be necessary to (at contractor's option) provide the manufacturer's split frame design, having concealed fasteners.
c. Acoustic Seals: Sides and head of door and frame shall include two (2) sets of self-aligning, magnetic compression seals. In closed position, acoustic labyrinth shall be created and door held in place by magnetic force of perimeter seals at head and jambs. Bottom of door leaf shall contain continuous seal, activated by gravity action of cam hinge that compresses against floor as door is closed. Raised sills and threshold drop seals shall not be permitted.
d. Hardware: Two (2) IAC Cam-Lift butt type hinges, finished in US 26D satin chrome, shall be supplied with each door leaf. Manufacturer shall provide test data showing that hinges of identical design have been cycled a minimum of 125,000 times while supporting a door leaf weighing at least 159 kg (350lb). Latches and other hardware (specified above) shall not be required to achieve an acoustic seal. All specified builder's hardware shall be factory fitted and installed.

4. Access Plug: (See drawings for location.) Provide wall opening and removable access plug, 610 mm x 610 mm. The access plug shall be bolted from the outside of the room and have two handles to remove it. The plug shall be designed so as to not degrade the performance of the wall system. Provide 20mm x 150 mm alignment lugs and associated hardware to assist in the placement and/or removal of the plug. Provide one spare plug, complete with all required hardware for mounting, to be delivered to the COTR at time of installation.
5. Air Silencers: The room shall be designed with acoustic air silencers to handle 330 L/S to the outer room. This room shall also have a set of silencers to service the inner room to handle 755 L/S. The silencer performance shall be equal to or better than the performance of the wall systems. Suggested locations of the silencers and

intake/outtake vents are indicated on the drawings. Final locations to be coordinated with the COTR during production of required shop drawings. It is important that the airflow be symmetrical and not cause low frequency vibration of the inner room or measurement systems. A total of 4 silencers to service the outer room and 8 to service the inner room is suggested.

6. Florescent light fixtures shall be provided by the shielding vendor, to be compatible with all shielding system designs. Lighting shall be installed in the ceiling area to light the area of the external room, including the corridor areas surrounding the inner shielded room. Lighting level shall be designed for a minimum of 500 Lux. Fixtures shall be "Metalux DCIM-332-277-EB28-WG" or approved equal.
7. Finish: The outer room shall be supplied clean and free of grease and oil suitable to be painted after installation. The vendor shall paint the room to match the wall color of the laboratory walls. Color chips for color matching are available (for loan) from the COTR. Painting of the inner surface shall be done in such a way to not degrade the acoustic absorption of the perforated wall panel. Refer to Section 09900.

C. Building 218 Room D0017 - Low Temperature STM - INNER ROOM:
1. Pre-engineered modular wall and ceiling panels inclusive of support framing and fasteners, providing attenuation and other properties as an assembly complying with design criteria.
2. Crane Rails and Crane: A bridge (XY) crane system must be provided for the inner room rated at 1-ton capacity. Crane must not interfere with track lighting or equipment within room (See drawings for location and height). Structural engineering services, frame and trolley system shall be provided by the shielded room manufacturer. Hoist to be supplied and installed by the Government.
3. Wall and Ceiling Panel Construction: The panel must have the performance of the "Noise-Lock II" panel by the Industrial Acoustics Company or better. The panel is to be at least 4" thick, but can be up to 8" thick to optimize low frequency performance. The panel shall have an outside surface of at least 16 gauge thick solid galvanized steel plate, and an inner surface of at least 22 gauge galvanized perforated steel. The panel shall be filled with sheet rock and acoustic isolation meaterial, which shall be taped and sealed and separated with a spacer. The design weight of the panel should be at least 10.5 lb/ft2.
   a. Wall, and Ceiling Panels shall be 102mm (4") minimum to 204mm (8") maximum thick and fabricated of steel face

sheets, framing members, and internal reinforcements welded and riveted together to form a rugged, metal-sheathed panel. Each panel shall be damped and filled with sound retardant and absorbing materials that are inert, mildew-resistant, vermin-proof, hydrophobic, and incombustible.

b. The A1-slab's floor and 1420 mm square hole (pit) shall be lined with a non-magnetic metal, a minimum of 16 gauge thick solid copper with all seams and joints compatible with the RF specifications. All materials and fasteners used must be non-magnetic and the pit lining must not cause interfere with a 1000 mm outer diameter cryostat. The pit shall be lined to a depth of 9 feet. The bottom of the pit must be both RF and acoustically shielded to the specifications of the inner room wall system or better. This is critical in order to maintain electrical shielding and not cause interference with the superconducting magnet system to be installed in the pit.

c. Raised Floor. The floor system will be raised to the height of the doorsill. The floor will have removable tiles for underneath access. An aluminum frame system is suggested to support the raised floor. All the floor systems materials and fasteners must be non-magnetic.

(1) Raised Access Flooring shall be installed within the inner room and have a free clearance of 130 mm from the slab floor to the access floor understructure.

(2) Provide system tested in accordance with CISA test procedures capable of supporting the following minimum loads, with no permanent set:

(a) Concentrated load of 565 kg on any 642 mm2 with maximum deflection of L/300.

(b) Design floor system to withstand lateral forces.

(c) Complete floor systems shall be rigid and free from rocking panels.

(d) A licensed structural engineer shall stamp underfloor support structure design.

(3) Tolerances:

(a) Squareness tolerance of +/- 0.13 mm measured on diagonal on top of panel.

(b) Flatness tolerance of +/- 0.51 mm measured on diagonal on top of panel.

(c) Tolerances apply before edging is applied.

(4) Electrical Conductance:

(a) Provide solid copper grounding jumper from grid system to room reference ground.

(b) Provide floor covering material meeting requirements of NFPA 99 for conductive flooring.

(c) Maximum electrical resistance shall be 1 ohm from

the top of the panel, less wear surface, to the pedestal base.

(5) Floor panels shall conform to CISCA test procedures.

d. Connecting Panel Joiners for stationary panels shall be fabricated on one length of roll-formed steel designed and sized to prevent noise leakage while acoustically and structurally joining the panels. Steel hardware and trim shall be provided as necessary to form a complete system.

e. Demountability: The structure shall be designed to permit disassembly without deformation or damage to components. Reassembly shall be accomplished without loss of acoustic or structural integrity and without requiring any replacement parts.

4. Door Construction: The inner room shall have one (1) single leaf acoustical door with an STC rating that shall not degrade the overall wall system acoustic performance. The door shall have an STC rating of 61 or better and triple seal. The doors shall have the necessary push/pull hardware with positive locking.

a. Door leaves shall be 63.5mm (2-1/2") thick and fabricated of steel face sheets and internal reinforcements. Face sheets shall be attached or structurally joined only at perimeter. Leaves shall be designed and filled with sound-retardant and absorptive materials that are inert, mildew-resistant, vermin-proof, hydrophobic, and incombustible.

b. Frames may be welded steel construction; however, for this application, it may be necessary to (at contractor's option) provide the manufacturer's split frame design, having concealed fasteners.

c. Acoustic Seals: Sides, bottom, and head of door and frame shall include two (2) sets of self-aligning, magnetic compression seals. In closed position, acoustic labyrinth shall be created and door held in place by magnetic force of perimeter seals.

d. Hardware: Two (2) IAC Cam-Lift butt type hinges, finished in US 26D satin chrome, shall be supplied with each door leaf. Manufacturer shall provide test data showing that hinges of identical design have been cycled a minimum of 125,000 times while suporting a door leaf weighing at least 159 kg (350lb). Latches and other hardware (specified above) shall not be required to achieve an acoustic seal. All specified builder's hardware shall be factory fitted and installed.

5. Access Plug: (See drawings for location.) Provide wall opening and removable access plug, 610 mm x 610 mm. The access plug shall be bolted from the outside of the room and have two handles to remove it. The plug shall be designed so as to not degrade the performance of the wall system. Provide 20mm x 150mm alignment lugs and associated

hardware to assist in the placement and/or removal of the plug. Provide one spare plug, complete with all required hardware for mounting, to be delivered to the COTR at time of installation.

6. Air Silencers: The room shall be designed with acoustic air silencers to handle 755 L/S to the inner room. The silencer performance shall be equal to or better than the performance of the wall systems. Suggested locations of the silencers and intake/outake vents are indicated on the drawings. Final locations to be coordinated with the COTR during production of required shop drawings. It is important that the airflow be symmetrical and not cause low frequency vibration of the inner room or measurement systems. Flexible ducting shall be used to connect air systems to the inner room. A total of 8 silencers is suggested. Note a separate set of 8 silencers shall be placed on teh outer room to feed the 8 silencers placed on the inner room, so that the ducts leading to the inner room can be disconnected if needed for sensitive measurements without the need for closing them off.
7. Incandescent track light fixtures shall be provided and installed by the shielding vendor to ensure compatibility with all shielding system designs. Incandescent track light fixtures shall be placed in the ceiling area to light the inner room and must not interfere with crane system. Lighting level shall be designed for a minimum of 500 Lux. Fixtures shall be "Halo L746-P-PAR30", 2 circuit track "Halo Power-Trac #L643" with all required fitting and hardware or approved equal.
8. Finish: The inner room shall be supplied clean and free of grease and oil suitable to be painted after installation. The vendor shall paint the room to match the wall color of the laboratory wall color of the laboratory walls. Color chips for color matching are available (for loan) from the COTR. Painting of the inner surface shall be done in such a way to not degrade the acoustic absorption of the perforated wall panel.

D. Shielded accessories: Shielding enclosure manufacturer/contractor shall provide all necessary accessories to maintain the integrity of the installed enclosures. Penetrations for mechanical and electrical services are shown on the hook-up drawings for this area.
   1. Filters: To provide specified attenuations.
      a. With integral means for secure mounting to service panel.
      b. With integral waveguide fittings for pass-through electrical conductors.
         (1) Provide (3) electrical filters for 3 panelboards; 3 phase, 4 wire, 208v, 60 amp, 60 Hz, 10K AIC, "Corcom #AYT6C" or approved equal.
         (2) Provide (7) dual wire 1 amp 125VAC/400VDC fire alarm filters, "Corcom #WFV3564" or approved equal.
         (3) Provide (3) dual wire 5 amp 125VAC/400VDC control

line filters, "Corcom #NF21593-5" or approved equal. For Oxygen Sensor, Temperature Sensor and Air flow sensor.

(4) Provide NEMA1 filter cabinet for mounting fire alarm and control line filters, "Corcom SLA Series" or approved equal.

2. Waveguide air vents: For supply intake and exhaust air ventilation ductwork.
   a. Waveguide below cut-off type.
   b. 4.76 mm steel hex cell, 25 mm deep.
3. Mechanical penetrations: Radio-frequency shielded waveguide type nonferrous pipe penetrations.
   a. (3) Stainless steel vacuum penetrations with (6) KF40 connectors.

E. Electrical work: Building 218 Room D0017 - LOW TEMPERATURE STM:
   1. Lighting: See specific requirements for each inner and outer shielding room above.
   2. Power:
      a. Provide all electrical devices and associated circuitry indicated on the drawings: Comply as specified in Division 16.
      b. Connect filters to panelboards for all feeder power circuits that penetrate shielded enclosure.
      c. Supply panelboards within the inner shielded room. Refer to Section 16000 Panelboard schedules for panelboard requirements.
         (1) Feed devices and circuitry within room from panelboards indicated on drawings.
   3. Electrical connections to the inner room shall not be made in conduit. Provide suitable wiring means and methods for vibration control. See Section 16901.

F. Finishing materials:
   1. Painting: Section 09900.

PART 3 - EXECUTION

3.01 PREPARATION

A. Refer to plumbing, HVAC and electrical drawings for utility penetrations locations of enclosure.
B. Coordinate with work of other sections to assure proper and adequate interface with shielding work.
C. Examine substrates and conditions under which this work is to be performed.
   1. Correct unsatisfactory conditions.
   2. Start of work indicates acceptance of responsibility for performance.

3.02 INSTALLATION

A. Shielding shall be continuous.
   1. Provide electromagnetically tight seams.
   2. Provide continuity of shielding where other work, materials or accessories penetrate shielding patches or sleeves.

B. Provide installation by manufacturer's certified field service technicians.

C. Install panels in straight lines with true even surfaces and aligned joints.
   1. Install wall panels plumb.
   2. Install floor and ceiling panels level.
   3. Install support framing with uniform pressure contact on full perimeter of panels, with members rigidly fastened into self-supporting framework for full enclosure.

D. Install doors, door frames and hardware to operate properly and to maintain shielding integrity when closed.

E. Install shielded accessories, light fixtures and associated work to maintain shielding integrity at all times.

F. During installation, immediately remove all spots, smears, stains, residues, adhesives and other debris from shielding work and from adjacent surfaces and areas resulting from work of this section.

3.03 FIELD QUALITY CONTROL

A. Enclosure shall be tested for isolation from ground during construction. Upon completion the enclosure will be tested for attenuation shielding and acoustic performance.

B. Testing for isolation from ground: System ground audio and visual alert alarm shall be utilized continuously during construction to ensure shielding system is electrically isolated from ground.
   1. System alarm shall activate when resistance between shielding and ground falls below specified design criteria.
   2. Upon activation of alarm, rectify cause of grounding condition.

C. Testing for attenuation shielding: Enclosure shall be fully tested to ensure compliance with specified design criteria.
   1. Tests shall comply with MIL-STD-285, modified for frequencies of NSA-73-2A.
   2. Minimum two sets of tests shall be required for each enclosure:
      a. Qualification test: After enclosure is installed, and before other construction and finishes erected within

shielded enclosure.
b. Acceptance test: After completion of other construction and finishes within shielded enclosure.

3. Each set of tests shall include testing of all shielding components, seams and door for the following properties:
   a. Magnetic field.
   b. Electric field.
   c. Plane wave.
4. If any test result fails to comply with specified design criteria, rectify cause of failure and repeat test until compliance.
5. Testing shall be witnessed by COTR.

D. Testing for acoustic performance: Enclosure shall be fully tested to ensure compliance with specified design criteria.
   1. Each room shall be tested individually to ensure compliance with specified STC and NRC ratings.
   2. Overall double walled system shall be tested to ensure compliance with specified STC and NIC ratings.
   3. If any test result fails to comply with specified design criteria, rectify cause of failure and repeat test until compliance.
   4. Testing shall be witnessed by COTR.

3.04 FINISHING

A. Monitor finishing work of other sections to assure maintenance of full shielding medium.

3.05 PROTECTION

A. Prevent damage to shielding linings and finished surfaces.

B. Damaged work shall be removed and replaced with undamaged work providing continuity of shielding.

END OF SECTION

SECTION 13100

LASER PROTECTION

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Manufacturer shall have been active in laser shielding business for at least five years and shall maintain a quality assurance program that will permit manufacturer to submit test reports on all components and assemblies to assure that material meets specification criteria.

B. Applicable Standards:
1. ASTM-D309.
2. ASTM-D257.
3. ASTM-F150.
4. NFPA-701.
5. ANSIZ-136.1

C. Laser shielding test:
1. After completion of installation, when laser equipment is in place, have test performed by a certified Office of Environmental Health and Safety (OHES) technician.
2. Administer and complete testing, including coordination of all items forming part of shielding.
3. Test result required: No laser penetration.
4. Perform corrective work.
5. After corrective work is performed, retest as required until successful results are obtained.

1.02 SUBMITTALS

A. Shop drawings:
1. Manufacturer's installation instructions and recommendations.

B. Project information:
1. Test reports: Laser shielding test report, signed by certifies OHES representative.

1.03 JOB CONDITIONS

A. Coordinate installation with work of other trades.

B. Assure that surfaces to receive laser shielding are sound and compatible with anchoring devices.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Laser shielding:
        a. Base:
            (1) Servicor, Inc.
        b. Optional:
            (1) Quantex Corp.
            (2) Laser-R Shield, Inc.
    2. Laser entrance screens:
        a. Base:
            (1) Wilson Industries, Inc.
    3. Other manufacturers desiring approval comply with Section 01640.

B. Laser Protection Material: To resist Class 4 lasers.
    1. Vinyl coated nylon.
    2. Adhesion: 1.8 kg/25 mm in accord with ASTM-D903.
    3. Low Temperature Bend: -23 øC in accord with ASTM-D2136.
    4. Surface Resistance: 1000 - 10,000 ohms/2500 mm2.
    5. Furnish in maximum sizes pertinent to project in thicknesses shown on the drawings or elsewhere specified.

C. Laser entrance screens: Floor mounted partitions with laser protection material surfacing.
    1. Square steel tube framing.
    2. 2400 mm high.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Coordinate installation of all laser shielding fabric with contractor's providing finishes over or adjacent to the shielding material.

3.02 CLEAN UP

A. Remove all debris and non-essential material from the shielded room prior to finishing of radiation shielding surfaces.

B. Prior to application of any finishes verify that shielding materials have been installed in conformance with applicable codes and manufacturer's installation criteria.

END OF SECTION

top view

204.472
5193.6
East Wall

Supply silencers on north and south walls, 4 places.

Exhaust silencer
Exhaust silencer
Exhaust silencer
Exhaust silencer

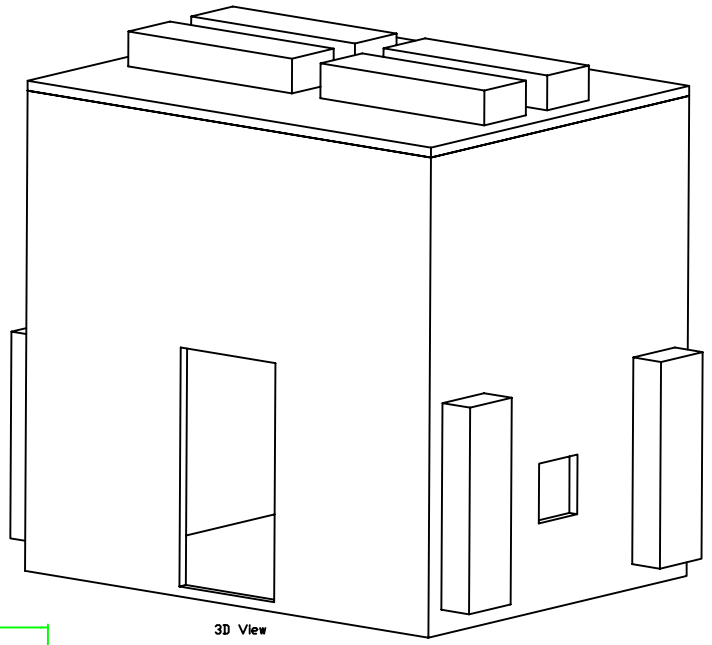
Track Lighting

161.291
4096.8
North Wall

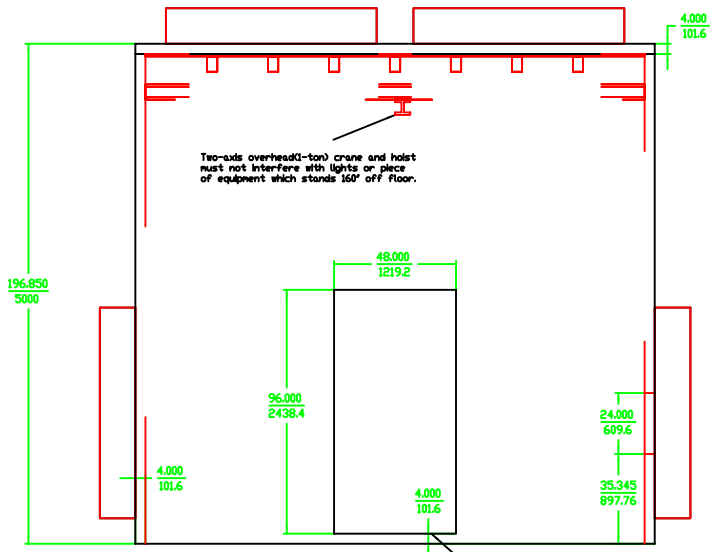
South Wall

Access hole

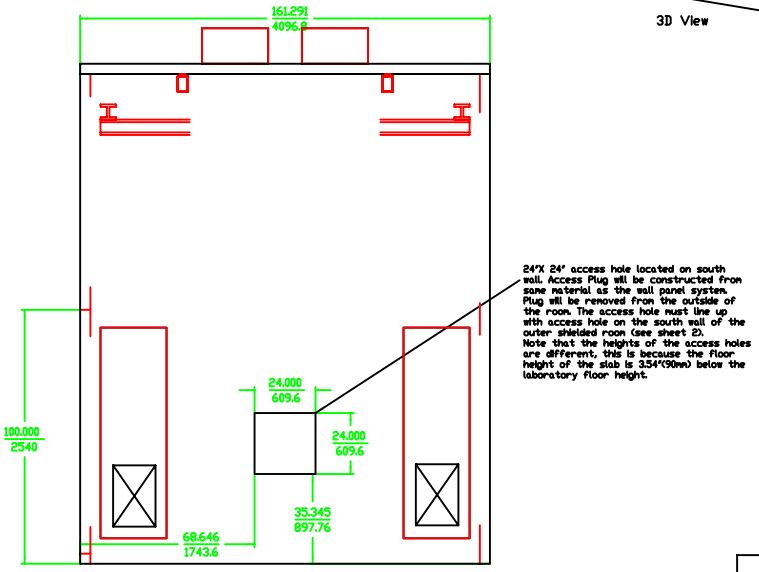
West Wall



3D View



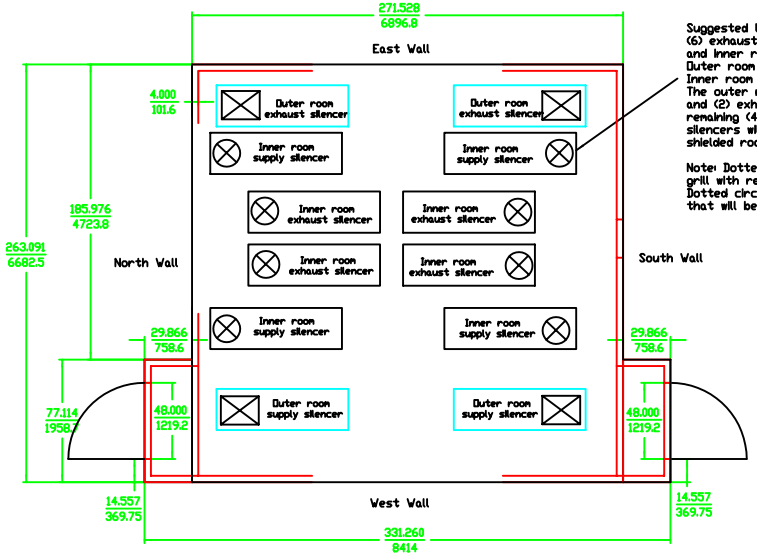
front (west wall)



right (south wall)

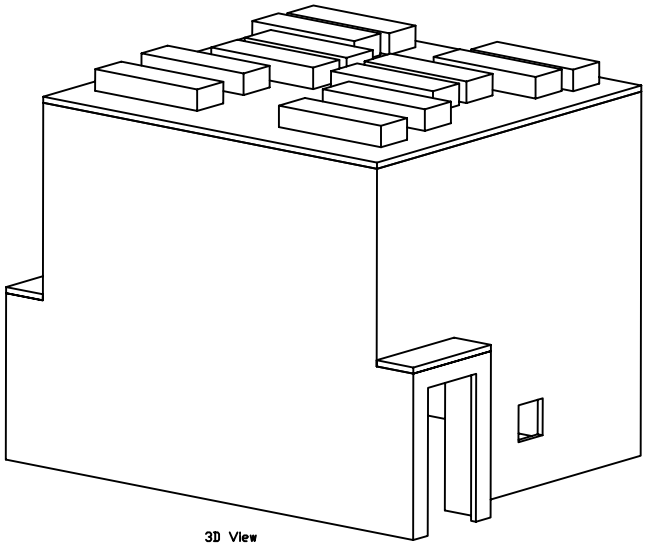
NIST Electron Physics Group	UNITS Inches/mm TOLERANCE Decimals x.xxx ← 0.005 x.xx ← 0.03 x.x ← 0.1 Angles ← 0.5deg	DESCRIPTION Inner shielded room centered on A1-slab	
DATE 8-16-02	SCALE NTS	DRAWING-FILENAME shielded room.sat	SHEET 1 OF 2
MATERIAL	QUANTITY 1	SURFACE FINISH	
DRAWN Steve Blankenship x3714	CHECK		

Top View

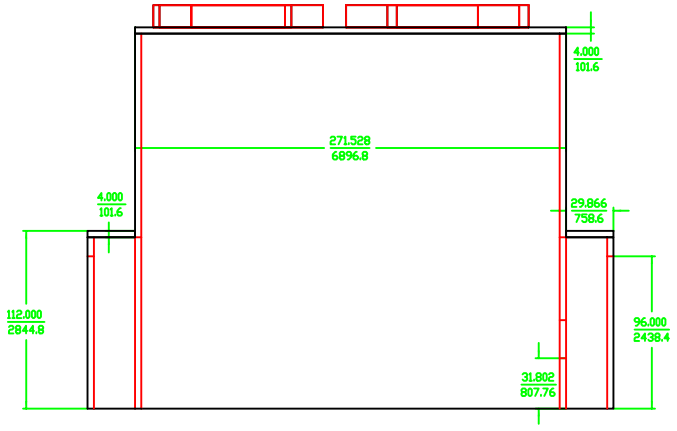


Suggested location for (6) intake and (6) exhaust silencers for outer room and inner room
Outer room CFM requirement 700CFM.
Inner room CFM requirement 1600CFM.
The outer room will utilize (2) intake and (2) exhaust silencers, while the remaining (4) intake and (4) exhaust silencers will be flex coupled to the inner shielded room silencers.

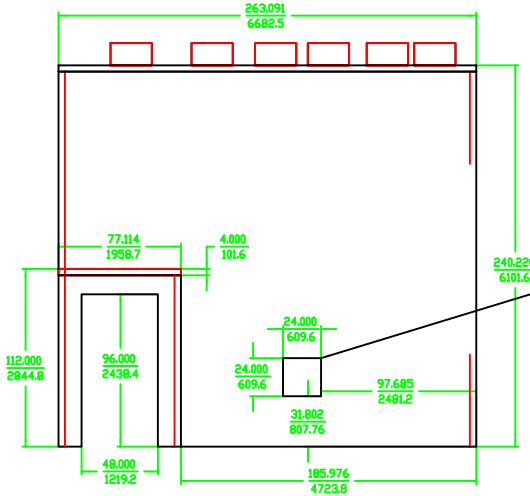
Note: Dotted rectangle represents position of grill with respect to the silencer.
Dotted circle represents postion of flexible duct that will be coupled to inner room silencers.



3D View



front (west wall)



24"X 24" access hole located on south wall. Access Plug will be constructed from same material as the wall panel system. Plug will be removed from the outside of the room. The access hole must line up with access hole on south wall of the inner shielded room (see sheet 1).
Note that the heights of the access holes are different, this is because the floor height of the slab is 3.54"(90mm) below the laboratory floor height.

right (south wall)

NIST Electron Physics Group	UNITS Inches/mm TOLERANCE Decimals X.XXX ← 0.005 X.XX ← 0.03 X.X ← 0.1 Angles ← 0.5deg	DESCRIPTION outer shielded room	
DATE 8-16-02	SCALE 1=10	DRAWING-FILENAME shielded room.sat	SHEET 2
MATERIAL	QUANTITY 1	SURFACE FINISH	OF 2
		DRAWN Steve Blankenship 301-975-3714	

SECTION 14300

HOISTS, TROLLEYS, MONORAILS AND CRANES

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Refer to latest editions of following standards for detailed specification requirements for materials, methods, tests and physical parameters:
   1. Hoist Manufacturers Institute (HMI):
      a. HMI 200: Standard Specifications for Hand Operated Chain Hoists.
      b. HMI 400: Standard Specifications for Electric Chain Hoists.
   2. ANSI-B30.11 for underhung bridge cranes.

B. Furnish equipment made by a recognized reputable manufacturer.

C. Have all welding done by certified welders in accordance with American Welding Society Standards.

D. Insure that all equipment selected is locally serviceable with replacement parts readily available.

E. After installation is complete, secure and pay for services of a representative of equipment supplier and provide supervision of any final adjustments.

F. Give Government personnel complete instructions regarding proper operation and maintenance procedures.

G. Secure from manufacturer's representative a written report stating installation has been examined and units are installed properly and in accordance with manufacturer's recommendations.
   1. Submit this report to COTR.

1.02 SUBMITTALS (See Division 1)

A. Shop drawings:
   1. Include shop drawings with structural calculations for track and supports, reports of tests verifying strength of inserts and rail, track layout including arrangement of supports, splices, and connections, and details of hoists, trolleys, etc.

B. Product data:
   1. Equipment and systems.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
1. Maintenance data.
2. Government instruction report.
3. Certification of installation in accordance with manufacturer's recommendations.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle, unload, and store equipment in full accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Bridge cranes, laboratory room monorails and related trolleys:
a. Base:
(1) Gorbel, Inc.
b. Optional:
(1) Zimmerman International Corp.
(2) Spanco, Inc.
(3) Twin City Monorail.
2. Hoists and related trolleys:
a. Base:
(1) Coffing Hoists.
b. Optional:
(1) Ingersoll-Rand.
(2) Harrington.
(3) J.D. Neuhaus.
3. Other manufacturers desiring approval comply with Section 01640.

B. Schedule of conveying systems:
1. See schedule at end of this Section.
a. Model numbers in schedule are products by Gorbel, Inc., and Coffing Hoists, as Indicated, to describe quality and other basic characteristics of equipment.
2. Provide systems as Indicated.
3. "Hook height" is minimum acceptable distance from bottom of hook in full raised position to nearest floor surface.
4. Refer to Drawings for location of hoists, cranes,

monorails, bridge crane rails, etc.

2.02 CRANE CONSTRUCTION - SINGLE GIRDER TYPE

A. General:
1. Provide manually operated underhung single girder bridge cranes as Indicated.
2. Design load carrying parts, except structural members and gears, so that calculated stress in material, based on rated load, does not exceed 20 percent of published average ultimate strength of material.
3. The crane will be designed to withstand the dead load (caused by the weight of the crane and components themselves), the live load and hoist load, and the inertia forces caused by movement of the crane, components, and loads during standard operation.
4. Standard capacity ratings will represent the net rated load at the hook of any type of hoist with the same load rating installed on the crane having a hoist trolley weight within the established limits.
5. The design load for stress calculations will be based upon the capacity plus 15% for the weight of the hoist, and an additional 25% for impact (capacity x 1.4). Design load for deflection calculations will be based upon the capacity plus 15% for the weight of the hoist (capacity x 1.15).
6. Comply with ANSI-B30.11 unless noted otherwise.
7. The rated load capacity of each system will be clearly labeled on both sides of the bridge using a label size easily read from the operator position.

B. Enclosed track:
1. Runways and bridges will use only an enclosed track design that permits trolleys and festoon carriers to ride on the lower inside flange. The track must keep most dirt and dust off the rolling surface. I-beam and Patented Track cranes with exposed flanges will be unacceptable.
2. Tracks for runways will be fabricated of a high-strength, cold rolled steel.
3. Tracks for bridges will be of high-strength, cold rolled steel, or structural aluminum 6061-T6 alloy.
4. The track profile will consist of only one piece. Any design consisting of two track halves welded together will be unacceptable.
5. Tracks may be either trussed or plain (untrussed) in design, depending upon the support center distance required. (Support Center distance is defined as the distance centerline to centerline between hanger points).
6. All runways with support centers greater than 1830 mm

will be trussed with a Vierendeel truss design.
7. The total track deflection will not exceed 1/450 of the support center distance.
8. The track's lower rolling surface will feature a 2 degree slope, descending towards the track's center, to help center the trolley in the enclosed track. Any flat, non-centering track design will be unacceptable.
9. Splice joints:
    a. Specially fabricated track and truss splicing will be utilized to ensure proper alignment when joining tracks together.
    b. Splicing will be able to be easily performed in the field.
    c. Each track splice will feature eight clamping bolts with jam nuts.
    d. Trussed track will feature a truss splice plate, in addition to the track splice, to splice the spines together.
    e. The maximum gap between spliced tracks will not exceed 0.8 mm.

C. Runway rails:
1. Provide straight, parallel and level rails at same elevation.
2. Make distance C to C and elevation within tolerance of plus or minus 3 mm.
3. Runways will utilize only enclosed steel track (ref. Section B above), and will be straight and level.
4. Runways will always be perpendicular to the bridge between them.
5. Runways will be rigid in design. Articulating runway systems will not be acceptable.
6. Each crane system will require only two (parallel) runways. Systems that require three or more runways will not be acceptable.

D. Bridges:
1. Design bridge to resist vertical, lateral and torsional stresses.
2. Maximum vertical deflection of bridge produced by dead load, weight of trolley and hoist and rated load not exceeding 1/600 of span.
3. Locate safety stops at each end of bridge to prevent over-travel of hoist trolley.
4. Bridges will utilize only enclosed steel or aluminum track (ref. Section B above) and will be level, straight, and perpendicular to the runways.
5. Bridges will roll between the runways via non-binding end trucks. The end trucks will provide the bridge its only support and connection to the runways.
6. Bridges will be rigid mounting for greater control,

with no articulating or threaded connections.
7. Only cranes with single-girder bridges will be acceptable.

E. End trucks:
1. Carry crane bridge on end trucks of ample size to carry rated load when lifted at one end of bridge.
2. End trucks will feature both horizontal and vertical wheels, so that each end truck rolls on two axes of the track, to help prevent "binding up" in the runways.
3. No welds on the end trucks will be in tension.
4. One end truck (of each pair) will be clamped to the bridge, and the other will remain unclamped, in case the runways are installed in a slightly non-parallel manner.
5. Restraining drop lugs will be utilized on both sides of the end truck, and will limit the end truck drop to a maximum of 25 mm, in the event of wheel, axle, or load bar failure, in accord with ASME/ANSI 11-1.7.3 specifications.
6. End trucks will have self-cleaning tapered wheels that match 2 degree tapered track profile.
7. Only rigid body (non-articulating) end trucks will be acceptable.

F. Crane wheels:
1. Support each wheel on roller bearings mounted on axles suitable to take radial and thrust loads.
2. Factory lubricate and seal bearings to exclude dirt and grease leakage.
3. Wheels for end trucks and hoist trolleys will be composed of a nylon composite that provides durable load capacity and reduced noise during travel (Dura Comp 4 or equal).
4. Wheels will be capable of being easily removed from the trolley or end truck in the field (i.e., all wheels will be replaceable without replacement of the trolley or end truck they are on). Any non-removable wheel design is unacceptable.
5. Wheels will feature a 2 degree taper that matches the track profile, to help center the wheels in the track.
6. Wheels will be designed to operate in temperatures up to at least 94 øC.

G. Bearings: Design bearings for minimum 5000 hours B-10 bearing life.

H. Bumpers and stops:
1. Provide bridge bumpers capable of stopping crane.
2. Design bumpers with sufficient damping capacity to

stop crane traveling with full load. Use molded composite construction for energy absorption.
3. Provide runway stops designed to resist full load.
4. Locate stops at limit of bridge travel.
5. Runway stops shall not engage wheel treads.
6. Plain steel end stops will not be acceptable.
7. In addition, provide energy absorbing rubber or neoprene bumpers at the contact points on end trucks and trolleys.

I. Capacity labels:
1. The rated load capacity of each bridge will be clearly labeled on both sides of the bridge using a label size easily read from the operator position.

J. Hanger assemblies:
1. All support hangers used to support the track will be straight and plumb in design, and will be designed to withstand the loads and forces of the crane and components during normal use.
2. All tracks will be supported only by rigid hangers; articulating hanger systems will not be acceptable since their moving parts increase the risk of loosening hardware.
3. Hanger assemblies will feature B7 alloy threaded rod with locking (anti-back-off) hardware, or will allow the track to flush-mount directly to the support structure.
4. All suspension fittings will be designed to be used with minimum SAE Grade 5/ASTM-A325 mounting bolts and hardware.
5. Means will be provided to allow for the vertical adjustment of the track so that is can be properly erected and maintained level.
6. The crane must be adequately braced to protect against swaying and damaging lateral loads, and to provide extra rigidity to prevent hardware from loosening.

K. Installation, operation, and maintenance:
1. One set of proper installation, erection, and operation instructions will be shipped with the crane by the manufacturer. Proper inspection and maintenance recommendations, and parts lists, will also be provided.

2.03 HOISTS

A. Provide hand geared hoists, as Indicated, and provide hoists to lift capacities over height specified.

B. Hand geared chain hoists:

1. Furnish hand chain spur geared hoists constructed and designed for safety of operation and durability of all components.
2. Replacement parts must be interchangeable and readily accessible.
3. Design load carrying parts so that calculated static stress in material, based on rated capacity, does not exceed 25 percent of average ultimate strength of material.
4. Furnish load chains of close link coil type or roller chain type.
5. Each link of uniform size and shape and free from scale.
6. Manufacture load chain wheels from steel, pearlitic malleable iron or nodular cast iron.
7. Form load and idler sheaves to fit chain.
8. Furnish hand chain of endless coil type with a drop that is about 600 mm less than specified lift of hoist.
9. Supply chain with yield point at least 3 times required hand chain pull for rated load.
10. Manufacture hand chain wheels from steel, malleable iron, high strength cast iron, or aluminum alloy.
11. Equip handwheel with suitable chain guard to prevent hand chain from slipping or jumping wheel rim.
12. Manufacture hooks from forged steel.
13. Provide that bottom hook free to swivel in loaded condition without twisting chain.
14. Equip hoist with automatic mechanical load brake which will prevent lowering of load unless manual power is applied to hand chain.
15. Use sleeve or anti-friction type bearings.
16. Enclose gearing in sealed construction and provide life time lubrication.
17. Provide following features:
    a. Load limit clutch to automatically prevent hoist from lifting loads greater than rated capacity.
    b. Latched hooks.
    c. Chain containers.

C. Identification - Mark hoist with following:
1. Name and address of manufacturer.
2. Manufacturer's unit identification number.
3. Rated load.

D. Warnings:
1. Affix to hoist or lower load block or controls, in a readable position a durable label or labels displaying following safe operating procedures.
2. Word WARNING or other legend designed to bring label to attention of an operator.

3. Cautionary language against:
    a. Lifting more than rated load.
    b. Operating hoist when hook is not centered under hoist.
    c. Operating hoist with twisted, kinked or damaged chain.
    d. Operating damaged or malfunctioning hoist.
    e. Lifting people, or lifting loads over people.
    f. Removing or obscuring warning label.

2.04 TROLLEYS

A. Provide hand geared and manually operated trolleys, as Indicated, and provide trolleys completely compatible with hoists, cranes and monorails specified.
    1. Total capacity of trolley:
        a. Ultimate load carrying capacity of trolley based on ultimate strength of material used (with a five to one safety factor) and bearing life.
        b. Ultimate load carrying capacity includes live load, weights of all equipment and a proper allowance for impact.
        c. Use bearings rated to provide a minimum B-10 life of 5000 hours based on 75 percent of wheel load, excluding impact, and on an assumed speed of 0.75 m/s.
    2. For tracks with curved sections, provide trolley capable of maneuvering curve without binding or scraping track.
    3. Provide trolley stops that engage trolley frame rather than trolley wheels.
    4. The hoist trolley design will incorporate a two-piece, stamped steel body with a removable clevis pin that allows for hook-mounting.
    5. The clevis will be tapered to center the hoist hook and evenly distribute the weight to all hoist trolley wheels. Non-tapered pins with washers are unacceptable.
    6. The hoist trolley will have self-centering wheels to match the track's profile.
    7. Drop lugs will be utilized on both sides of the hoist trolley, and will limit the hoist trolley drop to a maximum of 25 mm in the event of wheel, axle, or load bar failure.
    8. Only rigid body (non-articulating) hoist trolleys will be acceptable.

2.05 MONORAILS

A. Provide monorails in locations Indicated.

B. Assure track is completely compatible with trolley and

hoists specified.

C. Materials and installation:
1. Deleted.
2. Deleted.
3. Provide end stops at all track ends.
4. Insure that track splices have been designed by track supplier and are located at support points.
5. Support track as Indicated.
6. Deleted.
7. Arrange supports for easy removal of track for repair or replacement.
8. Align track true and level at locations Indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation by manufacturer or authorized representative.

B. Assure all required components are properly installed.

C. Verify operation prior to Acceptance and correct all deficiencies.

D. Comply with Section 13002.

3.02 OPERATIONAL TESTING

A. Perform in presence of COTR.

B. Instruct Government's personnel in correct operation and maintenance.

3.03 FINAL CLEANUP

A. Leave units in correct operational condition.

B. Perform final cleaning.

END OF SECTION

SECTION 16010

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Drawings use and interpretation:
   1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
   2. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
   3. Field measurements take precedence over dimensioned drawings.
   4. Intention is to Indicate size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.

B. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.
   1. In areas with Universal Channel Support System (UCSS) specified in Section 05505, coordinate with UCSS installer to avoid interference of lines, devices, hangers and other electrical components with UCCS components.

C. Dimensions indicated are limiting dimensions.

D. Do not use equipment exceeding dimensions indicated or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions.

E. Description of systems:
   1. Provide materials to provide functioning systems in compliance with performance requirements specified.
   2. Provide modifications required by reviewed shop drawings and field coordinated drawings.

1.02 QUALITY ASSURANCE

A. Perform all work in accordance with following codes:
   1. Federal, state and local codes, regulations and ordinances.
   2. Underwriter's (UL) code requirements.
   3. NFPA 70, 1999 National Electrical Code (NEC).
   4. Occupational Safety and Health Act (OSHA).
   5. All authorities having jurisdiction.

6. Factory Mutual System (FM) requirements.
7. BOCA, Basic Building Code.
8. NFPA 20: Installation of centrifugal fire pumps.
9. NFPA 45: Fire protection for laboratories using chemicals.
10. NFPA 780: Lightning protection code.
11. NFPA 101: Life safety code.
12. NFPA 110: Emergency and standby power systems.
13. ANSI-A17.1: Elevator code.

1.03 DEFINITIONS

A. Specification comparison:
1. Submit copy of specification annotated on line by line basis where proposed product or system complies or differs from specified product or system.
2. Explain differences.
3. No other submittal for product or system will be reviewed without required specification comparison.
4. Submit as product data.

1.04 SUBMITTALS

A. Shop drawings:
1. Schedule of equipment and circuit labels.
2. As indicated in each Division 16 section.

B. Product data:
1. Product list for Division 16 Equipment.
2. As indicated in each Division 16 section.

C. Samples:
1. As indicated in each Division 16 section.

D. Project information:
1. As indicated in each Division 16 section.

E. Contract closeout information:
1. As indicated in each Division 16 section.

1.05 PROTECTION

A. Provide covering and shielding for all equipment to protect from damage.

B. Protect nameplates on motors and similar equipment, to prevent defacing.

C. Repair, restore or replace damaged, corroded and rejected items.

1.06 JOB CONDITIONS

A. Examine Contract Documents to determine how other work will affect execution of electrical work.

B. Make arrangements for and pay for necessary permits, licenses, and inspections.

C. Cause as little interference or interruption of existing utilities and services as possible.
   1. Schedule work which will cause interference or interruption in advance with COTR and all affected trades.

D. Determine and verify locations of all existing utilities on or near site.

E. Record drawings:
   1. Keep a complete set of all electrical drawings in job site office for indicating actual installation of electrical systems and equipment.
   2. Use this set of drawings for no other purpose.
   3. Where any material, equipment, or system components are installed differently from that indicated, indicate differences clearly and neatly using ink or indelible pencil.
   4. At project completion, submit record set of drawings.

1.07 CLASS I, DIVISION I HAZARDOUS LOCATIONS

A. Hazardous locations:
   1. Make all equipment, wiring, devices, etc., located within this area of explosion proof construction.
   2. Ground all exposed non-current carrying parts of entire electrical system in these areas in accordance with NEC.

1.08 WEATHER PROOF EQUIPMENT

A. Use NEMA weatherproof (WP) enclosures for all exterior devices and equipment.
   1. NEMA 3R.

1.09 CORROSIVE ENVIRONMENTS

A. In areas noted with corrosive atmosphere; use NEMA 4X reinforced fiberglass watertight enclosures.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
   1. Individual items:
      a. Base: As noted.
   2. Access panels:
      a. Base:
         (1) J L Industries.
      b. Optional:
         (1) Ventfab.
         (2) American Warming & Ventilating Co.
         (3) Potter-Roemer.
         (4) Milcor, Inc.
   3. Other manufacturers desiring approval comply with Section 01640.

B. Use only prime quality, new materials, apparatus and equipment.

C. Use UL labeled electrical materials and fabricated assemblies.

D. Structural steel for supports: ASTM-A36/A36M.
   1. Galvanize members installed in areas of high humidity or condensation.
   2. Furnish other members with shop coat of rust inhibiting primer.
   3. Shop fabricate for field assembly using bolts.
   4. Minimize field welding.
   5. Retouch primer and galvanizing after field welding.

E. Access doors, panels and frames:
   1. Style and type required for material in which installed.
   2. Provide in walls, floors, and ceilings to permit access to all equipment requiring service, adjustment or inspection.
      a. Lighting fixtures shall not be used in lieu of access panels.
   3. Access panels:
      a. Size: Minimum 300 x 300 mm, or larger as required.
      b. Minimum 1.9 mm sheet metal, cadmium plated or galvanized after fabrication.
      c. Key lock, keyed alike, for panels in public areas.
      d. Prime painted.
      e. UL labeled in fire rated construction.

2.02 FIRESTOPPING

A. Firestop all penetrations of fire rated walls, floors and

assemblies.
1. Penetrations shall comply with UL listing for construction or assembly.

2.03 TERMINATIONS

A. All conductor terminations shall be rated for 75 degC copper conductors.

PART 3 - EXECUTION

3.01 GENERAL

A. Use only thorough, highly skilled, and experienced workmen.

B. When changes in location of any work are required, obtain approval of COTR before making change.
1. Make changes at no extra cost.

C. Do not change indicated sizes without written approval of COTR.

D. Provide all necessary offsets and crossovers in conduits, raceways, cabletrays and ducts.

E. Install exposed conduits parallel to walls and ceilings and vertically plumb, unless otherwise indicated.

3.02 CUTTING AND PATCHING

A. Provide cutting, fitting, repairing, patching and finishing of installed work.
1. Include installed work of other sections where it is necessary to disturb such work to permit installation of electrical work.
2. Repair or replace existing or new work disturbed.

B. Avoid cutting, where possible, by setting sleeves or frames, and by requesting openings in advance.

C. Before cutting, obtain approval of COTR. See Section 01044.
1. Use only approved methods.
2. Cut all holes neatly and as small as possible to admit work.
3. Do not weaken walls or floors; locate holes in concrete to miss structural sections.

D. Locate openings and sleeves to permit neat installation of

conduits and equipment.

E. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace fireproofing removed or damaged, at no extra cost.
   1. See Section 16375.

3.03 INSTALLATION OF EQUIPMENT

A. Install all equipment in accordance with manufacturer's recommendations.

B. Provide all necessary anchoring devices and supports.
   1. Use structural supports suitable for equipment.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.

C. Verify that equipment will fit support layouts indicated.
   1. Where substitute equipment is used, revise indicated supports to fit at no additional cost.

D. Arrange for necessary openings to allow entry of equipment.
   1. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves or other devices to allow later installation.

E. Install equipment to permit easy access for normal maintenance.
   1. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.
   2. Relocate items which interfere with access.

F. Provide concrete foundations or pads for all floor mounted electrical equipment.
   1. Provide as indicated or as follows:
      a. Where drawings do not indicate special foundations, install 100 mm high concrete pads.
      b. Use 20 MPa concrete.
      c. Reinforce with 150 x 150 - 18.7 mm2 x 18.7 mm2 mesh, with short dowels into floor at 300 mm OC around perimeter.
      d. Chamfer top edges 20 mm.
      e. Make all faces smooth.
      f. Set anchor bolts for equipment.

3.04 PAINTING (See Section 09900)

3.05 REMODELING

A. Field verify locations and arrangement of all existing systems and equipment.

B. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptable services, schedule work for minimal down time during slack period.
   1. Anticipate scheduling work during premium time and include cost in proposal.

C. Do not cut into existing services without first verifying with COTR that service has been correctly identified. Do not interrupt any existing service without approval of COTR.
   1. Perform work that interrupts any service during premium time.
      a. Include cutting into existing lines for new connection.
      b. Cause least interference to normal operation of building(s).
   2. Inform COTR in advance of any shut off that will occur and give estimate of duration.
   3. Begin work only after COTR is fully informed and has agreed to schedule of shut offs.

D. Fabricate and install interconnecting portions of these systems prior to shut down for final connections.

E. Maintain all existing services and equipment unless indicated to be removed.

F. Perform demolition as directed by COTR.
   1. Remove all equipment indicated.
   2. Relocate items indicated after thorough cleaning.
   3. Remove all existing wiring serving abandoned circuits.
   4. Remove all non-embedded conduit serving abandoned circuits.

G. Existing conduit and wire of proper sizes may be spliced and extended from appropriate points, but do not reuse after removal.

H. Existing equipment and materials removed from existing construction and not indicated or required to be reused shall become the property of the COTR, if they so elect.
   1. Present equipment and materials removed to COTR, who shall select equipment and materials to retain.
   2. Equipment and materials not retained shall become property of Contractor and shall be removed from site.

3.06 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
   1. Conduct tests in presence of COTR and, if required inspectors of agencies having jurisdiction.
   2. Arrange date of tests in advance with COTR, manufacturer and installer.
   3. Give minimum of 24 hours notice to all inspectors.
   4. Furnish or arrange for use of electrical energy, steam, water, diesel fuel, or gas required for tests.
   5. Furnish all lubricating materials required for test.

B. Repair or replace equipment and systems found inoperative or defective and retest.
   1. If equipment or system fails retest, replace it with products conforming with Contract Documents.
   2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems as indicated for each item, unless otherwise recommended by manufacturer.

3.07 FINAL PERFORMANCE TEST

A. Perform panel load balance, short circuit, and freedom from ground, and ground test (including ground fault protection where provided).
   1. Provide COTR a minimum of 24 hours notice to all final performance tests.

3.08 ADJUST AND CLEAN

A. Inspect all equipment and put in good working order.

B. Clean all exposed and concealed items.

C. Where new work occurs in existing areas where no other work has been done, clean area and restore to original condition.

3.9 PUTTING SYSTEMS IN OPERATION - START UP

A. Put all systems into satisfactory operation prior to final acceptance, at time agreed to by COTR.

B. Operate all systems in good working order for period of 5 working days.

3.10 DEVICE MOUNTING SCHEDULE

A. Dimensions are to center of device unless otherwise indicated.

B. Coordinate outlet locations with all Architectural millwork and/or casework elevations.

C. Coordinate outlet locations with service module details.

D. Mounting heights as indicated below:

Flush tumbler switch ---------- 1200 mm
Flush tumbler switches and other control devices above counters ---- 100 mm above backsplash or 100 mm above work surface if no backsplash provided unless otherwise indicated.
Dimmer ---------- 1200 mm
Receptacle (in offices and corridors) ------ 450 mm
Receptacle above counter ---- 100 mm above backsplash or 100 mm above work surface if no backsplash provided unless otherwise indicated.
Receptacle (in mechanical equipment rooms) - 1200 mm
Receptacle for electric water cooler ---- center vertically and horizontally behind unit
Telephone outlets for desk phone ---------- 450 mm
Telephone outlets for wall mounted phone ---- 1200 mm
Telephone outlets above counter --- Locate outlet 100 mm above backsplash or 100 mm above work surface if no backsplash provided unless otherwise indicated.
Exit light ------ mount 300 mm above door frame, center in space. Coordinate with outlet for future motion detector.
Data outlets ---------- 450 mm
Data outlets above counter --- Locate outlet 100 mm above backsplash or 100 mm above work surface if no backsplash provided unless otherwise indicated.
Clock outlet ---------- 2300 mm
Door pushbutton ---------- 1200 mm
Safety switch ---------- 1350 mm
Panelboard (to top) ---------- 1800 mm
Motor starter ---------- 1350 mm
Push button motor control station---------- 1200 mm

E. Locate exit signs so that all are visible from all corridor locations.
1. Relocate signs as required to resolve conflicts.

3.11 IDENTIFICATION AND LABELING

A. Equipment labels: Provide engraved laminated nameplates with 12 mm lettering for switchgears, switchboards,

disconnect switches, transformers, bus duct, uninterruptable power supplies, battery racks, panelboards, motor control centers and starters, transfer switches, relay cabinets, dimming cabinets, site lighting contractor cabinets, thermal element switches, etc.

1. Label text to include the following:
   a. Equipment name, i.e., "Panel XXXXX".
   b. Source, i.e., "Source - Switchboard XXXXX".
2. Label text shall include load where equipment serves one load, i.e., for disconnect switch, "Load - SF-XXX".
3. Letters shall be black on color background as follows:

□&dDSystem□&d@	□&dDColor□&d@
1	Yellow
2	Green
3	Orange
4	Blue
5	Red
6	Gray
7	Purple
15 KV	Gray
Substations	Gray

4. Permanently mount label on equipment with mechanical fasteners.
5. Coordinate labeling with commissioning and COTR.

B. Circuit labels: Provide engraved laminated nameplates with 6 mm lettering for each circuit within switchgears, switchboards and motor control centers, etc.

1. Label text shall include equipment or load served, i.e., "Panel XXXXX" or "Load - SF-XXX".
2. Letters shall be black on color background (color shall be of the source system) as follows:

□&dDSystem□&d@	□&dDColor□&d@
1	Yellow
2	Green
3	Orange
4	Blue
5	Red
6	Gray
7	Purple
15 KV	Gray
Substations	Gray

3. Permanently mount with mechanical fasteners label on the door of the device or adjacent to the device in

switchgear, switchboards and distribution panels.
4. Coordinate labeling with commissioning and COTR.

C. Conductor identification: See Section 16120.

D. Circuit identification: See Section 16120.

E. Device plates: See Section 16140.

F. Raceway identification: See Section 16110.

G. High voltage signs:
1. All distribution equipment rated over 600 volts and/or pull and junction boxes containing conductors rated over 600 volts shall have a sign posted on the front and rear as applicable:
a. 25 to 38 mm high red letters stenciled on a 75 mm high white background.
b. Sign shall read, "DANGER - HIGH VOLTAGE".

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Conduit runs are diagrammatic. Verify locations in field.

1.02 SUBMITTALS

A. Shop drawings:
   1. Cable trays.
   2. Feeder routing.
   3. Prewired aluminum surface metal raceway.

B. Product data:
   1. Sealers.
   2. Surface raceway.
   3. Cable tray.
   4. Wireway.

C. Samples:
   1. 1200 mm section of each type of aluminum surface metal raceway.
      a. Provide two compartment power surface raceway with lighting and laser safety controls, two NEMA 5-20R, one NEMA L6-30R, one NEMA L21-30R, and one blank covers. Raceway shall be prewired. Provide one circuit for the two 5-20R, and one circuit each for the specials. Provide circuit NEMA labels on receptacles and circuit labels on conductors. Twist circuit conductors as specified.
   2. Conduit banding.

D. Project information: Not required for COTR review.

E. Contract closeout information.
   1. Spare parts for aluminum surface metal raceway:
      a. Provide 5 percent of each type of receptacle with 300 mm covers. Provide 5 percent data covers, telephone covers and blank covers.
      b. For each type of special receptacle, provide 5 percent of the receptacles with matching plugs.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Steel conduit:
        a. Base:
            (1) Allied Tube and Conduit Corporation.
            (2) LTV Conduit.
            (3) Republic Steel Corporation.
            (4) Triangle.
            (5) Wheatland Tube Co.
    2. PVC coated steel conduit:
        a. Base:
            (1) Robroy Industries.
            (2) Occidental Coating Co.
            (3) Perma-Cote Industries.
    3. Neoprene coated flexible steel conduit:
        a. Base:
            (1) Anaconda.
            (2) Electri-Flex.
            (3) Kellems.
    4. PVC conduit:
        a. Base:
            (1) Carlon Electric Products.
            (2) Ethyl Corp.
            (3) Can-Tex Industries.
            (4) Condux.
    5. Surface raceway:
        a. Base:
            (1) Wiremold/Isoduct.
        b. Optional:
            (1) Versa-Duct/Post Glover.
        c. Devices provided in prewired aluminum surface raceway and in Section 16140, wiring devices shall be provided by the same manufacturer.
    6. Cable tray:
        a. Base:
            (1) Mono-Systems.
        b. Optional:
            (1) Wiremold Specmate/Atlas.
            (2) B-Line Systems, Inc.
            (3) Husky Products.
    7. Other manufacturers desiring approval comply with Section 01640.

B. Conduit:
    1. Rigid steel conduit: Hot dipped, sherardized or galvanized after fabrication.
    2. Intermediate metal conduit (IMC): Galvanized steel.
    3. Thinwall electrical metallic tubing (EMT): Galvanized steel.
    4. Flexible steel conduit for motor and equipment connections: Galvanized and listed equipment

grounding conductor.
a. Neoprene-coated type: With approved liquid-tight connectors; Anaconda Seal-Tite type LIA.

5. Rigid PVC conduit: High impact polyvinyl chloride, meeting minimum requirements of NEC.
   a. Direct burial type: Carlon Electric Products, Type 40.
   b. Concrete encased burial type: Carlon Electric Products, Type EB.
   c. Mark each length clearly and durably with nominal trade size, type of material, and UL label.
   d. Fittings: PVC, solvent weld type, with connectors and threaded adapters as required.
6. Stamp each length with name or trade mark of manufacturer and affix UL label.
7. PVC coated steel conduit: Galvanized rigid steel conduit with 1.00 mm minimum coating of PVC.
8. All conduit sizes are Industry Standard Conduit designated by their nominal (millimeter) diameter equivalent. See chart below:

Conduit Size Indicated on Drawings and in Specifications mm	Equivalent Conduit Size Indicated in the NEC mm	Equivalent Conduit Size inch
15	16	1/2
20	21	3/4
25	27	1
32	35	1-1/4
40	41	1-1/2
50	53	2
65	63	2-1/2
80	78	3
90	91	3-1/2
100	103	4
125	129	5

C. Steel surface metal raceway: Shall be used for branch circuit wiring and/or data, telephone and other low-voltage wiring. Data and telephone wiring and connectors are not in contract. System shall consist of raceway base and cover, appropriate fittings and device mounting plates necessary to complete installation per drawings.
   1. Steel shall be galvanized.
   2. Raceway shall be a two piece design with a metal base and a snap-on metal cover. The base shall be a minimum of 1.27 mm wall thickness and the cover a minimum of 1.02 mm wall thickness.

a. Raceway mounted above Instrument and Metrology tube steel for distribution of lighting circuits:
(1) Assembled base and cover shall be 70 mm wide by 40 mm high with a cross sectional area of 2265 mm2 (Wiremold G3000).
(2) Finish: Factory painted custom color baked-enamel, over phosphatized surfaces. Color to match architectural components. Refer to Section 09000 Color Schedule.

3. A full compliment of fittings shall be available including but not limited to flat, internal and external elbows, divided tees, entrance fittings, wire clips, cover clips, covers, couplings, c-hangers and end caps. The fittings shall be colored to match the raceway. All fittings shall be supplied with a base where applicable to eliminate mitering. Provide radius control components at elbows in data and telephone compartments.
4. Device brackets shall be available for mounting standard single or two gang devices horizontally within the raceway. Power devices shall be mounted flush. Data/communication devices shall have the capacity of mounting flush or in conjunction with standard faceplates.
5. Provide receptacle labels in accordance with Section 16140.
6. Coordinate outlet provisions in covers for data and telephone outlets with the COTR.
7. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets in accordance with manufacturer's installation instruction sheets.
8. All metal raceway shall be electrically continuous and bonded. Additionally, a separate #10 AWG green equipment grounding conductor shall be bonded to each compartment to ensure a redundant ground path.
9. Raceway shall be securely supported at intervals not exceeding 3050 mm or in accordance with manufacturer's installation sheets.
10. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.

D. Aluminum surface metal raceway: Shall be factory wired multioutlet raceway used for branch circuit wiring and/or data, telephone and other low-voltage wiring. Data and telephone wiring and connectors are not in contract. System shall consist of raceway, covers, appropriate fittings, receptacles, conductors, connections and receptacle identification necessary for a complete

installation as indicated on drawings.

1. Raceway shall be manufactured of extruded #6063-T5 aluminum with a minimum wall thickness of 1.98 mm.
2. Multiple compartment raceways shall have integral dividing barriers isolating wiring compartments and provided with fittings to maintain the separation throughout the system.
3. Raceway covers shall be 300 mm in length to facilitate future modification. Covers shall be removable with a standard straight blade screwdriver without marring. Raceways having two covers shall allow each cover to be removed separately without allowing access into the compartment enclosed by the other covers.
4. The finish shall be Architectural Class II clear anodized AA-C22A31 with a minimum thickness of 0.10 mm.
5. Raceway shall be electrically continuous and bonded. Additionally a separate #10 AWG green equipment grounding conductor shall be provided to ensure a redundant ground path.
6. Bond common ground of receptacles to raceway and to #10 AWG green equipment grounding conductor. Raceway covers shall be bonded.
7. Length of raceway shall be verified in the field and pre-cut in the factory. Field cutting is unacceptable.
8. Receptacles shall be mounted to and removed with 300 mm covers. In horizontally mounted raceway within labs, center one receptacle in cover. In vertically mounted raceway within galleys or chases, locate two receptacles at quarter points in cover (150 mm on centers).
9. Provide conductors from receptacle to feed location. Provide 300 mm pigtail at feed location and tag circuit with panelboard mark and circuit number. Provide 150 mm slack at receptacle. In multi-device circuits, do not wire in to and out of devices. Provide continuous circuits with 150 mm pigtails to devices.
10. Raceways shall allow for a minimum of 60 #12 AWG conductors in each compartment with all receptacles capable of being provided.
11. To reduce magnetic fields, twist phase, neutral and isolated ground conductors of each circuit within the raceway. Provide a minimum of 10 twist per meter of circuit.
12. Provide receptacles in accordance with Section 16140 and shall be the same manufacturer as receptacles provided under Section 16140.
13. Provide receptacle labels in accordance with Section 16140.

14. Provide conductors in accordance with Section 16120.
15. Provide radius control component at elbows in data and telephone compartments.
16. Outlet provisions in covers for data or telephone outlets shall be coordinated with the COTR.
17. Provide vibration isolation fitting where lab demizing wall meets lab/galley and lab/corridor walls.
18. Provide 150 mm x 300 mm barriered low voltage compartment where indicated on drawings for mounting of lighting controls and laser safety controls. Coordinate cover openings with suppliers of controls.
19. Types:
    a. Two compartment power surface raceway (prewired aluminum): 55 mm x 150 mm with two 55 mm x 75 mm compartment with separate covers for each compartment. Isoduct AL4800 Series.
    b. Two compartment communication surface raceway (aluminum): 55 mm x 150 mm with two 55 mm x 75 mm compartment with separate covers for each compartment. Isoduct AL4800 Series.
    c. One compartment power surface raceway (prewired aluminum): 55 mm x 75 mm single compartment. Isoduct AL5100 Series.
    d. One compartment communication surface raceway (aluminum): 55 mm x 75 mm single compartment. Isoduct AL5100 Series.

E. Cable tray.
1. Cable tray shall be aluminum center hung or wall mounted, single or double tier without side rails. Side support shall be provided by upturned rungs.
2. Cable tray system shall be made of straight sections, fitting and accessories in accordance with NEMA VE-1.
3. Cable tray width shall be 150, 300 and 450 mm as indicated on drawings. Load depth shall be 75 and 100 mm as indicated on drawings with an overall height of 100 and 125 mm respectively.
4. Rungs shall be spaced 150 mm on centers. Rungs shall have a minimum cable bearing surface of 12 mm with radiused edges.
5. Cable tray shall be center hung or wall mounted to allow laying of cable. Provide center hung tray with 12 mm x 150 mm long tube over threaded rod to provide additional rigidity and cable protection. Provide center hung tray with stiffener for latteral support.
6. Cable tray support spacing shall not exceed 3600 mm for center hung and 1200 mm for wall mounted.
7. Cable tray shall be sized with a service factor of 1.5. Deflection shall not exceed 1/120 the span. Load capacity shall be:

a. 74.4 kg/m, Class A.

8. Fitting radius shall be 300 mm to edge of tray horizontally and vertically.
9. Provide vertical barrier within straight sections and fittings where indicated on drawings. Barriers shall be equal in height to the load depth of the cable tray. Provide cross over separators at "T" and "X" fittings. Provide barrier alignment joint strips where section of barriers meet.
10. Cable tray shall be electrically continuous and be listed as an equipment grounding conductor.
11. Provide cable drop outs 600 mm on centers within telecommunication rooms.

F. Wireway: NEMA I lay-in wire-way of size indicated or larger as required by NEC.
   1. Arrange wireway cover for removal, hinging and locking closed by captive type fasteners.
   2. Finish: Gray baked-enamel, over phosphatized surfaces.
   3. With necessary fittings, with knockouts, with manufacturer's name or trademark visible after installation.
   4. Designed for continuous grounding.

G. Two and three compartment surface raceway: Instrument and metrology service galley.
   1. NEMA 1 lay-in raceway, manufactured of 1.6 mm cold rolled steel. Provide 15 mm and 20 mm concentric knockouts 600 mm on center on two sides and back of raceway. Raceway shall be capable of spanning 3050 mm between supports. Locate joints at supports.
      a. Two compartment: 75 mm x 100 mm with two 75 mm x 50 mm compartments.
      b. Three compartment: 75 mm x 150 mm with three 75 mm x 50 mm compartments.
   2. Factory assembled with removable cover and wing nuts for closure.
   3. Fittings shall include but not limited to inside elbows, couplings, hangers, end blanks, panel connectors, dividers and all other components necessary to make a complete system. Finish of fittings shall match raceway.
   4. Provide conductor retension clips 600mm on centers to hold conductors within raceway when cover is removed.
   5. Finish shall be factory painted custom color baked enamel over phosphatized surface. Color to match architectural components. Refer to Section 09000 Color Schedule.
   6. Raceway and fittings shall be electrically continuous and bonded. Additionally, a separate #10 AWG green

equipment grounding conductor shall be provided in each compartment to ensure a redundant ground path.

7. Wiremold NEMA Type 1 wireway SP Series.

2.02 SUPPORTS, SLEEVES AND SEALS

A. Conduit hangers - General: Threaded rods, with straps or clamp conduit holder.
   1. Do not use the following to support conduit:
      a. Wire including ceiling support wires.
      b. Perforated strap hangers.
      c. Plastic or nylon tie wraps.
   2. Use trapeze assemblies for multiple conduits.
   3. Provide sufficient hangers for support of electrical work and equipment to limit load on single hanger to 11 kg maximum; space not over 2400 mm OC.
   4. Hangers in metal roof deck: Do not extend above tops of ribs, or otherwise interfere with vapor barrier, insulation or roofing.

B. Hanger fasteners: Provide inserts or fasteners to attach hangers to structure.
   1. Do not use drilled or explosive driven inserts in precast-prestressed concrete construction.
   2. Attachment to metal roof deck may be by means of prepunched tabs, prepunched holes, or with screws in sides of ribs or toggle bolts in bottom of ribs.
   3. Do not use concrete nails in masonry walls.

C. Sleeves: Black iron pipe, RGS or IMC sized to accommodate work passing through.

D. Sealer for sleeves and openings around conduit: UL listed for assembly.

E. All penetrations of floor slab at cleanroom and mechanical rooms above grade shall be waterproofed.

F. See Section 16901 for vibration isolation mounting apparatus.

2.03 SCHEDULE OF CONDUIT APPLICATIONS

A. Use rigid steel conduit or intermediate metal conduit in following locations:
   1. Underground.
   2. Outdoors.
   3. In concrete other than slabs on grade.
   4. Under concrete slabs on grade.
   5. In exterior masonry walls.
   6. In wet locations.

7. For exposed runs below 3000 mm above floor unless otherwise indicated.
8. For feeders over 600 volts.
9. In explosion-proof areas.

B. Use PVC coated steel conduit in corrosive areas as noted.

C. Thinwall EMT may be used for other 600 volt and below indoor dry applications.

D. Exposed EMT may be used for branch circuits or low voltage circuits directly above panelboards and other equipment with installed height of 1800 mm or more above floor.

E. Exposed EMT may be used for branch circuits or low voltage circuits in instrument and metrology labs, service galleys, and cleanroom chases.

F. PVC conduit may be used only as follows:
1. Rigid PVC conduit may be used underground or under concrete slabs on grade.
a. Provide a green grounding conductor of proper ampacity in each PVC conduit.
2. Exterior lighting: See Section 16530.
3. Underground distribution: See Section 16375.
4. 45 degree and greater bends in PVC conduit runs shall be made with rigid steel conduit.

G. Use no conduit smaller than 20 mm.
a. Size conduit in accordance with NEC unless indicated larger.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Install all conduits concealed within walls, and above finished ceilings.

B. Do not install any conduit within demountable wall or walk-on ceiling panels except as follows:
1. Telephone and data conduit at Metrology and Instrument Lab/Corridor wall from cable tray to bench top raceway.
2. Power, telephone and data conduit at doors in demizing wall between Labs.

C. Exposed overhead conduit may be used in mechanical, electrical and other equipment rooms except conduit drops to flush mounted devices in walls.

D. Expose all conduits in labs, service galleys and cleanroom chases except as follows:
   1. Telephone and data conduit at Metrology and Instrument Lab/Corridor wall from cable tray to bench top raceway.
   2. Power, telephone and data conduit at doors in demizing wall between Labs.

E. Run exposed conduit in straight lines at right angles to or parallel with walls, beams or columns.

F. Keep conduit away from waterlines or heating duct lines. Where crossings are unavoidable, leave minimum 150 mm clearance.

G. Do not cross conduit in front of access door in HVAC duct.

H. Do not install conduit within floor slabs.

I. Install no conduit larger than 32 mm in concrete columns. Do not install multiple conduits in a single concrete column without COTR approval.

3.02 UNDERGROUND INSTALLATIONS

A. Do not install conduit underground unless indicated on the drawings.

B. Steel conduits in contact with earth or a vapor barrier, that are not completely encased in concrete: Coat with 2 coats asphaltum before installation, or use PVC coated steel conduit.

C. Install underground conduit 800 mm minimum below grade. Do not backfill before observation by COTR. Concrete encasements: Provide 800 mm of cover.

D. Encase underground PVC branch circuit conduits in 75 mm minimum of concrete where passing under roadways or parking areas.

E. Encase underground PVC feeder conduits in 75 mm minimum of concrete. Provide reinforcing steel throughout the entire length of the ductbank.

F. Where conduit enters a building and after installation of conductors or pull wires, seal conduit to prevent entry of water, gases or vapors.

3.03 CONDUIT INSTALLATION

A. No conduit or raceway shall enter or pass through a lab unless it serves that lab.

B. In labs, service galleys and cleanroom chases, support all raceways from support channels, service carriers, or service frames. Minimize support from demountable walls. Do not support from walk-on ceiling panels or cleanroom wall.

C. In other than lab, service galleys and cleanroom chases locations, support all conduit systems from building structure or walls with approved hangers.
   1. Do not support from piping, ducts or support systems for piping or ducts.
   2. Do not install to prevent ready removal of piping, ducts or ceiling tiles.
   3. Do not support from ceiling or ceiling support systems.

D. Feeders in instrument and metrology wings shall be routed as far away from the lab space (volume) as possible. No feeders shall be routed in labs, lab galleys and lab corridors (except feeders to lab panels). In Distribution areas, feeders shall be routed tight to the underside of the structure and where possible tight to the outside wall.

E. Sum of angles in any conduit run shall not exceed 360 degrees.
   1. Where more bends are necessary, install condulet or pullbox.
   2. Make all bends in 20 mm conduit and 25 mm EMT with a conduit bender.
   3. Use machine bends for larger sizes.

F. Make joints in threaded conduit watertight with white nonleaded compound applied to male threads only.
   1. Cut square, ream smooth, and properly thread field joints to receive couplings.
   2. Do not use running threads.

G. Fit all conduit ends at switch and outlet boxes with approved lock nuts and bushing forming approved tight bond with box when screwed tightly in place.

H. Remove moisture and debris from conduit before wire is drawn into place. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

I. Neatly seal openings around conduits, etc., where they pass through fire rated construction or exterior walls or roof.

3.04 CONNECTIONS AND FITTINGS

A. Above lay-in tile ceilings, make connections to lay-in type fixtures with 10 mm or 15 mm x 1800 mm (max.) long flexible steel conduit.
   1. Include No.18 branch and grounding conductors.
   2. Arrange conduit and box systems for easy removal of lay-in ceiling.

B. Connect switch legs for narrow switches in hollow metal jamb posts using 15 mm flexible steel conduit.

C. Connections to vibration isolated equipment: See Section 16901.
   1. Use neoprene coated type with liquid tight connectors in damp or wet locations.

D. Install expansion joint fittings on conduit at all building expansion joints where conduit is in slab or rigidly attached to structure.
   1. Flexible steel conduit may be used to isolate vibration sources where indicated on drawing.

E. Use sealing fittings on rigid galvanized conduit in hazardous areas. Install in accordance with NEC.

F. Use sealing fittings at penetrations of +/-0.1 degC and +/-0.01 degC temperature control modules.

G. Use sealing fittings at penetrations of cleanroom walls, floors, or ceilings and at perimeter of the clean zone.

H. Install conduit to roof exhaust fans through fan housing with no conduit exposed.

I. Install conduit stub-ups terminating 150 mm above corridor lift out ceiling. Terminate conduit with insulating bushing.

3.05 SURFACE RACEWAY INSTALLATION

A. Mount surface raceway on walls or support channels as indicated on drawings.

B. Install wiring devices of the type, quantity and location indicated on drawings.

C. Do not install more than 30 current carrying conductors in any compartment of any surface raceway.

D. Homerun conductors from sections of surface raceway shall be installed in accordance with Section 16120.

E. Maintain equipment grounding continuity of surface raceway systems and redundant #10 green equipment grounding conductor.

3.06 INSTALLATION OF CABLE TRAY

A. Install cable tray as indicated on drawing and in accordance with NEMA VE-1.

B. Cable tray shall remain accessible. Maintain adequate clearance to allow future installation and maintenance of cables.

C. Remove sharp edges from cable tray.

D. Support cable tray at end of runs, fittings and at 3600 mm intervals.

E. Maintain equipment grounding continuity of the cable tray.

F. Install expansion fittings as required.

G. Locate drop outs in closets as directed by the COTR.

3.07 CONDUIT IDENTIFICATION

A. Painted Conduit:
   1. Conduit containing 15 kV feeders and its associated spare conduit shall be painted orange for its entire length.
   2. Conduit containing fire alarm conductors and its associated spare conduit shall be painted red for its entire length.

B. Conduit Banding:
   1. Conduit containing the following system conductors and its associated spare conduit shall be identified by a color band as follows:

□&dDSystem□&d@	Color of □&dD Band □&d@
1	Yellow
2	Green
3	Orange
4	Blue
5	Red
6	Not Applicable
7	Purple

2. Conduit bands shall be a 150 mm wide painted band or a 150 mm wide pressure sensitive vinyl material.
3. Locate conduit bands as follows:
   a. At penetrations of slabs or foundation walls.
   b. At each junction or pull box or equipment enclosure.
   c. At spacings not exceeding 6000 mm.
   d. At least one in each room.
4. Color bands shall not be obsured by other work.

END OF SECTION

SECTION 16120

WIRE AND CABLE - 600 VOLT AND BELOW

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples:
   1. Separate neutrals for 120V receptacle and appliance circuits.
   2. Isolated equipment grounding conductor.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
   1. Splices and taps for smaller than No.6 AWG wire:
      a. Base:
         (1) 3M Co.
         (2) Ideal.
         (3) Heyco.
         (4) Elastimold.
         (5) Buchanan.
   2. Other manufacturers desiring approval comply with Section 01640.

B. Wire and cable for 600 volts and below: Single conductor, soft drawn, copper wire with 600 volt 90 degC insulation, UL listed.
   1. For feeders and branch circuits: Type THHN, THWN-2, XHHW or XHHW-2.
   2. For exterior feeder and branch circuits: Type XHHW-2.
   3. For branch circuits served by GFCI circuit breakers: Type XHHW or XHHW-2.
   4. Use no wire smaller than No.12 AWG, except as follows:
      a. Smaller size wire may be used only where specifically indicated.
      b. No.14 AWG may be used for pilot control and signal circuits.

5. In other than motor circuits, conductor ampacity shall equal or exceed the overcurrent protective device unless larger conductors are indicated. In motor circuits, conductor ampacity shall equal or exceed 125 percent of motor full load current unless larger conductors are indicated.
6. No.10 and smaller wire: Solid conductor.

C. Splices and taps for smaller than No.6 AWG wire: Use insulated conical spring-type connectors.

D. Splices and taps for No.6 AWG wire and larger: Use compression connectors with prestretched insulation to equal insulation of wire being spliced.

E. Splices and taps - General: Do not make splices and taps with crimp or indenter-type connectors.

F. Pulling lubricant: Do not use cable pulling lubrication compound containing petroleum or other products which may deteriorate insulation.

G. Color coding: Color code all conductors in accordance with NEC as follows:
1. Color code all wiring.
2. Use following colors in lighting and power wiring:

	120/208 VOLT	277/480 VOLT
Phase 1	Black	Brown
Phase 2	Red	Orange
Phase 3	Blue	Yellow
Neutrals	White	Gray
Ground	Green	Green

3. Use following colors in single phase receptacle and appliance wiring:
   a. Phase 1: Black
   b. Phase 2: Red
   c. Phase 3: Blue
   d. Separate neutral associated with Phase 1: Black with three continuous white strips for the entire length of the conductor.
   e. Separate neutral associated with Phase 2: Red with three continuous white strips for the entire length of the conductor.
   f. Separate neutral associated with Phase 3: Blue with three continuous white strips for the entire length of the conductor.
   g. Equipment grounding conductor: Green
   h. Isolated equipment grounding conductor: Green

with continuous yellow strip for the entire length of the conductor.

4. Color coding of ends only will be acceptable for feeder phase conductors.
5. Color coding of ends only will be acceptable for neutral and grounding conductors number 4 and larger.
6. Isolated equipment grounding conductor shall be green with yellow stripe.
7. Provide label for conductor color code at all panelboards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all line voltage wiring in raceways.
   1. Lighting and receptacle home runs indicated are for identification purposes only.

B. Install no more than 6 conductors in one conduit. This excludes ground wire(s). The neutral conductor shall be considered as a current carrying conductor.

C. Provide a separate neutral conductor for each phase conductor in all lighting circuits served by dimmers. Provide a separate neutral conductor for each phase conductor in all receptacle and appliance branch circuits.

D. Run panelboard and motor feeders in individual conduits.

E. Provide secondary feeders from K-rated transformers with neutral conductors sized at 200 percent of the phase conductor size.

F. In laboratory raceways, other than conduit, identify branch circuits with their appropriate circuit numbers every 3600 mm.

G. In laboratory raceways within the lab, twist the phase and neutral conductors, and isolated equipment grounding conductor of each circuit within the raceway. Provide a minimum of 10 twists per meter of circuit.

H. Install no more than 30 current carrying conductors in surface raceways or any compartment within a multi-compartment wireway.

I. Provide neutral in all circuits serving lab areas including circuits to 250V, 2P, 3W, single phase grounding receptacles, 250V, 3P, 4W, three phase grounding

receptacles, junction boxes for hardwired equipment and to all disconnect switches. Leave slack for future connection to device or equipment. Provide insulated connector at end of conductor.

J. Provide isolated equipment grounding conductor to all isolated ground receptacles.

END OF SECTION

SECTION 16130

BOXES AND FITTINGS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Technical data on multiservice recessed floorbox.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Galvanized boxes:
a. Base:
(1) Appleton Electric Co.
b. Optional:
(1) Thomas & Betts.
(2) Ragland Manufacturing.
2. Exposed corrosion resistant and weatherproof boxes and fittings:
a. Base:
(1) Appleton Electric Co.
b. Optional:
(1) Crouse-Hinds.
(2) Thomas & Betts.
3. Conduit fittings:
a. Base:
(1) Appleton Electric Co.
b. Optional:
(1) Ragland Manufacturing.
(2) O-Z Co.
(3) ETP/Berger.
(4) Thomas & Betts.
4. PVC coated conduit fittings and boxes:
a. Base:
(1) Robroy Industries.
(2) Occidental Coating Co.

(3) Perma-Cote Industries.

5. Box supporting brackets:
   a. Base:
      (1) Caddy.
   b. Optional:
      (1) Ragland Manufacturing.
      (2) Thomas & Betts.
6. Other manufacturers desiring approval comply with Section 01640.

B. Galvanized boxes and fittings shall be pre-galvanized touched-up after fabrication.

C. Lighting outlet boxes: Galvanized, 100 mm octagon.
1. Use extension and plaster rings as required.
2. Verify proper depth with partition thickness.
3. Provide with proper fittings to support and attach lighting fixtures.
4. Support outlet boxes for incandescent fixtures and other ceiling-mounting devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

D. Switch and receptacle boxes for concealed wiring: Galvanized.

E. Exposed switch and receptacle boxes: Corrosion resistant, cast, ferrous metal, with threaded hubs; Appleton Electric Co., Type FS.

F. Concealed gang-switch and junction boxes not dimensioned: 100 mm square, hot-dip galvanized.

G. Boxes for 277 volt switches on opposite phases: Gang-switch type, with barriers between switches.

H. Weatherproof receptacle boxes: Corrosion resistant cast ferrous metal type, with threaded hubs and neoprene gasket; Appleton Electric Co., Type FS.

I. Pull and junction boxes: Code-sized galvanized steel boxes provided with plain blank removable covers held in place with screws unless otherwise indicated.
1. Where sizes are not indicated, use 100 mm square or NEC size.

J. Fittings and boxes with PVC coated steel conduit: Specified boxes and fittings with 1.00 mm minimum coating of PVC.

K. Conduit bodies: Corrosion resistant conduit fittings, cast ferrous metal type, with sharp clean threads.

L. EMT fittings: Compression-ring type, steel or malleable iron electro zinc plated. Indenter or set screw type EMT fittings are unacceptable. Die cast zinc fittings are unacceptable.

M. Expansion joint fitting: Watertight deflection type, Appleton Electric Co., Type "DF".

N. Bushings: Threaded, galvanized, malleable iron.

O. Bushings for conductors No.4 and larger: Separate insulated bushings.
   1. Use at all points where such conductors enter boxes, raceways, cabinets, auxiliary gutter etc., and all other points required by NEC.
   2. Do not use insulated throat connectors.

P. Grounding bushings: With screw termination for green grounding wire.

Q. Box supporting brackets: Caddy SGB Series.

R. Multiservice steel recessed floorbox:
   1. Floorbox unit shall be constructed of a steel base, PVC housing, and steel combination bracket to allow wiring feed-through as well as load-bearing support.
      a. Steel base shall be 1.8 mm minimum and reinforced at all bends by 2 or more gussets.
      b. Housing shall be of UL recognized PVC with nominal wall thickness of 3.2 mm.
      c. Steel bracket shall be 2.5 mm minimum and be capable of supporting 450 kg.
      d. Unit shall be held together with no more than four #10-32 screws.
   2. Box construction shall be as required by UL 514A.
   3. Entire housing shall be removable for unrestricted access to all connector locknuts inside base.
   4. Once assembled, PVC housing shall be capable of supporting 2720 kg load.
   5. Unit shall contain 2 enclosed wiring compartments and 2 non-enclosed wiring compartments.
   6. Overall dimensions shall be 325 mm long x 250 mm wide x 90 mm deep.
   7. Total box volume shall be 3720 cm3 and shall be broken down as follows:
      a. Large enclosed compartment: 820 cm3.
      b. Small enclosed compartment: 525 cm3.
      c. Non-enclosed compartments (2): 330 cm3 each.

d. Main user access area: 1720 cm3.

8. Size and quantity of conduit knockouts shall be as follows:
   a. Large enclosed compartment:
      (1) Four 32 mm and two 25 mm.
   b. Small enclosed compartment:
      (1) One 25 mm, two 20 mm and one 15 mm.
   c. Non-enclosed compartments (2):
      (1) One 32 mm and one 20 mm.
9. Hand access area shall be no less than 25 000 mm2.
10. Unit shall provide for a minimum of 48 mm pre-pour adjustment and 20 mm post-pour adjustment.
11. Floorbox unit shall be capable of being activated in either the flush or recessed mode.
12. Recessed Activations shall provide no less than 2 wire/cable egress points. These shall include wire management blocks to adequately control wires/cables.
13. Floor boxes shall be located as indicated on drawings.
14. Floorbox shall be RFB4 Series for recessed and/or flush activation as manufactured by Walker Division of Butler Mfg.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mounting of outlet boxes for concealed wiring.
   1. Boxes mounted adjacent to studs shall be attached directly to stud with a minimum of 4 metal screws.
   2. Boxes that are not mounted directly to studs shall be attached to bracket spanning studs. Bracket shall be attached to studs with 2 screws at each end. Attach box to bracket with 2 screws minimum.

B. Thread fittings for rigid conduit and IMC.

C. Install rigid conduits squarely into boxes. Rigidly clamp to box with locknut on outside and inside and provide bushing on inside.

D. Fill unused punched-out openings in boxes with proper closures.

E. Use outlet boxes sized to accommodate quantity of conductors enclosed.

F. Provide pull boxes or junction boxes in conduit runs where indicated or as required to facilitate pulling of wires or making of connections. Make covers of all boxes accessible.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Technical data on each type of device.
2. Device plate labeling system.

C. Samples:
1. One set of device plates with each color label.

D. Project information: Not required for COTR review.

E. Contract closeout information:
1. Spare parts: For each type of special receptacle, provide 5 percent of the receptacles with matching plugs.

1.02 QUALITY ASSURANCE

A. Provide wiring devices conforming to the following standards:
1. Underwriter's Laboratories (UL).
a. Switches (UL 20).
b. Receptacles, plugs and connectors (UL 498).
c. Device plates (UL 514 and 514A).
d. Ground fault circuit interrupters (UL 943).
2. National Electric Manufacturers Association (NEMA).
a. General purpose wiring devices (NEMA WD-1).
b. Wiring devices dimensional requirements (NEMA WD-6).
3. US Federal Specifications.
a. Fed Spec switches (WS-896E).
b. Fed Spec receptacles (WC-596F).
c. Fed Spec device plates (W-P-455).

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. Acceptable manufacturers:
1. Wiring devices:
a. Base:
(1) Hubbell.

b. Optional:
(1) Leviton.
(2) Pass and Seymour.
(3) Arrow-Hart.
(4) General Electric.
c. All wiring devices shall be provided by the same manufacturer.

2. Explosion proof devices:
a. Base:
(1) Crouse-Hinds.
b. Optional:
(1) Appleton Electric Co.
(2) Hubbell.

3. Wallbox Dimmers:
a. Base:
(1) Lutron.
(2) Watt Stopper.
b. Optional:
(1) Lightolier.
(2) Prescolite.

4. Devices provided in this section and with prewired aluminum surface raceway in Section 16110 shall be provided by the same manufacturer.

5. Other manufacturers desiring approval comply with Section 01640.

2.02 SWITCHES

A. Lighting switches: "Specification Grade", quiet-operating flush toggle type lighting switches for back and side wiring, 20 amp, 120-277 volts, AC only, gray.
1. Switches shall be listed per UL 20 and certified by UL to Federal Specification WS-896E, and shall be visibly marked "Fed Spec WS-896".
2. All switches shall be equipped with a green grounding terminal.
3. Single-pole: Hubbell No.1221.
4. Double-pole: Hubbell 1222.
5. Three-way: Hubbell 1223.
6. Four-way: Hubbell 1224.
7. Single-pole key switch: Hubbell 1221-L.

B. Explosion proof single pole switches: 20 amp, 125 V, surface mounted.
1. Crouse-Hinds No.EFS-1129.

C. Wall-box lighting dimmer switches: Rated for load, 120 and 277 volts AC.
1. All devices shall be UL listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage transformer, electronic low

voltage transformer).

2. All dimmers and switches shall incorporate an airgap switch which shall be accessible without removing the faceplate. The airgap switch shall be capable of meeting all applicable requirements of UL 20 for airgap switches in incandescent dimmers.
3. Low voltage dimmers and switches shall provide power-failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
4. Dimmers and switches tested to withstand voltage surges of up to 600V and current surges of up to 200A without damage per ANSI/IEEE std. C62.41-1980.
5. Dimmers and switches shall meet the UL 20 limited short circuit test requirements for snap switches.
6. Dimmer control shall be linear slide. Dimmer shall provide a smooth and continuous Square Law Dimming curve.
7. Dimmer shall include voltage compensation circuitry that adjusts the firing angle of the dimmer in such a manner as to compensate light output for variations in the AC line voltage. Dimmers in which the firing angle is merely held constant with varying AC line voltage shall not be acceptable.
8. Faceplate shall snap on to device with no visible means of attachment. Heat fins shall not be visible on front of device. At locations with multiple devices, one seamless, multi-gang faceplate shall be provided. Contractor is responsible for coordination of proper switchbox size and faceplate type.
9. Dimmers and switches shall be Lutron Nova T Style.
10. Color: Gray.

D. See Specification Section 16512 for dimming switches associated with microprocessor based dimming control system in large partitioned conference area.

E. See Specification Section 16512 for low voltage switches and relay systems.

2.03 DUPLEX AND SINGLE RECEPTACLES

A. Receptacle outlets: Specification grade.
1. Specification grade receptacles shall be listed per UL 498 for general use and certified by UL to Fed Spec WC-596F, and shall be visibly marked with the "UL-FS" mark to confirm certification.
2. Flush, grounding convenience outlets for side wiring, or side and back wiring.

3. Color shall be gray.
4. Refer to symbol legend.
5. Hubbell Nos. listed.

B. 20A, 125V, 2 pole, 3 wire grounding, duplex: NEMA 5-20R; (Hubbell 5362).

C. 20A, 125V, 2 pole, 3 wire grounding, single; NEMA 5-20R; (Hubbell 5361).

D. Weatherproof receptacles:
1. Cast aluminum with gasketed lift cover for each outlet.
2. Suitable for wet location.
3. Mount on "FS" cast metal box.
4. Hubbell 7420 for single outlets.
5. Hubbell 5206 WO for duplex outlets.
6. Hubbell WPFS26 for duplex GFCI receptacles.

E. GFI type duplex receptacles: With built-in ground fault interruption, 5-mA sensitivity, indicator and reset. UL listed.
1. 20A, 125V, 3 wire duplex: NEMA 5-20R; (Hubbell GF-5362).

F. Pedestal-type floor-mounted duplex receptacles: 20A, 125V, 3 wire, grounding, back and side wired, NEMA 5-20R.
1. Horizontal design housing with threaded conduit fittings in base, with satin chromium finish.
2. Hubbell SC3091 with duplex receptacles installed on adjustable 100 mm flush floor box, Hubbell B2529 and cover plate Hubbell S2525.

G. Flush in floor receptacles: 20A, 125V, 3 wire, grounding, NEMA 5-20R.
1. Dual level, fully adjustable box, Hubbell B-2536 for floors over 75 mm deep or B-2537 for floors 75 mm deep or less with S-3725 power fitting and S-3182 brass carpet flange.

H. Isolated ground receptacles: 20A, 125V, 2 Pole, 3 Wire with receptacle ground isolated from conduit grounding system.
1. Specification grade, Hubbell, IG-5362.
2. Gray with orange triangle.

I. Explosionproof receptacles: 20A, 125V, 2 Pole, 3 Wire grounding.
1. Hubbell 24301 in cast iron box, Class I, Division 1.

2.04 SPECIAL PURPOSE RECEPTACLES (paragraph letters correspond

with device subscripts indicated on drawings)

A. NEMA 5-30R receptacle: 30A, 125V, 2 pole, 3 wire grounding, single; black (Hubbell 9308).

B. NEMA 6-20R receptacle: 20A, 250V, 2 pole, 3 wire grounding, side and back wired, single; black (Hubbell 5461).

C. NEMA 6-30R receptacle: 30A, 250V, 2 pole, 3 wire grounding, single; black (Hubbell 9330).

D. NEMA 6-50R receptacle: 50A, 250V, 2 pole, 3 wire, 1 phase, grounding, single; black (Hubbell 9367).

E. NEMA 15-20R receptacle: 20A, 250V, 3 pole, 4 wire, 3 phase grounding, single; black (Hubbell 8420).

F. NEMA 15-30R receptacle: 30A, 250V, 3 pole, 4 wire, 3 phase, grounding, single; black (Hubbell 8430).

G. NEMA 15-50R receptacle: 50A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black (Hubbell 8450A).

H. NEMA 15-60R receptacle: 60A, 250V, 3 pole, 4 wire, 3 phase, grounding, single, black (Hubbell 8460A).

I. NEMA 5-50R receptacle: 50A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, black (Hubbell 9360).

J. NEMA L6-30R receptacle: 30A, 250V, 2 pole, 3 wire, 1 phase grounding, single, twist-lock; black (Hubbell 2620A).

K. NEMA L21-30R receptacle: 30A, 120/208V, 4 pole, 5 wire, 3 phase, grounding, single, twist-lock, black (Hubbell 2810A).

L. NEMA L6-20R receptacle: 20A, 250V, 2 pole, 3 wire, 1 phase, grounding, single, black (Hubbell 2320A).

M. NEMA L5-20R receptacle: 20A, 125V, 2 pole, 3 wire, 1 phase, grounding, single, black (Hubbell 2310A).

2.05 DEVICE PLATES

A. Device plates for concealed wiring: Same manufacturer as devices, to suit device covered, single or ganged in one piece with beveled edges that match faces of plates.
   1. Flush impact resistant nylon wall plate: Gray (Hubbell "P8" Series).

2. Stainless steel wall plates (Hubbell "S8" Series) in mechanical rooms and janitorial closets.

B. Device plates for surface type cast-metal boxes: Corrosion resistant cast ferrous metal designed for application.

C. Labeling: Provide circuit label on each device plate indicating panelboard and circuit number supplying the device. Provide NEMA type label on each special receptacle device plate:
1. The label shall be indoor/outdoor, high gloss, durable, scratch proof, flexible, dimensionally stable, pressure sensitive adhesive backed vinyl film type.
2. Label shall be 12 mm high and 0.125 mm thick.
3. Label shall be suitable for use in ambient temperatures from -40 degC to 80 degC.
4. Label shall be suitable for continuous exposure to alcohols, detergents, grease and oils.
5. Circuit label shall have two lines of text with panelboard name centered on the top line and circuit number centered on the bottom line.
6. NEMA type label shall have two lines of text with NEMA type centered on the top line and voltage, phase and amperes centered on the bottom line.
7. Label shall have black text on color background as follows:

□&dDSystem□&d@	□&dDColor□&d@
1	Yellow
2	Green
3	Orange
4	Blue
5	Red
6	Gray
7	Purple

PART 3 - EXECUTION

3.01 POSITION OF DEVICES

A. Locate devices as indicated and as scheduled in Section 16010.

B. Center outlets with regard to paneling, furring, trim, etc.

C. Any outlet which is improperly located must be corrected

at Contractor's expense.

D. Set outlets plumb and extending to finished surface of wall, ceiling or floor as case may be without projecting beyond same.

E. Install receptacles, switches, etc., indicated on wood trim, cases or other fixtures symmetrically. Where necessary, set with long dimension of plate horizontal, or gang in tandem.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data.
1. Technical data.
2. Specification comparison.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
1. Operating and maintenance data.
2. Maintenance materials: Spare fuses, 10 percent or minimum of 3 of each type and rating of installed fuses.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Safety switches:
a. Base:
(1) Cutler Hammer/Westinghouse.
b. Optional:
(1) Square D Co.
(2) Siemens Energy & Automation, Inc.
(3) General Electric.
2. Other manufacturers desiring approval comply with Section 01640.
3. All fuses in fusible-type devices: Same manufacturer.

2.02 SAFETY SWITCHES

A. Safety switches: Fusible and non-fusible type, NEMA Type HD Heavy Duty construction, unless otherwise indicated.
1. Enclosure: NEMA 1 unless otherwise indicated. Provide weatherproof disconnect switches as required by Section 16010.
2. Switch blades fully visible in OFF position with door open.
3. Contact operation quick-make and quick-break.

4. Switches for motor circuits to be horsepower rated.
5. Switches for motor circuits controlled by Adjustable Frequency Drives (AFD) shall be electrically interlocked with the controlling AFD. Provide one normally open and one normally closed contact which operates with the initial movement of the switch and prior to the opening of the main switch.
6. Provide padlocking provisions in OFF position.
7. Finish: Baked enamel over rust-inhibiting primer.
8. Fuses for fusible switches: See Section 16475.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturers instructions and recommendations.

B. Provide labeling as specified in Section 16010.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Technical data on each component.

C. Samples: Not required for COTR review.

D. Project information:
1. Test reports.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Ground rods:
a. Base:
(1) Eritech.
b. Optional:
(1) Blackburn.
2. Exothermic weld kits:
a. Base:
(1) Cadweld.
b. Optional:
(1) Thermoweld.
3. Instrument ground block:
a. Base:
(1) Post Glover/Halsey.
b. Optional:
(1) Square D Co.
(2) Isotrol.
4. Other manufacturers desiring approval comply with Section 01640.

B. Ground rods:
1. Ground rods shall be one-piece copper-clad steel with high strength steel core and electrolytic grade copper outer sheath molten welded to core. Length and manufacturer's name shall be stamped at top. Size

shall be 19 mm diameter and 3050 mm long.

C. Conductors:
   1. Wire and cable: As specified in Section 16120.
      a. Below grade conductors shall be bare copper cable.
      b. Above grade conductors shall be insulated copper cable except bare conductors which are indicated within enclosures.
   2. Ground bus shall be bare annealed copper bar minimum 6 mm x 50 mm x length indicated.

D. Connectors:
   1. Welded connections shall be exothermic type. Kits shall be of the proper type and size for conductors or other material being connected.
   2. Pressure and compression type connectors shall be as specified in Section 16120.
   3. Conduit hubs shall be cast bronze.
   4. Pipe clamps shall be heavy duty cast bronze.
   5. Soldered connections are unacceptable.

E. Instrument ground block:
   1. Provide with three copper threaded screw post with 25 mm diameter green cap nut.
   2. Housing shall be 55 mm x 65 mm x 200 mm aluminum with clear anodized finish.
   3. Provide copper ground bus between screw posts equivalent to #6 AWG. Provide lug for terminating #6 grounding conductor.
   4. Engrave cover with 6 mm high green letters "INSTRUMENT GROUND".

F. Conduit:
   1. Conduit shall be as specified in Section 16110.

G. Conduit fittings:
   1. Grounding locknuts and insulated grounding bushings shall be as specified in Section 16130.

PART 3 - EXECUTION

3.01 GENERAL

A. Ground electrical system, raceway systems, enclosures, equipment, etc., in accordance with NEC and authorities having jurisdiction.

B. Where sizes and quantities indicated exceed NEC requirements, provide the indicated sizes and quantities.

C. Where conductors are installed in steel conduit, bond conductor to each end of the conduit.

D. Seal conduit where direct buried conductors enter the conduit.

3.02 INSTALLATION

A. Grounding electrode system:
   1. Install ground ring with interconnected cross conductors and ground rods as indicated on Grounding Plan Drawings.
   2. Conductors shall be 500 kcmil bare copper direct buried minimum 1000 mm below finish grade or below slab-on-grade.
   3. Install ground rods where indicated to a depth where a minimum 150 mm from top of rod to finish grade is provided.
   4. All below grade connections shall be exothermically welded.

B. Substation grounding electrode conductor:
   1. Install grounding electrode conductor in steel conduit from switchgear equipment grounding bus to grounding electrode system.
   2. Grounding electrode conductor shall be unspliced except at the electrical equipment room ground bus.
   3. Grounding electrode conductor size shall be in accordance with NEC Article 250-66 unless indicated larger on drawings.

C. Bonding of piping systems:
   1. Provide bonding jumper in steel conduit from electrical equipment room ground bus to metal piping systems including but not limited to:
      a. Domestic water.
      b. Fire water.
      c. Chilled water supply.
      d. Chilled water return.
      e. Steam supply.
      f. Condensate return.
      g. Gas.
      h. Compressed air.
   2. Bonding jumper shall be the same size as the grounding electrode conductor.

D. Main bonding jumper:
   1. Provide main bonding jumper between insulated grounded bus bar and the equipment grounding bus bar.
   2. Main bonding jumper shall be the same size copper bar as isolated grounded bus.

E. Neutral disconnecting link:
   1. Provide removable link between the neutral bus bar and the isolated grounded bus bar.
   2. Link shall be the same size copper bar as neutral bus.

F. Separately derived systems:
   1. Separately derived systems include:
      a. Generator.
      b. Dry type transformers.
   2. Connect grounding electrode conductor to:
      a. Generator:
         (1) Grounding electrode system.
         (2) Generator enclosure steel frame.
      b. Other than isolation dry type transformer:
         (1) Nearest water pipe or nearest building steel where available.
      c. Isolation dry type transformer:
         (1) In metrology and instrument wings: Structural steel frame of interstitial floor.
         (2) In cleanroom wing: Nearest water pipe.
         (3) Nearest instrument ground bus.
   3. Grounding electrode conductor shall be unspliced and in conduit and bonded at each end and in accordance with NEC Article 250-66 unless indicated larger on drawings.
   4. Provide main bonding jumper between neutral and ground terminals.
   5. Main bonding jumper shall be the same size as the grounding electrode conductor.
   6. At transformers, connect grounding electrode conductors and main bonding jumpers at the separately derived systems in lieu of at the system disconnecting means.

G. Equipment grounding conductor:
   1. Install separate green insulated equipment grounding conductor in all feeders and in all branch circuits. Install equipment grounding conductor in the same raceway as circuit conductors. Size shall be in accordance with NEC Article 250-122 unless indicated larger on drawings.
   2. Ground raceways, enclosures, equipment, etc., to provide a complete and redundant equipment grounding conductor.
      a. Where nonmetallic conduit is used, the insulated equipment grounding conductor shall be the sole type of equipment grounding conductor.
   3. Where metallic conduits terminate without mechanical connection to metallic enclosures (stub-ups at equipment enclosures) provide each conduit with a

grounding type insulated bushing. Bond each bushing to the grounding bus within the enclosure with bare copper conductor.

4. Where metallic conduits connect to metallic enclosure through knockouts, bond conduit to enclosure with bonding bushing, bonding locknuts or bonding jumper.
5. Install grounding screw or grounding clip in outlet boxes. Provide bonding jumper from outlet box to ground terminal of grounding receptacles except where isolated ground receptacles are provided.

H. Isolated equipment grounding conductor:
1. Install insulated and isolated equipment grounding conductor in systems derived from isolation transformers. Install isolated equipment grounding conductor in same raceway as equipment grounding conductor. Size shall be the same size as the equipment grounding conductor unless indicated larger on drawings.
2. Isolated equipment grounding conductor shall be bonded to the equipment grounding conductor at the shielded isolation transformer. No other intentional or unintentional contact shall be made with the equipment grounding conductor.
3. Provide insulated and isolated grounding terminal strip in electronic grade panelboards.
4. Connect isolated equipment grounding conductor to ground terminals of isolated ground receptacles.
5. In laboratories where direct connected equipment is indicated to have an isolated ground, provide insulating non-metallic raceway fitting at the point of attachment of the raceway to the equipment. Connect isolated equipment grounding conductor to ground terminals of equipment.

I. Instrument ground block: Install where indicated on drawings. Connect to instrument grounding bus with #6 in conduit.

J. Shielded enclosures: Connect ground stud of shielded enclosures to instrument grounding bus with #6 in conduit.

K. Ground bus:
1. Install ground bus on insulated standoffs spaced not more than 600 mm on centers.

L. Hazardous locations:
1. Provide grounding in accordance with NEC Article 501.
2. Provide ground bus and bond #10 AWG exposed insulated conductor to all non-current carrying metallic surfaces within classified location.

M. Manhole:
   1. Bond manhole frames, racks, pulling irons and cable shield at splices to ground rod with #6 AWG bare copper conductor.

N. Pole bases:
   1. Provide ground rod and #8 AWG in 15 mm PVC conduit from ground rod to inside surface of pole at each lighting pole.

O. Flammable storage cabinet:
   1. Provide #10 AWG wire in conduit between flammable storage cabinet and equipment grounding bus in the panelboard(s) serving the room where the cabinet is located.

3.03 TESTING

A. Provide earth resistance test of grounding electrode system. Perform test using fall of potential method in accordance with IEEE Standard 142. Perform test at least 48 hours after any precipitation.

B. Remove neutral disconnecting links and provide ground megger test of neutral system. Perform test at each substation. Temporarily disconnect all SPD equipment during test. Reconnect upon completion of test.

C. Remove main bonding jumper and provide ground megger test of neutral system. Perform test at each separately derived system. Temporarily disconnect all SPD equipment during test. Reconnect upon completion of test.

D. Remove bonding jumper from isolated equipment grounding terminal at panelboard and isolation transformer and provide ground megger test of isolated equipment grounding conductor. Perform test at each electronic grade panelboard. Temporarily disconnect all SPD equipment during test. Reconnect upon completion of test.

E. Provide test reports certified by testing agency of all tests performed. For grounding electrode system resistance test provide weather observations.

END OF SECTION

SECTION 16460

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings:
   1. Dimensioned drawings on each type and size of transformer.

B. Product data:
   1. Technical data on each type of transformer.
   2. Specification comparison.

C. Samples: Not required for COTR review.

D. Project information:
   1. Magnetic field strength testing.

E. Contract closeout information:
   1. Operating and maintenance data.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
   1. Dry-type transformers:
      a. Base:
         (1) Cutler Hammer/Westinghouse.
      b. Optional:
         (1) General Electric.
         (2) Siemens Energy & Automation, Inc.
         (3) Square D Co.
   2. Other manufacturers desiring approval comply with Section 01640.

B. Non-K-rated dry-type transformers: Air cooled, 3-coil, two winding type.
   1. Voltage rating: 480-208/120V wye, 60 cycle or as indicated.
   2. Three phase, 30-KVA and above: Four 2-1/2 percent FCBN taps and 2 above, suitable for indoor service, arranged for floor or wall mountings indicated.
      a. Insulation: Class H with average temperature rise not exceeding 115 degC (80 degC for transformers above 112-1/2 KVA) based on 40 degC ambient at full load.

b. Cutler Hammer/Westinghouse Type DT-3.

3. KVA rating as indicated.
4. Rated sound level equal to or below NEMA maximums.
5. Three phase, below 30-KVA: Class B, F or H insulation and two 5 percent FCBN taps; Cutler Hammer/Westinghouse Type EPT.
6. Single phase: 480-240/120 volts, two winding; Cutler Hammer/Westinghouse Type EP.

C. K-rated shielded isolation dry type transformer: Air cooled, 3-coil, two winding with electrostatic shield and suitable for use with non-linear loads.

1. Voltage rating: 480 volt, 3 phase, 3 wire delta primary and 208/120 volt, 3 phase, 4 wire wye secondary, 60 cycle.
2. K-rating: UL listed for non-sinusoidal current loads with a K-factor of 13.
3. KVA rating: As indicated.
4. Core: High grade, non-aging, grain oriented silicon steel with high permeability and low hysteresis and eddy current losses. Magnetic flux density shall be well below the saturation point to prevent core saturation by harmonics with a 10 percent primary overvoltage.
5. Neutral terminal: Sized at 200 percent of phase terminal.
6. Electrostatic shield: Full width between primary and secondary windings. Effective coupling between primary and secondary windings shall not exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz. Under rated conditions attenuation of noise and transients shall be not less than the following:

	Common Mode	Transverse Mode
0 - 1.5 kHz	120 dB	--
1.5 - 10 kHz	90 dB	50 dB
10 - 100 kHz	65 dB	30 dB
100 - 1 MHz	40 dB	30 dB

7. Insulation: Class H, 220 degC with an average temperature rise not to exceed 115 degC (80 degC for transformers above 112-1/2 KVA) based on a 40 degC ambient at full load and rated K-factor.
8. Taps: Two 2.5 percent FCAN and four 2.5 percent FCBN.
9. Sound rating: Equal to or below NEMA maximums.
10. Enclosure: Indoor, ventilated, NEMA 1.

D. Vibration isolation: See Section 16901.

E. External wiring connections: Use flexible steel conduit.

See Section 16110.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Provide 100 mm high concrete pad at floor mounted transformers. See Division 3 for concrete.

C. See Section 16901 for application of vibration isolation mounting apparatus.

D. Provide labeling as specified in Section 16010.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 PANELBOARD SCHEDULES

A. Panelboard Schedules are located in Appendix - Panelboard Schedule and are part of this Specification.

1.02 SUBMITTALS

A. Shop drawings:
   1. Identify panelboards by alphanumeric designation with branch circuit breaker sizes and types indicated in panelboard schedules or one-line-diagram.

B. Product data.
   1. Technical data on each type of panelboard.
   2. Specification comparison.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Operating and maintenance data.

PART 2 - PRODUCTS

2.01 PANELBOARDS

A. Acceptable manufacturers:
   1. Panelboards:
      a. Base: Same manufacturer for all panels on project.
         (1) Cutler Hammer/Westinghouse.
      b. Optional:
         (1) Square D Co.
         (2) Siemens Energy & Automation, Inc.
         (3) General Electric.
   2. Other manufacturers desiring approval comply with Section 01640.

B. All panelboards: As described herein and as indicated in one-line diagrams and specification Volume 5, Electrical Schedules.
   1. Dead front type.

2. Provide with non-insulated equipment grounding terminal strip located in top or bottom gutter including main grounding lug and individual terminals for 100 percent of panel circuits including spare circuits; increase gutter space accordingly for grounding strip.
3. Bus bars shall be plated copper. Heat rise for all buses shall not exceed UL standards.
4. Provide lighting panelboards with branch circuit connection to main bus arranged for sequence phasing.
5. Provide feed-thru lugs or sub-feed lugs for 2 and 3 section panels.
6. Equip bus bars for panelboard with main lugs or main circuit breaker, capacity as required or indicated.
7. Provide special features such as extra-width gutters as required.
8. Provide panelboard buses fully rated for specified interrupting rating. Series rating of panelboards and overcurrent protective devices is not acceptable.
9. Panelboards served by a K-rated transformer shall be provided with a single 200 percent neutral bus.
10. Provide panelboards with isolated ground bus as indicated.
11. Circuit breaker panelboards and electronic grade panelboard shall be manufactured by the same manufacturer.

C. Circuit breaker panelboards:
1. Bolted-on circuit breaker type. Plug-in circuit breakers not acceptable.
2. In larger power and distribution panelboards, provide main buses and back panels which permit changing of circuit breakers without additional machining, drilling or tapping.
3. All multi-pole breakers of single handle and common trip.
4. Provide shunt trip mechanism on breakers where indicated.
5. Provide ground fault protection as indicated coordinated with upstream devices.
6. Design so a combination of one, two and three pole circuit breakers can readily be assembled in the same panelboard.
7. Multi-section panels shall have equal height boxes.

D. Electronic grade panelboards:
1. Electronic grade panelboards are circuit breaker panelboards with an integrally mounted surge suppression device.
2. The electronic grade panelboards shall meet all the specifications of this section as well as those in

Section 16615, Surge Suppression Devices.
3. Electronic grade panelboards are designated on the Panelboard Schedules.

E. Panelboards 600 amp maximum, 120/208 and 277/480 volt, 3 phase, 4 wire:
1. Capable of accepting branch breakers up to 100 A.
2. Maximum of two sub-feed breakers.
3. Capable of accepting bus mounted surge suppression device when indicated on panelboard schedules.
4. Cutler-Hammer/Westinghouse: PRL1A, PRL2A or PRL3A.

F. Distribution panelboards 1200 amp maximum, 277/480 volt, 3 phase, 4 wire:
1. Capable of accepting branch breakers up to 1200 A.
2. Cutler-Hammer/Westinghouse: PRL4B.

G. Circuit breakers:
1. 1, 2 and 3 pole circuit breaker ratings:
a. In 120/208 V panelboards: Minimum 10,000 AIC symmetrical, or greater as indicated.
b. In 277/480 V panelboards: Minimum 14,000 AIC symmetrical, or greater as indicated.
2. Handles with three positions: "OFF", "ON", and "TRIPPED".
3. When circuit breaker opens on overload or short circuit, operating handle shall automatically assume "TRIPPED" position and clearly indicate abnormal condition of circuit.
4. Units operable in any position and removable from front of panelboard without disturbing adjacent units.
5. Tandem or half-size circuit breakers not allowed.

H. Ground fault circuit interrupter circuit breakers:
1. Operate on differential transformer principle; rated 20A, 120V or 240V, Class A fault-trip sensitivity of 5 milliamperes, UL approved, with built-in testing switch and ON-OFF switch.
2. Provide in panelboards in lieu of standard circuit breakers to serve circuits in wet areas.
3. Provide separate neutral for each interrupter circuit where neutral is required.

I. Cabinets: Trim, door and box, of galvanized sheet steel, code thickness.
1. 145 mm deep with gutter space meeting NEC Article 384 requirements for wire termination space in panelboards.
2. Distribution panelboards: Cabinet depth not to exceed 305 mm, with gutter space meeting NEC Article 384 requirements for wire termination space in

panelboards.

3. Fasten trim to cabinet by means of approved adjustable clamps.
4. Equip door with chrome-plated combination lock and catch; supply two milled keys with each lock; key locks alike.
5. Provide directory frame on inside of door.
6. Finish: Primed, one coat gray lacquer.
7. Identify all circuit locations in each respective panel with load and location served.
   a. Directory shall be typed.
   b. Mechanical equipment identified in directory shall be identified by COTR-furnished designation and not designation indicated on drawings.
   c. Room names and numbers in directory shall be final building room names and numbers as identified by COTR and not name or number indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Support panelboard cabinets from wall studs or unistrut cross members bolted to studs or from unistrut framework.

3.02 LABELING

A. Provide panelboard labeling as specified in Section 16010.

B. Permanently post, at each panelboard, the conductor color coding scheme specified in Section 16120 as required by NEC Article 210.

END OF SECTION

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
   1. Technical data on each type of device.
   2. Specification comparison.
   3. Time-current curves for all devices on project.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
   1. Overcurrent protective devices.
      a. Base:
         (1) Cutler Hammer/Westinghouse.
      b. Optional:
         (1) Square D Co.
         (2) Siemens Energy & Automation, Inc.
         (3) General Electric.
      c. Other manufacturers desiring approval comply with Section 01640.
   2. Fuses:
      a. Base:
         (1) Bussmann.
         (2) Shawmut.
         (3) Brush.
         (4) Littelfuse.
      b. Other manufactures desiring approval comply with Section 01640.
   3. Air circuit breaker microprocessor based trip unit shall be Cutler Hammer; no substitutions.

B. Equipment and devices by same manufacturer.

2.02 CIRCUIT BREAKERS

A. Molded case type:
   1. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
   2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
   3. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on drawings and Panel Schedules.
   4. Circuit breakers shall meet the appropriate classifications of Federal Specifications W-C-375b.
   5. Branch circuit breakers and 208 volt breakers shall have thermal-magnetic trip units with inverse time-current characteristics.
      a. 250 A and large frame breakers shall be provided with front adjustable magnetic trip elements.
   6. 480 volt feeder breakers less than 150 A shall have thermal-magnetic trip units with inverse time-current characteristics.
   7. 480 volt feeder breakers 150 A and larger shall be provided with microprocessor based trip units. Refer to paragraph 2.02.C below for additional information on microprocessor based trip units.

B. Air circuit breaker type:
   1. Air circuit breakers shall be the drawout low voltage power type.
   2. All breakers shall be UL tested for applications in their intended enclosure for 100 percent of their continuous ampere rating.
   3. The circuit breakers shall have silver-tungsten buff type contacts which operate under high pressure. The arcing contacts shall be of arc-resisting silver-tungsten. The breaker shall be equipped with DE-ION arc extinguishers which effectively enclose the arcing contacts and confine the arc to reduce the disturbance caused by the short circuit interruption. Each breaker shall be equipped with a position indicator, mechanically connected to the circuit breaker mechanism.
   4. Both electrically operated, and manually operated breakers shall have stored energy operating

mechanisms. Only one stroke of the operating handle shall be necessary to charge the stored energy spring when operating the manual breaker. The release of the energy to close the breaker manually shall be by means of a mechanical pushbutton which insures positive control of the closing operation. Electrical close shall be initiated by means of a release solenoid. Provide red and green indicating lights to indicate breaker position.

5. Tie breakers shall be electrically operated, current-limiting type. Provide 200,000 AIC with current-limiting fuses in series with breaker and mounted on a separate draw out fuse truck located in the same vertical section.
   a. 800 through 3200 A, Type DSLII-632.
   b. 1000 through 4000 A, Type DSLII-840.
6. Feeder breakers shall be current-limiting type. Provide 200,000 AIC with current-limiting fuses in series with breaker.
   a. 50 A through 800 A, Type DSLII-308.
   b. 50 A through 1600 A, Type DSLII-516.
7. Draw-out construction as indicated. Roll out type operated by removable crank handle. Interlock with door.
8. Provide two NO and two NC auxiliary contacts to indicate when the breakers are in the open position. Contacts will be monitored by the RMS system.
9. Refer to Paragraph 2.02.D below for additional information on microprocessor-based trip units.

C. Molded case circuit breaker microprocessor-based trip units:
   1. Each circuit breaker microprocessor-based tripping system shall consist of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and timed delay settings are reached.
   2. Interchangeable rating plus shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed or adjustable as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
   3. The microprocessor trip unit shall have thermal memory

capabilities to prevent the breaker from being reset following an overload condition until after a preset time delay.

4. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with an instantaneous override. Internal ground fault protection adjustable pick-up ratings shall not exceed 1200 amperes. Provide neutral ground fault current sensor for four-wire loads.
5. Breakers shall have built-in test points for testing the long time delay, instantaneous, and ground fault functions of the breaker by means of a 120-volt operated test set. Provide one test set capable of testing all breakers 400-ampere frame and above.
6. System coordination shall be provided by the following microprocessor- based time-current curve shaping adjustments:
   a. Adjustable long time pick-up and delay.
   b. Adjustable short time pick-up and delay, with selective curve shaping.
   c. Adjustable instantaneous pick-up.
   d. Adjustable ground fault pick-up and delay, with selective curve shaping.
7. Microprocessor-based trip units shall be Cutler-Hammer Westinghouse Digitrip RMS 310.

D. Air circuit breaker microprocessor based trip unit:
   1. Each draw-out low voltage power air circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time- current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker.
   2. The trip unit shall have an information system that provides LED's to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A red trip reset button shall be provided to turn off the LED indication after an automatic trip.
   3. The trip unit shall be provided with a display panel, including a representation of the Time/Current curve

of the trip unit, that indicates the protection function settings. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

4. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid- state elements:
   a. All breakers shall have adjustments for long delay pick-up and time.
   b. Ties and feeders shall have individual adjustments for short delay pick-up and time and include I2T settings.
   c. Feeders shall have an adjustable instantaneous pick-up.
   d. Feeders shall have individually adjustable ground fault current pick- up and time, and include I2T settings.
5. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with a discriminator or making-current release circuit to prevent closing the circuit breaker on a faulted system. The circuit shall be armed for approximately eight cycles and shall operate for all fault levels above 11 times the ampere value of the rating plug.
6. The trip unit shall contain an integral test panel with a test selector switch and a test pushbutton. A potentiometer shall be provided to enable the user to select the values of test currents within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in the Trip of No trip test mode.
7. The trip unit shall contain a keyed receptacle for use with a test unit. The test unit when connected to a 120V, 50/60 Hz source shall provide power for testing the trip unit while the breaker is out of the cell or in the disconnect or withdrawn position. Provide two test units.
8. Trip unit shall have thermal memory for enhanced circuit protection.
9. A four-digit, 18 mm high, LED alpha-numeric display shall be provided to indicate the following data:
   a. Cause of trip.
   b. Instantaneous value of maximum phase and ground current.
   c. Level of fault current that initiated an automatic trip operation.
   d. Display shall be high output LED for low-level light readability. LCD displays are unacceptable.

10. The trip unit shall include a power/relay module which shall supply control power to the readout display. Following an automatic trip operation of the circuit breaker, it shall maintain the cause of trip history and the mode of trip LED indication as long as its internal power supply is available. Internal relays shall provide contacts for remote indication of mode of trip and high load.
11. A red LED shall be provided on the face of the trip unit pre-set to turn on when 85 percent of load level is exceeded (a 40-second delay shall be provided to avoid nuisance alarms).
12. Metering display accuracy of the complete system including current sensors, auxiliary CT's, and the trip unit shall be +/- 2 percent of full scale for current values.
13. The trip unit shall include a potential transformer module, suitable for operation up to 600V, 50/60 Hz. The primary of the transformer shall be connected internally to the load side of the circuit breaker through a dielectric disconnect plug. The unit shall calculate energy monitoring parameters as follows:
    a. Peak demand (Megawatts).
    b. Present demand (Megawatts).
    c. Energy consumption (Megawatt-hours).
14. The energy-monitoring parameter values (peak demand, present demand, and energy consumption) shall be indicated in the trip unit alpha-numeric display panel.
15. Metering display accuracy of the complete system of full scale shall be +/- 3 percent for power values, +/- 4 percent of full scale for energy values.
16. The trip unit shall communicate via a network twisted pair with the assembly monitor. See Section 16427.
17. The trip unit shall be Cutler-Hammer Westinghouse Digitrip RMS 810.

E. Motor circuit protector (MCP) providing adjustable instantaneous short circuit protection only by means of a magnetic or solid state trip element.
1. Molded case construction, Series C Type HMCP.
2. Current-limiting as indicated or required providing 200,000 AIC by means of a current-limiter attachment.
3. See motor control center schedules for required sizes and interrupting ratings.
4. Set magnetic trip for motor circuit protector (MCP) above locked rotor current for each motor: Not to exceed 1300 percent of motor full load current for other than Design E motors and Design B high efficient motors and not to exceed 1700 percent for Design E motors and Design B high efficient motors.

2.03 FUSES

A. UL Class L fuses: Dual-element time-delay and current-limiting type fuses; UL Class L listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 600V, 601-6000A, Type KRP-C.
   1. Use for main and feeder devices over 600A, where fuses are indicated.

B. UL Class RK-1 dual-element fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-1 listed for 200,000 rms AIC symmetrical; Bussmann "Low-Peak" 0-600A, 250V Type LPN-RK and 600V Type LPS-RK.
   1. Use for feeder devices 600A and smaller where fuses are indicated.

C. UL Class RK-5 fuses: Dual-element time-delay and current-limiting rejection type fuses; UL Class RK-5 listed for 200,000 rms AIC; Bussmann "Fusetron" 1/10-600A, 250V Type FRN-RK and 600V FRS-RK.
   1. Use for motor feeder and branch circuit devices where fuses are indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in switchboards, panelboards and motor controllers as indicated in those sections.

B. Install individually enclosed as specified in other sections or indicated. Use NEMA 1 enclosure unless indicated otherwise.

C. Set adjustable devices as indicated in approved coordination analysis.

D. For circuit breakers serving adjustable frequency drives which serve Design E motors or Design B high efficient motors, increase breaker ratings as required to allow motor starting when the AFD is in the by-pass mode.

END OF SECTION

SECTION 16510

INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUBMITTALS

A. Shop drawings:
    1. Fixture Type 'T'.

B. Product data:
    1. Specification comparison.
    2. Lighting:
        a. Names of manufacturers, cuts, catalog numbers and photometric data of all lighting fixtures to be used on project.
        b. Identify fixtures by Fixture Schedule number, including special notations for finishes, colors, and mountings.

C. Samples:
    1. Fixture Type 'T' with mounting brackets, cord, raceway cover and connector, or cord and plug.

PART 2 - PRODUCTS

2.01 LIGHTING FIXTURES - GENERAL

A. Acceptable manufacturers:
    1. Lighting fixtures:
        a. Base:
            (1) As indicated on Fixture Schedule or Drawings.
        b. Optional:
            (1) As indicated on Drawings.
    2. Lamps:
        a. Base:
            (1) General Electric.
            (2) Osram/Sylvania.
            (3) Venture Lighting International.
            (4) Philips.
    3. Other manufacturers desiring approval comply with Section 01640.

B. All lighting fixtures and electrical components: UL labeled, complete with lamps.

2.02 LAMPS

A. Incandescent lamps: As indicated in fixture schedule.

1. Use lamps that meet current Federal energy standards.

2.03 INCANDESCENT FIXTURES

A. Incandescent fixtures: Track type.
   1. Major structural parts: Minimum 1.50 mm electro-plated zinc-coated steel, bonderized for paint adhesion and rust prevention.
      a. Body of fixture shall be painted after fabrication.
   2. Finish: Baked-on white enamel paint applied after fabrication, 0.035 mm to 0.045 thick, with minimum reflection factor of 89 percent.
   3. Sizes: As indicated on schedule.
   4. Minimum efficiency: 65 percent.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate installation with other ceiling mounted equipment.

3.02 ADJUST AND CLEAN

A. Wipe all lighting fixture reflectors, lenses, lamps and trims, clean, after installation. All fixtures shall be installed with caution so as to avoid any fingerprints or smudges on surfaces of parabolic louvers and downlight reflectors. Any fixtures with fingerprints or smudges shall be cleaned.

B. Replace all lamps operated during construction period with new lamps prior to final acceptance.

C. Adjust all incandescent fixture sockets to match the lamp specified and aim all adjustable fixtures as directed by COTR.

END OF SECTION

SECTION 16512

LOW VOLTAGE LIGHTING CONTROL AND DIMMING SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division-1 Specifications section and Division-16 Basic Materials and Methods sections apply to work of this section.

1.02 DESCRIPTION OF WORK

A. The extent of control work is indicated by drawings and schedules.

B. The intent of this Specification is to provide for the furnishing, installing, testing and placing in the operation, the necessary equipment for complete lighting control system installations. This equipment is designed to provide high quality lighting capabilities, with maximum ease of use and reliability for the wide variety of functions housed in these facilities. Essential to the design of these systems is the portability and interchangeable nature of the components between systems.

C. Provide all labor and materials and make all necessary arrangements, except as specifically noted herein, so that when the Contractor is finished, fully working systems will be turned over to the COTR. Any errors, omissions, or ambiguities are not to condition this requirement, but shall be brought to the attention of the COTR in their possible effect on the intent of this Specification.

1.03 QUALITY ASSURANCE

A. The equipment specified is the result of efforts to select equipment for reliability, ease of maintenance, and suitability for the COTR's purposes. Strict adherence to these Specifications shall be required.

B. All of the equipment specified under this section shall be the products of a single manufacturer. Manufacturer shall have a minimum of 5 years experience in control systems.

C. Component pretesting: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

D. System checkout: A factory trained technician or factory authorized personnel shall functionally test the control system and verify performance after installation.

E. Warranties:
   1. The systems specified herein shall be warranted by the Contractor to be free from defects of material or workmanship, from the date of acceptance, for a period of:
      a. Ten (10) years on the individual relays.
      b. One (1) year on all other components.
   2. During the period of this warranty equipment which proves to be defective shall be repaired or replaced at no charge.
   3. Factory telephone support shall be available at no cost to the COTR for the duration of the warranty period. Factory assistance shall consist of solving programming or application questions concerning the control equipment. The factory shall maintain toll free numbers for technical support for their customers.

F. Listing and labeling: All items of equipment, and individual components, where applicable standards have been established, shall be "Listed and Labeled" by a "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7. The terms "Listed and Labeled" shall be defined as they are in the National Electrical Code, Article 100.

G. Code compliance: Comply with National Electric Code (NFPA 70), Uniform Building Code (UBC), and all local codes as applicable to installation and construction of architectural dimming equipment.

H. Standards: Comply with all applicable portions of the standards from the following organizations.
   1. American National Standards Institute (ANSI).
   2. National Electrical Manufacturers Association (NEMA).
   3. Institute of Electrical and Electronic Engineers (IEEE).

I. Certificate of Installation: Submit certificates from the manufacturer's field engineer stating installed system is operating properly and complies with manufacturer's recommendations.

1.04 SHOP DRAWINGS

A. After the award of contract, prepare and submit shop

drawings to the COTR for approval. Drawings shall include details of all components, and shall be approved prior to fabrication, or installation.

1. Include all critical equipment dimensions, in order to assure that the equipment will fit into the "Laboratory Service Modules" as designed.
2. Include Riser Diagrams and drawings of Switch Input Wiring.
3. Include oscilloscopic evidence, from an independent testing lab, of current rise time met by dimmer chokes.

B. Shop drawing approval shall not relieve this contractor from the responsibility to provide equipment in accordance with the Specifications. Any deviations from these Specifications shall be starred and noted in 6.5 mm high letters. Only deviations which upgrade the compatibility of the equipment within "Laboratory Service Module" designs will be considered.

1.05 OPERATION AND MAINTENANCE MANUALS

A. When the installation is complete, the COTR shall be supplied with three (3) sets of "Operation and Maintenance Manuals", which shall, as a minimum, incorporate:

1. Operator's manuals on the controls systems.
2. Maintenance information on all major units and principal components of the system.
3. Record drawings, and a complete set of product data sheets.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver equipment and controls securely wrapped in factory fabricated wooden or fiberboard type containers.

B. Handle equipment and control carefully to prevent breakage, denting and scoring finish. Do not install damaged equipment and controls; replace and return damaged units to equipment manufacturer.

C. Store equipment and controls in clean dry spaces. Store in original cartons and protect from dirt, physical damage, weather and construction traffic.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptance manufactures:

1. Low voltage lighting controls and dimmimg system:
    a. Base:
        (1) Lithonia Lighting.
    b. Optional:
        (1) Thomas Industries, Inc.
        (2) General Electric.
        (3) Lutron.
        (4) Lehigh.
        (5) ILC.
2. Occupancy sensors:
    a. Base:
        (1) Watt Stopper.
    b. Optional:
        (1) UNENCO, Inc.
        (2) Sensor Switch.
3. Other manufactures desiring approval comply with Section 01640.

2.02 REMOTE CONTROL STATIONS

A. Where indicated on drawings (labs, etc.), provide Remote Control Stations, as specified herein.
    1. General:
        a. Remote Control Stations shall provide presets and control channels as indicated.
        b. Faceplates shall attach to mounting frame without visible screws and, when in place, shall provide a clean architectural appearance.
        c. Faceplate finish shall be brushed aluminum.

B. Buttons shall provide positive tactile feedback. Button functions shall be as follows:
    1. Raise and lower buttons to adjust intensity for each dimmable zone.
    2. On/off button turns on and off all dimmable lighting in a room.
    3. Non-dim buttons to toggle non-dimmable zones on and off.

C. Capacities:
    1. Each room shall have up to:
        a. Wall mounted stations, as indicated on drawings, containing:
            (1) Four (4) individually controlled dimmers.
            (2) One (1) master dimmer on/off control.
            (3) Seven (7) individually controlled non-dims.
        b. One (1) portable remote:
            (1) The remote shall be infrared, with receiver and decoder.
            (2) In order to assure capability between rooms, each remote shall contain sixteen (16)

pushbuttons, as follows: (a) Four (4) dimmer raise buttons. (b) Four (4) dimmer lower buttons. (c) One (1) master dimmer on/off button. (d) Seven (7) non-dim on/off buttons.

2. The control button caps shall be engraved, as directed by the COTR.

2.03 DIMMING PRESET STATIONS

A. Where indicated on drawings (conference rooms, etc.), provide dimming preset stations, as specified herein.
   1. General:
      a. Stations shall provide presets and control channels as indicated.
      b. Faceplates shall attach to mounting frame without visible screws and, when in place, shall provide a clean architectural appearance. Full length piano hinge shall allow faceplate to fold down flat against wall when open.
      c. Faceplate finish shall be brushed aluminum.
      d. Faceplate shall be provided with translucent window for viewing of LED bargraph indicating channel intensity. Preset, master raise/lower, and off push buttons shall be accessible with the faceplate closed. All other controls shall be concealed behind the faceplate.

B. Buttons shall provide positive tactile feedback. Preset buttons shall incorporate an integral LED indicator. Button functions shall be as follows:
   1. Off button turns off all lighting dimmed from this station.
   2. Master intensity control for all lights, to override a preset without changing memory.
   3. Raise and lower buttons with LED bargraphs to adjust intensity for each zone.
   4. Face time shall be adjustable for each preset scene. Available fade times shall be:
      a. 0, 5, 10, 15, 30 and 45 seconds.
      b. 1, 5, 10, 30 and 60 minutes.
   5. Select button to record changes in preset memories.
   6. Preset buttons to save and activate lighting presets.

C. Capacities:
   1. This station shall have six (6) preset, one (1) master raise, one (1) master lower, and one (1) master off pushbutton. The preset button caps shall be engraved, as directed by the COTR.
   2. This station shall have four (4), or eight (8) control channels, with dimmers assigned to channels on a one to one basis. Controls channels shall be labeled, as

directed by the COTR.

D. Room assignment:
1. Where indicated on drawings, provide a room assignment station, similar in appearance to the "Remote Control Stations" specified herein.
2. Pushbutton switches shall permit one of two "Dimming Preset Stations" to control two adjacent areas. The second station shall be automatically disabled in this mode.

2.04 DIMMERS

A. Dimmer cabinets:
1. Dimmer cabinets shall be NEMA enclosures with black enamel finish, suitable for mounting in the "Room Control Modules" or as indicated on drawings.
2. Critical dimmer cabinet dimensions shall be 495 mm high, 468 mm wide, and 104 mm deep.
3. Cabinet shall be prewired factory assembly. Contractor wiring shall be limited to connecting line, load and control wiring to labeled terminals within the cabinet.
4. Cabinet electronics, including low voltage power supply, shall be furnished as plug-in assemblies. No disconnection of wires or terminals shall be required to replace these assemblies in the field.
5. Cabinets shall be designed to operate in ambient temperatures between 0 and 40 degC, with natural convection cooling. Forced air cooling shall not be acceptable.

B. Power modules:
1. Each dimmer cabinet shall include four (4) dimmers, fed from the same 20 amp, 120 volt or 277 volt circuit as indicated on drawings.
2. Dimming modules shall employ Silicon Controlled Rectifiers in an inverse parallel configuration. Triacs or other power devices not utilizing SCR's shall not be acceptable. SCR's shall be encapsulated into an insulated assembly providing ground fault isolation tested to 2500 volts RMS.
3. Dimmers for incandescent, low voltage, neon and cold cathode loads shall be "universal" type and rated for control of an individual 20 amp circuit. Digital firing circuits shall ensure that all dimmers set to the same intensity shall track together. No adjustment shall be required to ensure this operation.
4. Dimmers shall use toroidal filter chokes to reduce RFI and lamp filament noise. Choke shall limit current rise time of output wave form to a minimum of 450

microseconds, measured between 10 percent and 90 percent of total rise, at 50 percent intensity. Submittals shall include oscilloscopic evidence of meeting this standard.

2.05 RELAYS

A. Relay cabinets:
1. Relay cabinets shall be NEMA enclosures with hinged locking door, suitable for mounting in the "Room Control Modules" or as indicated on drawings.
2. Critical relay cabinet dimensions shall be 356 mm high, 241 mm wide and 125 mm deep.
3. Cabinet shall be prewired factory assembly. Contractor wiring shall be limited to connecting line, load and control wiring to labeled terminals within the cabinet.

B. System description:
1. Each system, as indicated on drawings, shall consist of an intelligent lighting relay control panel with at least 8 programmable low voltage switch inputs.
a. The low voltage (class 2) switch inputs shall each be field assignable as momentary three wire, momentary two wire, or maintained contact.
b. Switch inputs shall be assigned, through field programming to:
(1) One, some or all relays.
(2) Adjustable time-out value per switch input (1-999 minutes).
(3) time-out to scheduled state.
2. The programmable intelligence of each panel shall provide stand alone control for each panel. Programmable intelligence shall include:
a. Seven-day operation, with 8 relays linked to 64 unique timeclock events.
b. Holiday schedule, with 32 definable holidays.
c. Auto Daylight Savings Time adjustments with disable.
d. Astronomic operation with sunrise/sunset offsets.
e. A "Warn Off" feature to generate a one second flash of lights 1 to 99 minutes before they are turned off. The "Warn Off" feature shall be programmed to warn the occupant in sufficient time to override the "Off".
f. A built-in alphanumeric programming keypad. Systems requiring remote programming units, or computer interface for programming shall not be acceptable.
g. A two line, 32 character, LCD display with English language prompts. User programming shall be menu

driven from this display.

3. Each panel shall further contain:
   a. Direct relay override from the keypad.
   b. A Master ON/AUTO/OFF override switch.

C. Relays: The system shall utilize magnetically held relays which are rated to at least 20 amps at 277 VAC. Relays which are latched or mechanically held are not acceptable. A limited 10 year warranty shall be provided on the individual relays.

D. The system shall utilize a memory back-up device which is system integrated and shall be maintenance-free. Both the system clock and data in RAM shall be protected against power interruptions lasting as long as one week. Power restoration for as little as thirty minutes shall restore the interrupt protection circuit to its full seven day protection capability. Systems which require any periodic battery maintenance shall not be acceptable.

E. The control panel shall incorporate the use of a multi tapped transformer. The panel shall not require specification of voltage for each control location. The voltages of 120, 208 and 277 VAC shall be available with each standard control panel.

F. The system shall provide visible status indication of all relays through the window of each panel. The visual indication shall disclose ON/OFF status and relay number.

2.06 PHOTOCELLS

A. General:
   1. Each photocontrol point shall consist of an architecturally compatible sensor mounted in the appropriate location for measuring the available daylighting. Each sensor will have a separate control/calibration unit via a single 20/4 shielded conductor with a maximum distance of 152 m. The control unit shall be powered by 24 VAC.
   2. Control/calibration unit:
      a. Control unit shall allow for direct control of up to three separate devices. These devices can be a relay, or any other device which allows control by a three wire momentary contact.
      b. Control unit shall be a standard device which can work with any of the possible sensor devices. The unit shall be switchable between four measurement ranges (10-100 lux, 100-1000 lux, 1000-10000 lux and 10000-100000 lux), depending on the sensor head and application.

c. Control unit shall have separate trip points for the high and low response settings. These settings will be entered via easily readable dial switches, and will not require a separate meter or look-up table to insure a reliable lux setting. LEDs shall be provided to illustrate whether the sensor is below the "Low" setting, above the "high" setting, or in the deadband range.
d. Control unit shall allow for a momentary contact device to act as a master ON/OFF override of the photocell relays. This master override will only be in effect until the next change in light level or the next master override.
e. The control device shall also provide a photocell lockout input to allow an external contact closure to disable the daylight switching.
f. Control device shall employ a 3 minute time delay between switching outputs to avoid nuisance tripping. It shall be possible to disable the time delay to aid in initial setup and troubleshooting.

3. Sensor devices: Four different sensors shall be available to match the specific application. Each sensor shall employ photodiode technology to allow a linear response to daylight in its given lux range.
a. For exterior lighting: A hooded sensor that can be horizontally mounted on a 15 mm KO or threaded conduit. Shall employ a flat lens, and work with a lux range between 10-100 or 100-1000 in 10 percent increments. The entire sensor shall be encased in optically clear epoxy resin.
b. For indoor lighting: A sensor with a fresnel lens providing for a 60 øCone shaped response area shall be employed to monitor indoor lighting levels with a sensitivity range of 100 to 2000 LUX. Provide adjustable time delay and adjustable dead band to prevent cycling.

2.07 OCCUPANCY SENSORS

A. Passive Infrared Sensors - Open Office Location - Detail 3/E5-16:
1. The passive infrared sensors shall be capable of detecting presence by detecting changes in the infrared energy.
2. The sensor shall utilize a temperature compensated dual element sensor and a multi-element Fresnel lens.
3. Sensor shall have a daylight filter which ensures that the sensor is insensitive to short-wavelength infrared waves such as those emitted by the sun.
4. Sensor shall have a 30 element Fresnel lens, 5 layers

vertically and 6 layers horizontally, with a field of view of 110 deg vertically and horizontally.

5. Sensor shall cover 300 square feet at normal mounting heights.
6. Time delay range shall be adjustable from 30 seconds to 30 minutes.
7. Sensor shall have user-adjustable sensitivity setting.
8. Adjustments and mounting hardware shall be concealed under a removable cover to prevent tampering of adjustments and hardware.
9. Sensor shall operate from a 24 volts DC power supply.
10. Sensor can be wired in parallel to allow coverage of large areas.
11. WATT stopper - WPIR.

B. Passive Infrared Sensors - Enclosed Office Locations - Detail 2/E5-16:

1. The sensor shall be dual technologically capable of detecting presence by detecting doppler shifts in transmitted ultrasound and by detecting passive infrared heat changes.
2. Upon a person entering a space, motion from both technologies must be sensed before lighting will be turned on. After this has occurred, detection by either technoloby will hold lighting on for the set time period. Sensor shall have a retrigger time delay where only one motion is necessary to turn on the lights within 5 seconds after turning off.
3. Ultrasonic circuit shall be solid state controlled with advanced signal processing and crystal accuracy. The ultrasonic frequency shall be 40 kHz +/- .006 percent.
4. Ultrasonic receivers shall be temperature and humidity resistant with less than a 6dB shift in the humidity range of 10 percent to 90 percent and less than a 6dB shift in the temperature range of -20 degC to 60 degC.
5. The passive infrared sensor shall utilize a temperature compensated dual element sensor Fresnel lens.
6. Sensor shall have a daylight filter which ensures that the sensor is insensitive to short-wavelength infrared waves such as those emitted by the sun.
7. Sensor shall have a 30 element Fresnel lens with 15 layers horizontally and 4 layers vertically for wide angle coverage.
8. Sensor shall cover 1500 square feet for walking motion when mounted at a ceiling height of 3600 mm.
9. Sensor shall have a sensitivity adjustment for each technology.
10. Sensors shall operate on 24 VDC.
11. Sensor shall have two outputs. One output is based

on occupancy only and the other is based on occupancy with a hold OFF and an internal photocell setting when a minimum light level is present - adjustable from 25 to 4300 lux.

12. Provide ceiling and swivel mounting brackets.
13. Watt Stopper: DT-100L, CM-100, and BR-1.

C. Ultrasonic Sensors - Toilets and Corridors - Detail 1/E5-16:

1. The ultrasonic occupancy sensors shall be capable of detecting presence by detecting doppler shifts in transmitted ultrasound.
2. The ultrasonic frequency shall be 25 kHz at +/- 0.005 percent. The sensors shall not interfere with each other when two or more are placed in the same area.
3. Each sensor shall be furnished with a shunt provision which will by pass the sensor in the event of failure.
4. Sensors can be wired in parallel with up to 3 sensors per power pack to allow coverage of large areas.
5. Time delay range shall be adjustable from 15 seconds to 15 minutes.
6. Sensor shall have user-adjustable sensitivity setting.
7. Sensors shall operate on 24 volts DC power, current draw is 16 milliamps.
8. Toilet sensors shall cover 360 deg and up to 45 square meters.
9. Corridor sensor shall be able to cover 13.5 meter each direction in a 3.0 meter wide corridor with walls.
10. Toilets: Watt Stopper W-500A.
11. Corridors: Watt Stopper W-2000H.

D. Power and Slave packs:

1. Power pack shall be a self contained transformer and relay.
2. Slave packs shall contain relay only.
3. Relays shall be dry contacts capable of switching 20 amp ballast load, or 1 hp at 277 VAC.
4. Power packs shall provide 24 VDC at 100 ma output.
5. Power packs shall be capable of parallel wiring without regard to AC phases on primary.
6. WATT Stopper: A277E-P and S-277E-P.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install controls where indicated, in accordance with manufacturer's written instructions and with recognized industry practice to ensure that lighting control equipment complies with applicable requirements of NEC and

UL standards and with the applicable portions of NECA's "Standard of Installation".

B. Install all wire in conduit or raceway.

C. Check and test wiring to insure the system is free from grounds, opens and shorts.

3.02 SYSTEM COMMISSIONING

A. This Contractor shall provide accurate record drawings to the COTR for correct programming and proper maintenance of the systems. The "as builts" shall indicate the load controlled by each relay and dimmer, along with the appropriate relay and dimmer cabinet numbers.

B. The manufacturer of the control system shall arrange to have an engineering representative on the job after installation has been completed and prior to energization of the system to test and adjust the system.

C. This representative shall also instruct persons designated in the operation and maintenance of the system.

3.03 LABELING

A. Provide labeling of relay, dimming, and contactor cabinets as specified in Section 16010.

B. Provide a framed typed directory on the inside of each relay, dimming and contactor cabinet door. Directory heading shall indicate cabinet designation and location (room number). Directory shall indicate relay, dimming and contactor circuit number, panel board circuit number, the type of load and location (room number) of the load, and the load. Room names and numbers in the directory shall be the final building room names and numbers as identified by the COTR and not the names and numbers indicated on the drawings.

3.04 OCCUPANCY SENSOR INSTALLATION

A. Install sensors and power/slave packs as indicated on the drawings and in accordance with Manufacturer's recommendations.

B. Adjust placement, aiming and sensitivity to insure that lights are on when the space is occupied. In enclosed offices and open offices insure that the lights are not switched on when the space is unoccupied from activity in the adjacent corridor when the corridor door is open.

C. Install all wire in conduit or raceway.

END OF SECTION

SECTION 16741

EMPTY CONDUIT AND OUTLET BOXES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work in this section is for following systems:
   1. Telephone.
   2. Data processing.
   3. CCTV.
   4. Security.
   5. Audio/Visual.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cable tray: As specified in Section 16110.

B. Conduit: As specified in Section 16110.
   1. Provide insulated grounding bushing on all conduit ends which do not terminate at an outlet box.

C. Conduit stub-outs: From outlet box to nearest cable tray, or telephone or data closet, terminated with insulated grounding bushing.
   1. Provide pulling wire or heavy nylon pulling cord for conduit more than 7600 mm long.
   2. Telephone stub-outs: 20 mm, unless indicated larger.
   3. Data processing stub-outs: 32 mm.

D. Outlet box - General: With extension ring, of proper size and depth, with cover plate to match wiring device cover.

E. Telephone outlet boxes: Standard flush switch box with

blank plate.

F. Data processing terminal outlet boxes: 120 x 120 x 55 mm box with single gang blank plate.

G. Telephone backboards: 19 x 1220 x 1220 mm, fire retardant plywood as specified in Section 06000, painted white as specified in Section 09900.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all components as indicated.

B. Install pull wire in all empty conduit runs.

C. Tag ends of conduit with system identification letters.

D. Test conduit for clear passage.

E. Mark inside of outlet boxes with system identification letters using black felt-ink mark.

F. Bond conduit termination to cable tray with minimum #6 AWG.

END OF SECTION

SECTION 16901

VIBRATION ISOLATION OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide vibration control devices, materials, and related items. Perform all work as indicated on drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.02 QUALITY ASSURANCE

A. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.

C. Provide any incidental materials needed to meet the requirements stated herein, even if not expressly specified or indicated on drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each components with manufacturer's specifications.

E. Should any electrical equipment cause excessive noise or vibration, Provide remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

F. Upon completion of the work, COTR shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the COTR that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.03 SUBMITTALS

A. Shop drawings:
   1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.

2. Detailed selection data for vibration isolator supporting the generator, including:
    a. The isolator type.
    b. the actual load.
    c. The static deflection expected under the actual load.
    d. Specified minimum static deflection.
    e. The additional deflection-to-solid under load.
    f. The ratio of spring height under load to spring diameter.
3. Steel rails, steel base frames, and concrete inertia bases indicating all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

B. Product data:
1. Specifications and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
    a. The equipment identification mark.
    b. The isolator type.
    c. The actual load.

C. Samples:
1. Sample of each type of vibration isolation device.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
1. Double neoprene pads and hanger neoprene:
    a. Base:
        (1) Amber/Booth.
        (2) Korfund Dynamics.
        (3) Mason Industries.
        (4) Kinetics Noise Control.
        (5) Vibration Mountings & Controls.
2. Flexible electrical connections:
    a. Base:
        (1) Crouse-Hinds.
        (2) Spring City Electrical Mfg. Co.
3. Other manufacturers desiring approval comply with Section 01640.

2.02 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad):
   1. Neoprene pad isolators shall be formed by two layers of 7 mm to 8 mm thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. Neoprene shall be 40 to 50 durometer. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
   2. Type DNP isolators shall be formed from one of the following products or approved equal:
      a. Type NR: Amber/Booth.
      b. Type Korpad: Korfund Dynamics.
      c. Type WSW: Mason Industries.
      d. Type NPS: Kinetics Noise Control.
      e. Multi Layers of Series Shear-Flex or Maxi-Flex: Vibration Mountings & Control.

B. Type HN (Hanger Neoprene):
   1. Vibration isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30 degree arc before contacting the hanger housing.
   2. Type HN isolators shall be one of the following products or approved equal:
      a. Type BRD-A: Amber/Booth.
      b. Type H: Korfund Dynamics.
      c. Type HD: Mason Industries.
      d. Type RH or FH: Kinetics Noise Control.
      e. Type RHD or RFD: Vibration Mountings & Control.

C. Type FN (Floor Neoprene):
   1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
   2. Type FN isolators shall be one of the following products:

Type RVD	Amber/Booth
Type F	Korfund Dynamics
Type ND	Mason Industries
Type RD	Kinetics Noise Control
Series R/RD	Vibration Mountings & Control

2.03 FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:
   1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wire way, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
   2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) "XD Expansion/Deflection Coupling", Spring City Electrical Mfg. Co., (Spring City, PA) "Type DF Expansion and Deflection Fitting".

B. Type B:
   1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 600 mm length of flexible conduit or cable.

C. Type C:
   1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 1200 mm length of flexible conduit or cable.

2.04 GENERATOR ISOLATION

A. The engine generator set shall be rigidly mounted on a steel rail skid base.

B. The skid base shall be resiliently mounted on the steel underframe of the enclosure.
   1. Skid base shall be supported on spring isolators that achieve at least 38 mm deflection under load.
   2. Provide side-mounted height saving brackets for attachment of the isolators positioned on the sides of the skid base that are parallel to the axis of rotation.
   3. There shall be at least 25 mm clearance between the underside of the skid base and the underframe.
   4. Spring isolators shall be "Floor Spring and Neoprene Travel Limited" Type FSNTL as indicated in Section 15240.

C. The enclosure shall be rigidly mounted on three separate and equally sized steel framed concrete inertia bases.

1. Inertia bases shall extend a minimum 150 mm beyond the foot print of the enclosure and shall be 400 mm thick. Provide 25 mm separation between each section.
2. Inertia bases shall be "Base-Inertia Base" Type BIB as indicated in Section 15240.

D. Inertia bases shall be resiliently mounted on foundations.
1. Inertia bases shall be supported on spring isolators that achieve at least 38 mm deflection under load.
2. Provide side-mounted height saving brackets for attachment of the isolators positioned on the sides of the inertia base that are parallel to the axis of rotation.
3. There shall be at least 75 mm clearance between the underside of the inertia base and the foundation and/or slab-on-grade.
4. Spring isolators shall be "Floor Spring and Neoprene Travel Limited" Type FSNTL as indicated in Section 15240.

E. Exhaust pipe and catalytic converter/silencer shall be resiliently supported on spring and neoprene isolators that achieve at least 38 mm deflection under load.
1. Spring and neoprene isolators shall be "Hanger Spring and Neoprene" Type HSN as indicated in Section 15240.

F. Electrical connections from ductbank to enclosure and enclosure to generator shall be provided with a 90 degree bend of liquidtight flexible conduit or flexible conduit as indicated on drawings.

PART 3 - EXECUTION

3.01 APPLICATION

A. Unit substations and uninterruptible power supply (UPS) systems:
1. Each of the network transformers, low voltage switchgear assemblies and UPS's shall be mounted on Type DNP isolators.
2. Incoming electrical connections to the network transformers, outgoing connections from the low voltage switchgear assemblies, and incoming and outgoing connections to and from the UPS's shall be made using flexible electrical connections Type A or Type B.
3. All conduit and bus duct hung within the main electrical rooms (ME2007, ME2008, ME2009) and UPS Rooms (CR2004, MW2003, MW2019, ME2006, ME2001, IW5001, IW5003, IE5001, IE5003) and originating or terminating

at the aforementioned equipment shall be suspended on trapeze hangers using Type HN isolators.

B. Transformers (480-208/120V):
   1. Transformers above the Metrology Labs (Rooms MW2012, ME2017), and the Instrument Labs (Rooms IW4024, IE4024) shall be mounted on type DNP isolators.
   2. Transformers below and above the Cleanroom Labs (Rooms CR2005 and CR5002) shall be mounted on Type DNP isolators.
   3. Electrical connections to transformers shall be made using flexible connections Type A or Type B.

C. Dimming cabinet:
   1. Dimming cabinets shall be mounted on Type DNP isolators.
   2. Electrical connections to cabinet shall be made using flexible electrical connections Type A or Type B.

D. Mechanical equipment:
   1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

E. Load bank:
   1. Load bank shall be mounted on Type FN isolators with 6 mm minimum static deflection.
   2. Electrical connections to load bank shall be made using flexible electrical connections Type C liquidtight flexible steel conduit.

3.02 INSTALLATION

A. General:
   1. In all cases, isolated electrical equipment shall be positioned so that it is free-standing and does not come in rigid contact with the building structure or other systems.

B. Isolation mounts:
   1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
   2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
   3. Hanger rods for vibration isolated support shall be connected to structural beams or joists, not to the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
   4. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod

assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.

C. Flexible electrical connections:
   1. Type C connections shall be installed in a grossly slack "U" shape or a 360 degree loop.
   2. Rigid conduit on the isolated-equipment side of the flexible connections, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION

SECTION 15010

SPECIAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of system:
   1. Special mechanical requirements.
   2. Products:
      a. Access doors, panels, and frames.
      b. Equipment guards.
      c. Motors and controls.
      d. Rain hoods and counter flashings.
      e. Penetrations.
      f. Structural steel for supports.

B. Drawings use and interpretation:
   1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
   2. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
   3. Field measurements take precedence over dimensioned drawings.
   4. Piping and ductwork plans are intended to indicate size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.

C. Installation of systems and equipment:
   1. Installation is subject to clarification as indicated in reviewed shop and field coordination drawings.
      a. Generally, lay out large pipe mains first; then lay out piping requiring gravity drainage, ductwork and electrical conduit.
      b. This procedure is intended to promote orderly installation, but not to establish trade precedence.
      c. Dimensions indicated are limiting dimensions.
      d. Do not use equipment exceeding dimensions indicated on detail drawings or arrangements that reduce required clearances or exceed specified maximum dimensions.
      e. In mechanical equipment room corridors and aisle ways, maintain clear head room between floor and underside of ducts, pipes, and equipment to allow for future replacing of equipment and major components (e.g., coils, fans, heat exchangers, pumps).

f. Coordinate with all work provided under other sections, including Section 05505.
g. In areas with Universal Channel Support System (UCSS), coordinate with UCSS installer to avoid interference of lines, devices, hangers and other mechanical components with UCSS components.

D. Description of systems: Provide materials resulting, upon completion, in functioning systems in compliance with performance requirements specified, and modifications resulting from reviewed shop and field coordination drawings.

1.02 QUALITY ASSURANCE

A. Perform work in accordance with following codes and standards:
1. BOCA Building Code.
2. BOCA Mechanical Code.
3. ASHRAE/IESNA Standard 90.1-1999 Energy Conservation for Buildings Except Low-Rise Residential Buildings.
4. ANSI/ASHRAE Standard 62-1999 Ventilation for Acceptable Indoor Air Quality.
5. ANSI/ASHRAE Z9.5-1992 - Standards for laboratory Ventilation.
6. ANSI/ASHRAE 110-1985 Method of Testing Performance of Laboratory Fume Hoods.
7. National Fire Protection Association.
8. American Gas Association.
9. Sheet Metal and Air Conditioning Contractors' National Association Standards for Ductwork Design.
10. Authorities having jurisdiction.
11. Washington Suburban Sanitary Commission Plumbing and Gasfitting Regulations.
12. Air Diffusion Council (ADC).
13. Air Movement and Control Association (AMCA).
14. Air-Conditioning and Refrigeration Institute (ARI).
15. National Environmental Balancing Bureau (NEBB).
16. Compressed Air and Gas Institute (CAGI).

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Access doors, panels and frames.
2. Electric motors 0.37 kW and larger with corresponding nameplate horsepower equivalent and rated efficiency.

C. Samples:
1. Custom colors for factory-painted finishes.

D. Project information: Not required for COTR review.

E. Contract closeout information:
1. Pepco's New Building Design Program Worksheet E1 for high efficiency motors. Submit after Pepco's approval of motors.

1.04 PROTECTION

A. Provide covering and shielding for equipment provided to protect from damage.

B. Repair, restore and replace damaged items.

C. Protect nameplates on motors, pumps and all other equipment.

D. Protect plumbing fixtures and brass or chromium plated trim, valves and piping from damage.

E. Keep dirt and debris out of pipes and ducts by capping or plugging open ends.
1. Keep plug or cap in place until final connections are made.

1.05 RESPONSIBILITIES OF MECHANICAL WORK

A. Under this section, Contractor shall provide assistance to Contractors performing work under Section 15991 (TESTING AND BALANCING), and Section 15992 (HIGH ACCURACY CONTROL SYSTEM PERFORMANCE VERIFICATION). This assistance shall include but not be limited to those items specifically listed therein.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Access doors, panels, and frames:
a. Base:
(1) Milcor, Inc.
b. Optional:
(1) J L Industries.
(2) Karp Associates, Inc.
(3) Potter-Roemer.
(4) C E Sparrow Co.
(5) Ventfab.
(6) Williams Brothers Corp.

(7) Zurn.

2. Motors:
   a. Base:
      (1) Reliance XE.
   b. Optional:
      (1) Balder.
      (2) Century Electric, E-Plus.
      (3) General Electric, Energy Saver.
      (4) Westinghouse, MAC II Lifeline.
3. Other manufacturers desiring approval comply with Section 01640.

B. Use only prime quality, new materials, apparatus and equipment.

2.02 ACCESS DOORS, PANELS, AND FRAMES

A. Access doors, panels, and frames:
   1. Style and type to be truly compatible with material in which installed.
   2. Size:
      a. As required to allow inspection and removal of items served.
      b. Minimum 460 x 460 mm.
   3. Minimum 1.9 mm sheet metal, galvanized after fabrication and factory primed ready for painting.
   4. Panels in public areas: Key lock and keyed alike.
   5. Fire rated construction:
      a. Provide in fire rated walls, floors and ceilings.
      b. UL listed.
      c. Sandwich type door filled with insulation.
      d. 1.5 HR(B) fire rating.
      e. Automatic door closing system.
   6. Provide and rough-in at walls, floors, and ceilings as required to permit access to equipment, devices and piping requiring service or adjustment.

2.03 EQUIPMENT GUARDS

A. Equipment guards:
   1. Use suitable structural frames with minimum 2.7 mm, 20 mm galvanized mesh, or expanded metal mesh.
   2. Attach to equipment by removable clips and bolts with wing nuts, or other approved connectors.
   3. At belts, provide opening for measuring RPMs.
   4. Provide at belts, couplings, moving machinery and equipment in accordance with OSHA.
   5. Design for easy access to belts and other items requiring replacement.

2.04 MOTORS AND CONTROLS

A. Motor controls and wiring for controls:
   1. Provide complete installation of controls and wiring for controls for Division 15 packaged/pre-wired equipment.
   2. Include line voltage controls, low voltage controls, control switches, starters, disconnects, conduit and wiring. Control voltage shall not exceed 120 volts.
   3. Where equipment provided requires different sizes or additional motors, Provide additional wiring or controls necessary.
   4. Where equipment is specified with packaged/pre-wired controls and is furnished instead with components shipped loosely which require field wiring, coordinate complete installation and assume costs.
   5. Starters, disconnects, conduit, and wiring furnished under Division 15 shall comply with applicable Division 16 specifications.
   6. Locate disconnects on outside of equipment enclosures or guards.

B. Motors:
   1. Provide motors indicated in Division 15.
   2. Ball or roller bearing type, high efficiency type, with starting and running characteristics consistent with torque and speed requirements of driven machine.
   3. Low vibration, precision balanced. See vibration criteria of equipment driven.
   4. Cast iron body and ends.
   5. Motor efficiency:
      a. NEMA Standard MG1-12.53a.
      b. Indicate full load efficiency on each nameplate.
      c. Minimum efficiency in compliance with requirements of the Energy Policy Act of 1992 and ASHRAE/IESNA Standard 90.1-1999. Motors shall be so marked.
   6. Use motors rated in accordance with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 40 degC above ambient with service factor of 1.15.
   7. Motor powers as scheduled.
   8. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
   9. Do not include service factor when selecting motor power.
   10. Motors 0.37 kW and over: 460/3/60.
   11. Motors less than 0.37 kW: 115/1/60.
   12. Provide for items which require electric drive.
   13. Motors for certain pieces of equipment will be controlled by adjustable frequency drives (AFD's). These motors shall be designed for inverter-duty and shall have 1600 volt insulation for 460 V motors.

2.05 RAIN HOODS AND COUNTER FLASHINGS

A. Rain hoods and counter flashings not exposed to view:
   1. Stainless steel: Minimum 1.0 mm.

2.06 STRUCTURAL STEEL FOR SUPPORTS

A. Structural steel for supports: ASTM-A36/A36M.
   1. Galvanize members installed in fan plenums or areas of high humidity or condensation, and outdoors.
   2. Provide other members with shop coat of rust inhibiting primer.
   3. Shop fabricate for field assembly using bolts.
   4. Minimize field welding.
   5. Retouch primer after field welding.

2.07 COLORS-FACTORY PAINT

A. Equipment and appurtenances which are exposed to view in laboratories and public places and which are specified in factory painted finish, shall be provided in custom colors selected by COTR.

PART 3 - EXECUTION

3.01 GENERAL

A. Some of the work may not fit in the exact location indicated because of coordination with other contractor furnished elements. When changes in location of work are required, obtain approval of COTR before making change.
   1. Make changes at no extra cost.

B. Provide necessary offsets and crossovers in piping and ductwork, whether indicated or not.

C. Install piping and ductwork parallel to walls and vertically plumb.

D. Do not change indicated sizes without approval of COTR.

E. Electrical equipment rooms (including closets) and elevator equipment rooms: Install no piping except heating and air conditioning unit piping and fire protection piping that specifically serves the room.

F. Roof penetrations:
   1. Make penetrations through roofs prior to installation of roofing.

2. For penetrations required after installation of roofing:
    a. In built up roofing (BUR), Provide curbs, cants and counter flashings.
    b. Repair and replace roof construction which is damaged by work under Division 15 in a manner which will not degrade roof warranty.

3.02 LOCATING SERVICEABLE DEVICES

A. Install devices that may require adjustment, service, or maintenance in normally accessible locations, or provide flush-mounted access doors.
    1. Such devices include but are not limited to equipment, valves, filters, motors, drives, compressors, unions, traps, strainers, thermometers, gauges, switches, measurement devices, coils, detectors, dampers, sensors, monitors, backflow prevention devices, water-hammer arresters, drains, floor sinks, cleanouts, test stations, signal devices, sprinkler heads, air vents, expansion joints, and system drains.
    2. Arrange piping, conduit, ducts, and related work to facilitate maintenance.
    3. Relocate items which interfere with access.

3.03 CUTTING AND PATCHING

A. Perform or pay for cutting, fitting, repairing, patching and finishing of work of other Sections where it is necessary to disturb such work to permit installation of mechanical work.

B. Avoid cutting, where possible, by setting sleeves or frames, and by requesting openings in advance.
    1. Coordinate locations with work of other Sections.

C. Before cutting of structural elements, obtain written approval of COTR.
    1. Use only approved methods.
    2. Neatly cut or core drill holes as small as possible to admit work.
    3. Do not weaken walls or floors; locate holes in concrete to miss structural sections.

D. Locate openings and sleeves to permit neat installation of piping, ductwork and equipment.

E. Do not remove or damage fireproofing materials.
    1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
    2. Repair or replace fireproofing removed or damaged.

3.04 INSTALLATION OF EQUIPMENT

A. Install equipment in accordance with manufacturer's recommendations and as specified.

B. Provide necessary anchoring devices and supports.
   1. Use structural supports suitable for equipment, or as indicated.
   2. Check loadings and dimensions of equipment with shop drawings.
   3. Do not cut, or weld to, building structural members.
   4. Provide equipment supports even though not detailed on architectural and structural drawings.

C. Verify that equipment will fit support layouts indicated.
   1. Where substitute equipment is used, revise indicated supports to fit.

D. Arrange for necessary openings to allow entry of equipment.
   1. Where equipment cannot be installed as structure is being erected, Provide built in boxes, sleeves or other devices to allow later installation.

E. Provide rain hoods and metal counter flashings as indicated, and to make penetrations of mechanical work through walls and roofs water and weathertight.
   1. Furnish clamps, waterproofing material and labor.
   2. Where metal flashings are applied over concrete, paint concrete with 3 mm of mastic cement first.
   3. Set flashing in mastic cement, watertight.

F. Provide housekeeping pads for all floor mounted mechanical equipment unless indicated otherwise:
   1. Provide pads as detailed on structural drawings.

G. Maintain equipment prior to start up as per manufacturer's recommendations.

3.05 CONNECTION TO EXISTING UTILITIES

A. Provide interconnecting portions of these systems prior to shut down for final connections including valve assemblies in piping systems.

B. Locate existing piping and make connections as required.
   1. Do not cut into existing services without first verifying with COTR that service has been correctly identified.
   2. Perform work that interrupts service (this includes

cutting into existing lines for new connection) at time (usually night) to cause least interference to normal operation of facility.
3. Inform COTR in advance of shut offs that will occur and give estimate of duration.
4. Begin work only after COTR is fully informed and has agreed to schedule of shut offs.

C. Maintain existing services and equipment unless indicated to be removed.

3.06 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.
1. Conduct tests in presence of COTR and, if required, inspectors of agencies having jurisdiction.
2. Arrange date of tests in advance with COTR, manufacturer and installer.
3. Give inspectors minimum of 24 hours notice.
4. Furnish or arrange for use of electrical energy, steam, water or gas required for tests.
5. Furnish materials, tools and equipment required for test.

B. Repair or replace equipment and systems found inoperative or defective and retest.
1. If equipment or system fails retest, replace it with products conforming to Contract Documents.
2. Continue remedial measures and retests until satisfactory results are obtained.

C. Test equipment and systems for each item, unless otherwise recommended by manufacturer.

D. Vibration producing equipment field and factory tests and the results shall be kept in the form of records by individually numbered pieces of equipment with incremental witnessing/sign-off by COTR.

E. Procedures for handling and assembly of cleanroom components:
1. HVAC vendor fabrication: Before shipment, clean and seal HVAC components which are fabricated by vendors. This includes equipment such as make-up air handling units, recirculating air handling units and air plenums. Leave the seals on this equipment in place until the equipment is located in a clean zone or assembled to another section of sealed equipment. Wrap and seal all field assembled components in a manner which will permit the seal to be removed just

prior to assembly.

2. HVAC field fabrication: Clean interior surfaces of field fabricated HVAC components, in a manner which will minimize contamination to the interior surfaces during fabrication. Subsequent to fabrication and just prior to assembly, wipe interior surfaces clean with cleanroom wipes (impregnated with dilute solution of isopropyl alcohol). Vacuum the surfaces after wiping down. After sections are connected, seal open joints, to keep interior of HVAC system clean.

3.07 ADJUST AND CLEAN

A. Inspect equipment and put in satisfactory working order.

B. Clean exposed and concealed items: See Cleaning (Section 01710).
   1. Clean air surfaces of coils, fans (including fan wheels and motors), air handler plenums and air filter frames.
   2. Clean floor drains, cleanouts, and plumbing fixtures.
   3. Clean specialties such as traps and strainers and equipment surfaces such as pumps, motors, heat exchangers, chillers, and all other items requiring cleaning.
   4. Clean finned elements of fin tube radiation with compressed air.
   5. Clean piping of tags, debris and other construction materials before insulating or painting.
   6. Clean dirt and debris out of ductwork.

3.8 PUTTING SYSTEMS IN OPERATION - START UP

A. In addition to commissioning requirements specified in other Sections, prior to final acceptance and building occupancy, at time agreed to by COTR, put systems into satisfactory operation.
   1. At first heating or cooling season following final acceptance, put systems not yet operated under their seasonal loads into satisfactory operation.

B. Operate systems in satisfactory working order for period of 10 working days.
   1. After the 10 days, clean dirt and debris out of ductwork.

END OF SECTION

SECTION 15060

PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of system:
    1. Pressurized piping.
    2. Nonpressurized piping.
    3. Accessories:
        a. Dielectric fittings.
        b. Unions.

1.02 QUALITY ASSURANCE

A. Pipe and fittings to be ASTM labeled for rating specified.

B. Welder qualifications: Certified under requirements of ANSI/ASME-B31.1 Power Piping.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data.
    1. Polyethylene tubing.
    2. Rubber hose.

C. Samples: Not required for COTR review.

D. Project information:
    1. Manufacturer of listed products.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
    1. Fittings, mechanical groove-end and plain-end pipe:
        a. Base:
            (1) Victaulic Company of America.
        b. Optional:
            (1) Grinnell Corp.
            (2) Guston-Bacon.
    2. Dielectric fittings:

a. Base:
(1) Perfection Corp., (Victaulic Company of America).
b. Optional:
(1) Watts Regulator.
(2) Zurn/Wilkins Division.

3. Crosslinked polyethylene (PEX) tubing:
a. Base:
(1) Wirsbo.
b. Optional:
(1) REHAU Inc.
(2) MAXXON Corporation.

4. Rubber hose:
a. Base:
(1) Potomac Rubber Co.
b. Optional:
(1) Swan Co.

2.02 PIPE

A. Black steel pipe:
1. Seamless or welded steel pipe, ASTM-A53, standard weight unless otherwise indicated.
2. For fire sprinkler service: ASTM-A135 and ASTM-A53, Grade B, Schedule 40 or Schedule 10, 20, or 30 with minimum 6.4 mm wall thickness.

B. Galvanized steel pipe:
1. Seamless or welded, hot-dipped galvanized steel pipe, ASTM-A53, F.S.WW-P-404D, or ASTM-B36/B36M.
2. Joints:
a. Threaded.
b. Welded.
c. Cut or rolled grooved.

C. Stainless steel pipe:
1. Welded chromium nickel alloy steel pipe A358, Schedule 40 Grade 304.
2. Joints:
a. Welded.
b. Roll grooved.

D. Copper pipe:
1. Seamless copper tubing, ASTM-B88/B88M or F.S.WW-T-799E, type K, L or M as indicated, 150 maximum size.
2. Joints:
a. Soldered: Use ASTM-B32, 95 percent tin, 5 percent antimony solder, or Silvabrite 100.
b. High temperature soldered: Use 540 degC solder.
c. Roll grooved.

E. Cast iron soil pipe:
    1. ASTM-A74.
    2. Bell and spigot joints: Use oakum and lead, or neoprene gaskets (if allowed by code).
    3. Gaskets: ASTM-C564.

F. No hub cast iron pipe:
    1. ASTM-A888.
    2. Mechanical joints: Use stainless steel couplings with neoprene gaskets.
    3. Gaskets: ASTM-C564.
    4. Cast iron couplings with neoprene gaskets and stainless steel bolts and nuts.

G. Ductile iron pipe:
    1. Centrifugally cast, ANSI/AWWA-C151/A21.51, lined and coated.
    2. Joints:
        a. Gasketed mechanical joints: ANSI/AWWA-C111/A21.11.
            (1) Gaskets: ANSI/AWWA-C111/A21.11.
        b. Cut grooved.

H. Crosslinked polyethylene (PEX) tubing:
    1. Seamless polyethylene tubing, ASTM-F876-90, ASTM-F877-89.
    2. Tube shall be cross-linked polyethylene, rated at 83 degC maximum working temperature and 690 kPa working pressure.
    3. The tube shall be of cross-linked polyethylene manufactured by the "Engel Method". The tube shall have an oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than 0.10 g/m3 per day at 40 degC water temperature.
    4. The minimum bend radius for cold bending of the tube shall not be less than six times the outside diameter.
    5. Fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The fittings shall consist of a barbed insert, a compression ring, and a compression nut.

I. Rubber hose:
    1. Flexible black, smooth, abrasion resistant rubber compound.
    2. Single layer reinforcement braid of highly twisted, high-tensile rayon.
    3. Working pressures to 1370 kPa maximum.
    4. 12 mm inside diameter.
    5. Brass threaded male coupling attached to each end with

brass ferrule or stainless steel band.

2.03 FITTINGS AND COUPLINGS

A. Steel pipe fittings:
   1. Socket welding fittings: ANSI/ASME-B16.11 and ASTM-A234/A234M.
   2. Butt welding fittings: ANSI/ASME-B16.9, ANSI/ASME-B16.25 and ASTM-A105.
   3. Grooved fittings: Square cut, ASTM-A53 steel, or roll grooved, ASTM-A135.
   4. Flanged fittings: ANSI/ASME-B16.5 and ASTM-A105.

B. Malleable iron pipe fittings:
   1. Threaded fittings: ANSI/ASME-B1.20.1 and ANSI/ASME-B16.3, Class 150.
   2. Threaded couplings: Same as threaded fittings except Class 300.
   3. Grooved couplings: ASTM-A47, coupling segments with EPDM Grade E gasket.
   4. Galvanized malleable iron couplings: Victaulic; or ITT Grinnell.

C. Cast iron pipe fittings:
   1. Drainage fittings: Coated or galvanized, ASTM-A74.
   2. Threaded fittings: ANSI/ASME-B1.20.1 and ANSI/ASME-B16.4, Class 125.
   3. Threaded drainage fittings: ANSI/ASME-B1.20.1, ANSI/ASME-B16.12 and ASTM-A126.
   4. Flanged: ANSI/ASME-B16.1, Class 125.

D. Copper pipe fittings:
   1. Wrought copper fittings: ANSI/ASME-B16.22.
   2. Cast brass fittings: ANSI-B16.18.
   3. Mechanical groove-end fittings: Factory roll grooved.
   4. Flared tubing fittings: Use only on annealed pipe.
   5. Cast flanged fittings: ANSI/ASME-B16.24, Class 150.
   6. 2760 kPa fittings: Heavy wall type, Mueller "Steamline".

E. Stainless steel pipe fittings:
   1. ASTM-A182/A182M-92a.
   2. Roll grooved: Stainless steel, Victaulic type.
   3. Butt welding fittings: ANSI/ASME-B16.9.
   4. Socket welding fittings: ANSI/ASME-B16.11.

F. Ductile iron pipe fittings:
   1. ANSI/AWWA-C110/A21.10.
   2. Gasketed mechanical joints: ANSI/AWWA-C111/A21.11.
   3. Laying length (AWWA fittings): Short body dimensions.
   4. Flanged fittings: ANSI/ASME-B16.5.

5. Thickness of iron: Not less than for ductile iron pipe with additional thickness as required for proper reinforcement of branches for tees and crosses.

G. Dielectric fittings:
   1. General:
      a. Standard manufactured product for prevention of galvanic corrosion, appropriate for service under respective sections.
   2. Dielectric union:
      a. Ground-joint union with end connections of different material.
         (1) End connection materials: Compatible with respective piping materials.
         (2) Gasket and inert, non-corrosive thermoplastic sleeve shall electrically isolate end connections from each other.
   3. Dielectric waterway fitting:
      a. ASTM-A53 Schedule 40, hot dip galvanized, steel pipe casing with inert, non-corrosive thermoplastic lining (NSF/FDA listed).
      b. Threaded or threaded X rolled grooved connections.
      c. Victaulic, "Clearflow".

H. Mechanical groove-end couplings and fittings:
   1. Couplings:
      a. Malleable iron, ASTM-A47 or ductile iron, ASTM-A536.
      b. Gaskets: EPDM Grade E conforming to ASTM-D2000 for water services up to 110 degC.
      c. Gaskets on plastic piping: ASTM-F477.
      d. Bolts and nuts: ASTM-A183.
         (1) Heat treated plated carbon steel, track-head.
         (2) Minimum tensile strength: 760 MPa.
   2. Fittings:
      a. Malleable iron, ASTM-A47 or ductile iron, ASTM-A536.
      b. Copper:
         (1) DN50 to DN100: ASTM-B75, C12200.
         (2) DN125 to DN150: ASTM-B584, CDA 844 (81-3-7-9).

I. Unions.
   1. Same type, pressure rating and material as piping.
   2. Flanges: Raised face type of same type, pressure rating and material as piping.
   3. Unions in copper pipe:
      a. DN50 and smaller: Use wrought copper solder joint copper to copper unions.
      b. DN65 and larger: Use brass flange unions.
   4. Dielectric unions: See Dielectric fittings.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with ANSI/ASME-B31.9 for pressure piping installations.
   1. Install piping without "bull-head" fittings.

B. In general, make connections to components in piping systems with 3-elbow swing joints to allow for movement.
   1. Movement includes but not limited to expansion, contraction, and equipment vibration isolation.

3.02 PIPING

A. Install piping parallel to building walls at such heights as not to obstruct portion of window, doorway, stairway, or passageway.
   1. Where interference develops in field, offset or reroute piping as required to clear such interferences.
   2. Consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details and report discrepancies to COTR, before installing piping.

B. Pitch piping to drain:
   1. Minimum pitch of 1 mm/m(except drainage piping).
   2. Pitch coil condensate drains at slope of 2 mm/m.
   3. Make piping and equipment drainable.
   4. Accomplish pipe drainage using drain valves located on equipment and fixtures or separate drains.
   5. Drains: See Section 15120.

C. Factory cut and thread nipples from seamless stock.
   1. Use nipples of same material as pipe with which they are used.
   2. Do not use close nipples except where such use is unavoidable.
   3. Use Schedule 80 seamless pipe for close nipples and nipples of pipes DN10 or smaller.

D. Provide backing and sleeves required in walls or floors for setting of fixtures or equipment.

E. Where transition occurs from sweated fittings (as at connection to fixture supplies, etc.), Provide rigid anchorage so that no strain will be placed upon tubing.

3.03 JOINTS

A. Threaded joints:
   1. Cut piping carefully, ream, thread and work into place without springing.
   2. Use a small amount of prepared pipe thread lubricant on outside threads only.
   3. Provide in accordance with ANSI/ASME-B1.20.1.

B. Use dielectric waterway fittings for connections between dissimilar metals.

C. Flanged joints:
   1. Take care to ensure that there is no restraint on opposite end of pipe or fittings which would prevent uniform gasket compression or cause unnecessary stress in flanges.
   2. Keep one flange free to move in any direction while flange bolts are being tightened.
   3. Do not pack or assemble bell and spigot joints affected by flanged joints until such flanged joints have been tightened.
   4. Tighten bolts gradually and at a uniform rate, so that gasket compression is uniform over entire area of gasket.

D. Mechanical joints:
   1. Assemble in accordance with instructions and recommendations of pipe manufacturer.
   2. Clean joint surfaces and lubricate with soap solution or water soluble lubricant immediately before joint is assembled.
   3. Groove-end and plain-end joints:
      a. Use mechanical joint system only with pipe meeting joint manufacturer's requirements.
         (1) When joint manufacturer's pipe requirements exceed specified requirements, provide pipe that meets joint manufacturer's requirements.
      b. Prepare pipe and install system in accordance with joint manufacturer's instructions and recommendations.

3.04 UNIONS

A. Provide a union between valves, at connection to each fixture, device or item of equipment including coil pull areas, and elsewhere as required to facilitate installing, servicing, making up and disconnecting piping.
   1. Install each union to facilitate removal of parts, equipment or fixtures for inspection or cleaning.
   2. Install in a position which will permit device,

fixture or part to be removed without disconnecting piping except unions.

B. Provide unions as directed by Fluid Controls Institute, Inc., (FCI).
   1. Grooved piping systems:
      a. Grooved type couplings may serve as unions.
   2. Make connections between couplings and flanged equipment with slip-on flanges and a grooved nipple, or groove-to-flange adapter.
   3. Welded piping systems:
      a. Where flanged end-service valves are used at equipment connections, flange unions will not be required.
      b. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
      c. Flanged cast iron ells may be used for connections between pumps, strainers, check valves and other flanged equipment.

C. Install dielectric fitting at each piping joint and equipment connection between ferrous and non-ferrous materials.

3.05 PIPING EXPANSION

A. Install piping to allow thermal expansion and contraction without injury to piping, equipment or structure.
   1. Use loops or expansion joints where necessary and where detailed.

B. Where screwed piping is used for soil, waste or vent risers, or downspouts, use caulked joints or expansion joints at intervals to allow expansion movement.

3.06 WELDED STEEL PIPING

A. Where welded piping is specified, make welds by oxy-acetylene or electric process in accordance with ANSI/AWS-D10.12 and ANSI/AWWA-C206.
   1. Welding rods: Grade recommended for purpose by manufacturer; each rod stamped with manufacturer's name and identification.

B. Line welds:
   1. Single V-butt type.
   2. Mill or machine bevel pipe at 37.5 degrees to within 1.6 mm of inside wall.
   3. Pipe with a wall thickness of 4.8 mm or less need not be beveled but may be welded by melting down into, and

building up over abutting ends.
4. Separate abutting ends of joints before welding to permit complete fusion to bottom without overlapping.
5. Tack in 2 or more points to maintain alignment, and fusion weld.
6. Weld continuously around pipe.

C. Make welds of sound weld metal, thoroughly fused into ends of pipe, and to bottom of vee.
1. Build in excess of pipe wall to give reinforcement of 0.25 pipe wall thickness.
2. Weld metal shall present a gradual increase in thickness from surface of pipe to center of weld.
3. Minimum weld width: 2.5 times thickness of pipe wall.

D. Use welding ells at turns in welded lines except where pipe bends are indicated or are required for flexibility.

E. Mitered ells will not be permitted.

F. Do not weld pipe couplings in place of welding fittings for branch connections.

G. Weld-O-Lets and Thread-O-Lets:
1. Scribe and cut openings in main pipes for welded branches accurately taking care to remove plug and cuttings from main pipe.
2. Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by Weld-O-Let manufacturer.
a. Partially filled fillets not acceptable.

H. Cut openings into pipe for welded connections accurately to give carefully matched intersections.

I. Make welded fittings of same material with same pressure and temperature rating as pipe with which they are used.

J. Make flanged connections to control valves, pump suction, and specialties with ANSI standard welding neck flanges.
1. Other flange connections may be made with slip-on flanges provided they are seal welded on inside.

K. Fuse fillet welds for flanges or fittings into pipe and plate for minimum distance of 1.5 times pipe wall thickness and depth of weld of 1.25 times pipe wall thickness.

3.07 THREADED STEEL PIPING

A. Branch connections to screwed piping may be made with

Weld-O-Lets or Thread-O-Lets.

B. Do not weld pipe couplings in place of welding fittings for branch connections.

3.08 DUCTILE IRON AND CAST IRON PRESSURE PIPING

A. Perform cutting without damage to pipe or to cement lining.
   1. Make pipe cuts smooth, straight and at right angles to pipe axis.
   2. Use approved type mechanical pipe cutters.
   3. In locations where use of mechanical cutters would be difficult or impracticable, existing pipe may be cut with diamond point chisels, saws, or other tools which will not cause damaging impact or shock.

B. Use equipment, tools and methods in handling and laying pipe and fittings which prevent damage.
   1. Hooks inserted in ends of pipe shall have broad, well padded contact surfaces.

C. Replace pipe and fittings in which cement lining has been broken or loosened.
   1. Where damaged areas are small and readily accessible, lining may be repaired, if COTR approved.

D. Repair pipe coating which has been damaged before installing pipe.

E. Make connections between below ground piping and above ground piping with a flanged spigot adapter.
   1. Hold spigot piece in place with bolts on 2 sides of flanges between mechanical joint and flange connector.

F. Comply with AWWA-C600 for installation.

3.09 CAST IRON DRAINAGE PIPING

A. Lay underground pipe on undisturbed earth excavated to provide firm bearing on at least 0.333 of pipe circumference for full length, with bell holes cut out.
   1. Where excavation has been carried too deep, place a layer of sand well tamped to bring pipe to proper grade.
   2. Where fill or unsound earth is encountered, place a layer of 17.3 MPa concrete to properly bed pipe.

B. Bell and spigot joints:
   1. Install neoprene gaskets in accordance with manufacturer's recommendations.

2. Caulk tarred oakum well into joint and pour in molten lead continuously around joint, using at least 1.4 kg of lead per 100 mm of pipe diameter.
3. Furnish sufficient lubricant to provide a thin coat on each spigot end.
4. Use lubricant that is non-toxic, imparts no taste or odor to conveyed liquid, and has no deleterious effect on rubber gasket, with consistency so that it can be easily applied to pipe in hot or cold weather and will adhere to either wet or dry pipe.

C. Threaded joints:
1. Clean cut, American National taper pipe threads.
2. Ream pipe ends to full pipe size and remove burrs, chips, cuttings before making up.
3. Pipe joint cement permitted on male threads only.

3.10 COPPER PIPING

A. Brazed (high temperature soldered) joints:
1. Take care to avoid annealing of pipe material.
2. For pipe sizes DN50 and larger: Use a circular torch such as Circa Torch by Cedarberg Industries, Inc., for soldering joints.

B. Use lead-free solder.

C. T-drilling:
1. Tapped pipe shall be least DN25 diameter and branch shall be at least 2 pipe sizes smaller.
2. Braze (high-temperature solder) joints.
3. Branch pipe shall not protrude into main.

3.11 CORROSION RESISTANT PIPING

A. Install in accordance with manufacturer's recommendations and instructions.

3.12 POLYETHYLENE TUBING

A. Hydronic heat tubing shall be installed in accordance with the manufacturer's recommendations and as indicated.

B. All fittings shall be accessible for maintenance. Tubing shall be installed without splices from the point where it enters the slab to the point where it exits the slab.

C. Installation shall follow the drawings for tubing layout, tube spacing, manifold configuration, manifold location, and controls. All notes on the drawings shall be followed.

D. The tubing system shall be pressurized with water or air, in accordance with applicable codes, to a pressure of 400 kPa 24 hours prior to encasement in the concrete slab. The tubing system shall remain at this pressure during the pour and for 24 hours thereafter to ensure system integrity.

3.13 RUBBER HOSE

A. Install for vibration isolation as indicated.

END OF SECTION

SECTION 15100

MANUAL VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definitions:
1. Class: ANSI Class.
2. SWP: Steam Working Pressure.
3. WOG: Water/Oil/Gas non-shock working pressure.
4. WWP: Cold water non-shock working pressure.

1.02 QUALITY ASSURANCE

A. Fire protection valves: UL listed, NFPA and FM approved.

B. Valves used in flammable liquid or flammable gas systems: UL listed for applicable service.

C. Valves cleaned for oxygen service: CGA Pamphlet G-4.1, Cleaning Equipment for Oxygen Service.

D. Valve bodies, shells and seats: Designed, manufactured, and tested in accordance with the following:
1. Ball valves: Federal Specification WW-V-35.
2. Pressure testing of steel valves: MSS SP-61.
3. Butterfly valves: MSS SP-67.
4. Butterfly valves, bronze: Federal Specification WW-V-1967.
5. Cast iron gate valves, flanged and threaded ends: MSS SP-70.
6. Cast iron swing check valves, flanged and threaded ends: MSS SP-71.
7. Cast iron plug valves, flanged and threaded ends: MSS SP-78.
8. Bronze gate, globe, angle and check valves: MSS SP-80.
9. Valve pressure testing methods: MSS SP-82.
10. Cast iron globe and angle valves, flanged and threaded ends: MSS SP-85.
11. Diaphragm type valves: MSS SP-88.
12. Resilient seated eccentric cast iron plug valves: MSS SP-108.
13. Ball valves--threaded, socket-welding, solder joint, grooved, and flared ends: MSS SP-110.

E. Standard for pressure containing parts of valves rated for 870 kPa SWP and 1035 kPa SWP: ASTM-B62.

F. Standard for metallic seats in valves rated at 1380 kPa SWP and 2070 kPa SWP: ASTM-B61.

G. Iron body valves:
1. Pressure containing parts: ASTM-A126, Grade-B.
2. Face to face and end to end dimensions: ANSI/ASME-B16.10.

H. Valve stems: ASTM-B371, Alloy C69400; ASTM-B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

I. Pressure castings: Free of impregnating materials.

J. Indicate following information on valves:
1. Stamped or cast into body:
a. Manufacturer's name or trademark.
b. Pressure rating as Class, SWP, WOG, or WWP.
c. "UL-FM" for UL-FM valves.

1.03 SUBMITTALS

A. Product data: Not required for COTR review except as follows:
1. Valves, include with submittals for each specification section where required.
a. Submittal shall include the following:
(1) For submittals with model numbers not listed in this section, include published cross reference sheet. Indicate association between submitted model number and the listed model number on the cross reference sheet.
(2) For each valve submitted indicate in which system(s) the valve will be used.
b. When valve assembly includes components other than the base valve body and handle (e.g., operator, valve box), include data on entire valve assembly.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Angle valves:
a. Base:
(1) Nibco.
(2) Stockham Valves & Fittings.
b. Optional:
(1) Crane Valves.
(2) Grinnell.

(3) Hammond Valve.
(4) Jenkins Valves.
(5) Lunken.
(6) Milwaukee Valve.
(7) Powell.
(8) Walworth.

2. Ball valves:
   a. Base:
      (1) Milwaukee Valve.
      (2) Nibco.
   b. Optional:
      (1) Apollo.
      (2) Chemtrol.
      (3) Crane Valves.
      (4) Grinnell.
      (5) Hammond Valve.
      (6) Neles Jamesbury.
      (7) Jenkins Valves.
      (8) Jomar Intl.
      (9) Lance Valves.
      (10) Ohio.
      (11) Pittsburgh.
      (12) Powell.
      (13) Puritan.
      (14) Stockham Valves & Fittings.
3. Butterfly valves:
   a. Base:
      (1) DeZurik.
      (2) Campbell Foundry.
      (3) Milwaukee Valve.
      (4) Stockham Valves & Fittings.
      (5) Victaulic of America.
   b. Optional:
      (1) CenterLine Inds.
      (2) Crane Valves.
      (3) Grinnell.
      (4) Hammond Valve.
      (5) Jenkins Valves.
      (6) Keystone Valve.
      (7) Lunken.
      (8) Mueller Steam Specialty.
      (9) Nibco.
      (10) Powell.
      (11) Universal Valve.
      (12) Walworth.
4. Check valves:
   a. Base:
      (1) Apco Valve & Primer.
      (2) Nibco.
      (3) Stockham Valves & Fittings.
   b. Optional:

(1) Crane Valves.
(2) Grinnell.
(3) Hammond Valve.
(4) Jenkins Valves.
(5) Kennedy Valve.
(6) Lunken.
(7) Marlin Valve.
(8) Milwaukee Valve.
(9) Mission.
(10) Mueller Steam Specialty.
(11) Powell.
(12) Victaulic of America.
(13) Viking.
(14) Walworth.
(15) Waterous.

5. Diaphragm valves:
   a. Base:
      (1) Engineered Valves, ITT.
   b. Optional:
      (1) Barnsted.
      (2) Saunders Valve.
6. Gate Valves:
   a. Base:
      (1) Mueller Steam Specialty.
      (2) Nibco.
      (3) Stockham Valves & Fittings.
   b. Optional:
      (1) Crane Valves.
      (2) Grinnell.
      (3) Hammond Valve.
      (4) Jenkins Valves.
      (5) Kennedy Valve.
      (6) Lunken.
      (7) Milwaukee Valve.
      (8) Mueller Steam Specialty.
      (9) Powell.
      (10) Walworth.
      (11) Waterous.
7. Globe valves:
   a. Base:
      (1) Stockham Valves & Fittings.
   b. Optional:
      (1) Crane Valves.
      (2) Grinnell.
      (3) Hammond Valve.
      (4) Jenkins Valves.
      (5) Lunken.
      (6) Milwaukee Valve.
      (7) Nibco.
      (8) Powell.
      (9) Walworth.

8. Plug valves:
    a. Base:
        (1) DeZurik.
        (2) Resun Valves.
    b. Optional:
        (1) Lunken.
        (2) Milliken.
        (3) Rockwell International.
        (4) Victaulic of America.
9. Valve boxes and stop boxes:
    a. Base:
        (1) Tyler Pipe.
        (2) Western.
    b. Optional:
        (1) Neenah Foundry.
        (2) Vulcan.
        (3) Local foundry.
10. Other manufacturers desiring approval comply with Section 01640.

B. Ball valves:
1. Full-port chrome-plated or stainless-steel ball.
    a. DN65 and DN80 valves may be standard port.
2. Blow-out proof stems.
3. Reinforced Teflon seats.
4. Teflon seals.
5. Adjustable packing.
6. 3-piece valves:
    a. May be standard port.
    b. Repairable in line.

C. Butterfly valves:
1. Ninety degree operation.
2. Bi-directional, bubble-tight shut off at full pressure rating (at full differential pressure).
3. 50 mm extended neck.
4. Lugs, where specified, shall be drilled and tapped.
5. Operators:
    a. DN65 to DN100: Position lock handle.
    b. DN125 and larger: gear operator with 4-arm or wheel handle.
6. Blow-out proof stem.
7. Viton seals.
8. Pressure rating: 1205 kPa WWP, 2415 kPa WOG.

D. Chain operators:
1. Provide operators for valves located in mechanical spaces 2440 mm or higher above floor.
2. Chain lever or chain sprocket operator with sufficient chain to reach within 1525 mm of floor.
3. Remote operator accessories by same manufacturer as

valve.
4. Do not provide for Fire Protection valves.

E. Diaphragm valves:
1. Working parts of valve shall be isolated from process fluid.
2. Valve shall be constructed to allow neither accumulation nor stagnation of process fluids within valve.
3. Valve shall have tight shut off.
4. Diaphragm shall be positively supported in every position.

F. End styles, general:
1. Compatible with piping systems served.
2. Flanged valves:
a. Class 125 cast iron: Flat flanges.
b. Class 250 cast iron: Raised flanges.
c. Ductile iron: Raised flanges.
3. Valves with solder ends for use in brazed piping systems shall be constructed for brazing.

G. Extended necks and stems:
1. For valves specified with extended necks or stems, provide design that isolates moving valve parts from insulation.
2. For valves specified with extended necks or stems and memory stops, provide design that allows access to memory stop without disturbing insulation.

H. Packing shall not contain asbestos.

I. Plug valves:
1. Eccentric plugs:
a. Non-lubricated valves with resilient seats shall be suitable for 122 degC service.
b. Rubber seated eccentric plugs: Bolted stem seals shall permit replacement of packing without removing valve from line or removing parts other than operator.

2.02 VALVES

A. General:
1. Example model numbers may indicate a general series, or may be abbreviated. They may not reflect all features described. Provide valves with described features.
2. Specified requirements are minimums. Valves that meet or exceed specifications may be submitted.

B. V-1: Gate valve, Class 125, bronze body, screwed bonnet, non-rising stem, solid wedge disc, solder. Example: Stockham B-112.

C. V-2: Gate valve, Class 150, bronze body, union bonnet, rising stem, solid wedge disc, threaded. Example: Stockham B-120.

D. V-3: Gate valve, Class 125, cast iron body, bronze trim, bolted bonnet, rising stem, OS&Y, solid wedge disc, flanged. Example: Stockham G-623.

E. V-4: Gate valve, same as V-2 except Class 200. Example: Stockham B-135.

F. V-5: Gate valve, same as V-3 except Class 250. Example: Stockham F-667.

G. V-6: Globe valve, Class 150, bronze body, union bonnet, renewable Teflon disc, solder. Example: Stockham B-24T.

H. V-7: Globe valve, same as V-6 except threaded. Example: Stockham B-22T.

I. V-8: Globe valve, Class 125, cast iron body, bronze trim, bolted bonnet, OS&Y, renewable seat and bronze disc, flanged. Example: Stockham G-512.

J. V-9: Globe valve, Class 200, bronze body, union bonnet, renewable plug type seat and disc, threaded. Example: Stockham B-62.

K. V-10: Globe valve, same as V-8 except Class 250. Example: Stockham F-532.

L. V-11: Ball valve, 1035 kPa SWP, 2760 kPa WOG bronze body, adjustable memory stop, 3-piece construction, extended stem, solder. Example: Milwaukee BA-350.

M. V-12: Ball valve, same as V-11 except threaded. Example: Milwaukee BA-300.

N. V-13: Ball valve, 1035 kPa SWP, 2760 kPa WOG bronze body, 2-piece construction, extended brass stem, solder. Example: Nibco S-585.

O. V-14: Ball valve, same as V-13 except threaded. Example: Nibco T-585.

P. V-15: Ball valve, 1035 kPa SWP, 2760 kPa WOG, 735 mm Hg vacuum service, bronze body, 3-piece construction, cleaned

and capped for oxygen service, lockable in either the open or closed position, color coded handle to match gas service, braze. Example: Milwaukee 30BS.

Q. V-16: Ball valve, 1035 kPa SWP, 4140 kPa WOG, 1720 kPa UL listed for flammable liquids and LP gas, bronze body, 2-piece construction, full or standard port, bronze ball, non-lubricated, threaded. Example: Nibco T-580-70-UL & T-585-70-UL.

R. V-17: Angle valve, Class 125, bronze body, screwed bonnet, bronze disc, threaded. Example: Stockham B-216.

S. V-18: Angle valve, Class 125, cast iron body, bolted bonnet, bronze trim, renewable seat and disc, flanged. Example: Nibco F-818-B.

T. V-19: Angle valve, Class 200, bronze body, union bonnet, bronze disc, threaded. Example: Stockham B-237.

U. V-20: Angle valve, Class 250, cast iron body, bronze trim, flanged. Example: Stockham F-541.

V. V-21: Angle valve, automatic stop-check, Class 250, cast iron body, bolted bonnet, renewable disc and seat, flanged. Example: Stockham F-541.

W. V-22: Check valve, in-line pattern, spring-operated double doors, Class 250, cast iron body, renewable bronze doors and Viton-A seal, Inconel springs, stainless steel trim, flat faced wafer. Example: Stockham WG-976.

X. V-23: Check valve, Y-pattern, horizontal swing, Class 150, bronze body, threaded cap, renewable Teflon disc and seat, threaded. Example: Nibco T-433-Y.

Y. V-24: Check valve, Y-pattern, horizontal swing, Class 125, bronze body, threaded cap, renewable bronze disc and seat, solder. Example: Nibco S-413-B.

Z. V-25: Check valve, same as V-23 except Class 125. Example: Nibco T-413-Y.

AA. V-26: Check valve, in-line pattern, spring-operated disc, Class 125, bronze body, renewable Teflon disc and seat, 316 stainless-steel spring, threaded. Example: Nibco T-480-Y.

BB. V-27: Check valve, T-pattern, horizontal lift, Class 150, bronze body, union bonnet, renewable Teflon disc and seat, threaded. Example: Stockham B-322-T.

CC. V-28: Check valve, T-pattern, horizontal swing, Class 125, cast iron body, bolted bonnet, bronze trim, renewable bronze or cast iron disc and seat, flanged. Example: Stockham G-931.

DD. V-29: Check valve, in-line pattern, spring-operated double doors, Class 125 (cast iron body) or Class 150 (steel body), Buna-N or EPDM seal, aluminum bronze or stainless steel doors, 316 stainless steel spring; grooved, threaded, flanged, wafer, or lugged at locations other than equipment; grooved, flanged or lugged if between equipment and its isolation valve. Example: APCO L9000.

EE. V-30: Check valve, silent, in-line pattern, spring-operated disc, Class 125, cast iron body, renewable bronze disc and seat, stainless steel spring, flat faced wafer. Example: Nibco W-910-B.

FF. V-31: Check valve, same as V-23 except Class 200. Example: Nibco T-473-Y.

GG. V-32: Check valve, same as V-28 except Class 250. Example: Stockham F-947.

HH. V-33: Butterfly valve, 1400 kPa WWP; 10 kPa vacuum; cast or ductile iron body; EPT (EPDM) sleeve; stainless steel stem; aluminum-bronze or stainless steel disc; lugged body. Example: Stockham L#-7#2.

II. V-34: Butterfly valve, same as V-33 except wafer body. Example: Stockham L#-5#2.

JJ. V-35: Butterfly valve, 1400 kPa WWP for DN300 and smaller, 1200 kPa WWP for DN350 and larger; 10 kPa vacuum for all sizes; cast or ductile iron body; EPT (EPDM) seat; stainless steel stem; replaceable forged brass, aluminum-bronze, stainless steel, or EPDM coated ductile iron disc; grooved. Example: Victaulic 300/709.

KK. V-36: Eccentric plug valve, 1205 kPa WOG, cast-iron body, bronze or nickel-plated cast-iron plug, Isobutene-Isoprene steam and plug seals, high-temperature plug face, capped drip tap on seat end of valve, memory stop, lever handle, threaded. Example: DeZurik 499S.

LL. V-37: Eccentric plug valve, 1205 kPa WWP for DN300 and smaller, 1035 kPa WWP for DN350 and larger, cast-iron body, Viton filled TFE U-ring seal, Isobutene-Isoprene plug face, memory stop; lever handle for sizes DN65 to

DN100; gear operator with handwheel actuator for sizes DN150 and larger; flanged. Example: DeZurik 118F.

MM. V-38: Eccentric plug valve, same as V-36 except flanged, or grooved. Example: DeZurik 499.

NN. V-39: Ball valve, same as V-13 and V-14 except include adjustable memory stop. Example: Nibco S-585-70.

OO. V-40: Butterfly valve, 1400 kPa WWP, bronze body, adjustable memory stop with visual disc position range of 90 degrees, stainless steel disc and stem, Viton seal, threaded. Example: Milwaukee BB2-100.

PP. V-41: Plug valve, lubricated, 1400 kPa WOG, semi-steel, bottom or bolted-top entry, UL listed for application, lubricant compatible with application, short pattern flanged. Example: Resun R-1431.

QQ. V-42: Not used.

RR. V-43: Diaphragm valve, weir style; unlined, 316 stainless steel body; 1000 kPa at 50 degC for DN100 and smaller, 860 kPa at 50 degC for DN150; 690 kPa at 50 degC for DN200; 450 kPa at 50 degC for DN250 and larger; FDA PTFE diaphragm; Stainless steel bonnet with indicating travel stop; handwheel operated; threaded for DN50 and smaller, flanged for DN65 and larger. Examples: ITT 2403 and 2433.

SS. V-44: Diaphragm valve, weir style; solid PVC body; 1035 kPa at 27 degC; FDA butyl rubber diaphragm; solvent weld socket. Example: ITT 2451.

TT. V-45, Gate valve with stop box:
1. Gate valve, inverted key, integral drain, DN20 to DN25, threaded. Example Mueller H-15210.
2. Stop box, coated cast-iron, adjustable, cast-in marking indicating service. Example: Western 100.

UU. V-46, Gate valve with stop box:
1. Gate valve, curb stop, integral drain, DN40 to DN50 , threaded. Example: Mueller 15214.
2. Stop box, coated cast-iron, adjustable, cast-in marking indicating service. Example: Western 100.

VV. V-47, Gate valve with valve box:
1. Gate valve, AWWA-C500, 1400 kPa WWP for DN300 and smaller, 1035 kPa for DN350 and larger, iron body, bronze mounted, bronze or cast-iron double disc, non-rising stem, parallel seat, mechanical joint.

Example: Stockham G-743.

2. Valve box: coated cast-iron, 135 mm shaft, screw type, 3-piece, drop-in lid with cast-in marking indicating service. Example: Tyler 6860.

WW. V-48, Butterfly valve with valve box:

1. Butterfly valve, AWWA-C504, Class 150, iron body, stainless steel seat, aluminum-bronze or cast iron disc, natural rubber or Buna-N seat, mechanical joint or flanged. Example: DeZurik BAW.
2. Valve box: coated cast-iron, 135 mm shaft, screw type, 3-piece, drop-in lid with cast-in marking indicating service. Example: Tyler 6860.

XX. V-49: Gate valve, UL-FM, 1205 kPa WWP, bronze body, union or screwed bonnet, solid wedge disc, OS&Y, threaded. Example: Nibco T-104-O.

YY. V-50: Gate valve, UL-FM, 1205 kPa WWP, cast iron body, bolted bonnet, resilient or solid wedge, OS&Y, flanged. Example: Stockham G-634.

ZZ. V-51: Butterfly valve, UL-FM, 1205 kPa WWP, ductile iron body, O-Ring seals, aluminum-bronze or ductile-iron disc, stainless steel stem, Buna-N seal, manual geared operator with visual position indicator, lugged. Example: Stockham LD-72UF.

Aa. V-52: Gate valve, UL-FM, AWWA C-509, 1205 kPa WWP, cast iron body, resilient wedge, non-rise stem, indicator post flange, MJ or flanged. Example: Stockham G-600/601/602.

Bb. V-53: Check valve, T-pattern, horizontal swing, UL-FM, 1205 kPa WWP, cast iron body, bolted bonnet, bronze trim, renewable bronze or cast-iron disc and seat, flanged. Example: Stockham G-939.

Cc. V-54: Check valve, in-line, spring-operated single or double door(s), UL-FM, 1380 kPa WWP, cast iron body, renewable bronze door and rubber or EPDM seat, stainless steel spring, wafer or grooved. Example: Stockham WG-990.

Dd. V-55: Butterfly valve, UL listed, 1205 kPa WWP, bronze body, stainless steel stem and disc, Viton seal, threaded. Example: Milwaukee BB2-100.

Ee. V-56: Butterfly valve, same as V-40 except include extended neck, solder. Example: Milwaukee BB2-350.

Ff. V-57: Butterfly valve, same as V-40 except include

extended neck, threaded. Example: Milwaukee BB2-100.

Gg. V-58: Not used.

Hh. V-59: Butterfly valve, same as V-55 with tamper switch. Example: Milwaukee BB2-100.

Ii. V-60: Plug valve, lubricated, 870 kPa WOG semi-steel, bottom or bolted-top entry, UL listed for application, lubricant compatible with application, threaded. Example: Resun R-1430.

Jj. V-61: Butterfly valve, UL-FM, 1205 kPa WWP, coated cast or ductile iron body, aluminum bronze or ductile iron disk with EPDM coating, manual geared operator with visual position indicator, grooved. Example: Victaulic 708.

Kk. V-62: Butterfly valve, 2070 kPa WOG, 10 kPa vacuum, bronze body, ductile iron disk with EPDM coating, extended neck, grooved. Example: Victaulic 600.

Ll. V-63: Butterfly valve, Class 150, carbon steel body, RTFE seat, stainless steel shaft, stainless steel disc, TFE packing, wafer. Example: Campbell 1W.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to individual sections for specific valve installation requirements.

B. Keep valves clear of pull spaces.

C. Install valves in accessible locations for operation, removal, inspection, and repair of valves and equipment.

D. Install gate and globe valves with stem in vertical upright to horizontal position.

E. Install butterfly valves with stem in horizontal position.

F. Install diaphragm valves to be self draining.

G. Support valves individually to relieve pipe stress and allow equipment removal.

H. Follow manufacturer's recommendation for disassembly of valves for end joining method employed.

I. Provide shut off valve on each side of control valve. Coordinate with Controls Contractor.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of system:
    1. Products:
        a. Expansion joints.
        b. Pressure gauges.
        c. System drains.
        d. Thermometer wells and test gauge connections.
        e. Thermometers.
        f. Wye strainers for steam and hydronic systems.

1.02 QUALITY ASSURANCE

A. Comply with UL, ANSI or ASTM Standards.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
    1. Expansion joints.
    2. Pressure gauges.
    3. Thermometers.
    4. Wye strainers.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
    1. Operating and maintenance data.
    2. Warranty.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
    1. Expansion joints, bellows type:
        a. Base:
            (1) Flexonics.
        b. Optional:
            (1) ATS.
            (2) American BOA, Inc.
            (3) Barco.

(4) Keflex.
(5) Tempflex Division of Johnson Controls.
(6) Yarway.

2. Pressure gauges:
   a. Base:
      (1) Ashcroft.
   b. Optional:
      (1) H O Trerice Co.
      (2) Marsh Instrument Co.
      (3) Weiss Instruments.
      (4) Weksler Instruments Corp.
3. Thermometers:
   a. Base:
      (1) H O Trerice Co.
   b. Optional:
      (1) Marsh Instrument Co.
      (2) Marshalltown Instrument Inc.
      (3) Palmer Instruments.
      (4) Taylor Scientific Instruments.
      (5) Weiss Instruments.
      (6) Weksler Instruments Corp.
4. Wye strainers:
   a. Base:
      (1) Armstrong.
   b. Optional:
      (1) Gustin-Bacon.
      (2) ITT Hoffman.
      (3) O C Keckley.
      (4) Metraflex.
      (5) Mueller Steam Specialty.
      (6) Spence.
      (7) Spirax Sarco, Inc.
      (8) Victaulic.
5. Other manufacturers desiring approval comply with Section 01640.

2.02 EXPANSION JOINTS

A. Expansion joints, bellows type:
   1. Suitable for 1040 kPa working pressure and 200 degC maximum temperature.
   2. In DN65 and smaller lines:
      a. Expansion-compensator type with external shrouds.
      b. Bellows: Stainless steel.
      c. Shrouds and end fittings: Carbon steel or bronze (compatible with system piping material).
   3. In DN75 and larger lines:
      a. Controlled-flexing type with neck and control rings.
      b. Bellows: Stainless steel.
      c. Flanges: Steel.

d. Control rings: Nickel iron.

2.03 PRESSURE GAUGES

A. Pressure gauges:
1. 110 mm dial, surface or flush type, white face, black numerals, black pointers, bronze bourdon tubes and shatterproof glass.
2. Pressure gauge range schedule:

		Range kPa	Interval kPa	Inter. Graduations kPa
Chilled Water (Site)	CWS	0-1000	200	20
Chilled Water Bldg Primary	CWS	0-1000	200	20
Chilled Water Secondary	SCWS	0-600	50	5
Process Cooling Water	PCWS	0-600	50	5
Low Temp Glycol Water (P25)	LTGWS	0-600	50	5
Cooling Tower Water	CTS	0-250	20	2
Cooling Tower Water Pump Suction	CTS	-100-150	20	2
Chiller Heat Recovery Water	CHRWS	0-600	50	5
Heating Hot Water	HWS	0-600	50	5
High Temp Glycol Water (P40)	GWS	0-600	50	5
High Pressure Steam	HPS	0-1600	200	20
Medium Pressure Steam	MPS	0-1000	200	20
Low Pressure Steam	LPS	0-160	20	2
Clean Steam	CLPS	0-160	20	2
Pumped Steam Condensate	CPD	0-600	50	5
Domestic/Laboratory Hot Water	HW/LHW	0-1000	50	10
Domestic/Laboratory Cold Water	CW/LCW	0-1000	50	10
Laboratory Slab Conditioning Water System	LSWS	0-400	50	5

3. High and medium pressure steam: Ashcroft 1010 with 1100 pigtail siphon; 7000 series shutoff valve.
4. Low pressure steam: Ashcroft 1010 with 1092 gauge cock.
5. Water: Ashcroft 1010 with 1092 gauge cock and 1106 pulsation dampener.
6. Clean steam shall have stainless steel siphon and shutoff valve.
7. Low temperature glycol water: Ashcroft 1010 with 1092 gauge cock, 1106 pulsation dampener, and 1100 pigtail siphon.

B. Differential pressure gauges:

1. 100 mm dial, surface or flush type, whiteface, black numerals, black pointers, brass body, teflon seals, shatterproof glass.
2. Piston sensor.
3. +/-2-1/2 percent accurate over entire range.
4. Select range such that operating point is approximately 50 percent of full range.
5. Provide with Ashcroft 1092 gauge cock and 1106 pulsation damper.

2.04 SYSTEM DRAINS

A. Valved drains (nonpotable water):
   1. Piping DN50 and smaller:
      a. DN15 V-13 with male hose-thread outlet and brass cap.
      b. Hose bibb with male hose-thread outlet and brass cap.
   2. Piping DN65 and larger:
      a. DN40 V-13 or V-14 ball valve with DN40 fire hose adapter and cap.

B. Un-valved drains (potable and nonpotable water):
   1. Minimum 150 mm long nipple with male NPT outlet and brass cap.

C. On nonpotable systems, label system drains as nonpotable.

2.05 THERMOMETER WELLS (SOCKETS) AND TEST GAUGE CONNECTIONS

A. Temperature sensing wells (sockets) and test gauge connections:
   1. Brass or stainless steel.
   2. Provide extension necks for insulated piping.

2.06 THERMOMETERS

A. Thermometers: Industrial type, with separable brass sockets, red reading mercury with 225 mm scale minimum, black lines and numbers, right or left side angle type and shatterproof glass or acrylic plastic window.

B. Thermometers range schedule:

		Range degC	Division
Chilled Water (Site)	CWS	-15-50	1
Chilled Water Building Primary	CWS	-15-50	1
Chilled Water Secondary	SCWS	-15-50	1
Process Cooling Water	PCWS	-15-50	1
Low Temp Glycol Water (P25)	LTGWS	-15-50	1
Cooling Tower Water	CTS	-15-50	1
Chiller Heat Recovery Water	CHRWS	-15-50	1
Heating Hot Water	HWS	0-115	1
High Temp Glycol Water (P40)	GWS	0-115	1
Domestic/Laboratory Hot Water	HW/LHW	0-82	1
Domestic/Laboratory Cold Water	CW/LCW	0-82	1
Laboratory Slab Conditioning Water System	LSWS	0-115	1

C. Low temperature glycol water thermometer to be remote mounted with 450 mm bendable extension.

2.07 WYE STRAINERS FOR STEAM AND HYDRONIC SYSTEMS

A. Wye strainers.
   1. Screwed or flanged.
   2. Body:
      a. DN50 and smaller:
         (1) Brass, screwed ends.
      b. DN65 and larger:
         (1) Cast iron, flanged ends.
         (2) Coating: Rust inhibiting.
      c. Clean steam system, all sizes:
         (1) 304 stainless steel body.
   3. Working pressure, non shock: 1040 kPa.
   4. Screens:
      a. Water: Bronze, monel or stainless steel.
         (1) DN50 and less: 1.2 mm perforations.
         (2) DN65 and larger: 3.2 mm perforations.
      b. Steam: Stainless steel or brass.
         (1) 1.2 mm perforations.

PART 3 - EXECUTION

3.01 GENERAL

A. Install piping specialties according to manufacturer instructions and as specified.

3.02 EXPANSION JOINTS

A. Expansion joints in hot water and steam piping, bellows type:
   1. Suitable for 1040 kPa working pressure and 200 degC maximum temperature.
   2. Provide pipe guides at 4 and 14 pipe diameters from each expansion joint.
   3. Install pipe guides in accordance with Expansion Joint Manufacturers Association Standard.
   4. Size in accordance with manufacturer's recommendation, with 30 percent excess traverse available at maximum expansion.
   5. Axial traverse shall include 30 percent excess.

3.03 PRESSURE GAUGES

A. Provide filter type pressure snubbers at pumps and chillers.

B. Provide syphons on steam gauges.

C. Provide brass tee handle cock and DN8 hard tempered tubing from gauge to pipe connection.

D. Provide additional brass tee handle cock at gauge for panel mounted gauge.

E. Calibrate and zero gauges at job site.

3.04 SYSTEM DRAINS

A. At low points of piping systems, provide valved drains to allow complete drainage of each system.

B. Neither terminate nor run drains over electrical equipment.

3.05 THERMOMETER WELLS AND TEST GAUGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

B. Placement and sizing:
   1. For DN100 piping and larger, place tee in piping to create perpendicular flow-to-stem measurement.
      a. Size stem length based on pipe size as indicated below:

(1) DN100 and DN125 pipe: 90 mm stem.
(2) DN150 and DN200 pipe: 150 mm stem.
(3) DN250 and DN300 pipe: 230 mm stem.
(4) DN350 pipe and larger: 300 mm stem.

2. For piping smaller than DN100, place oversize piping well and tee in 90-degree piping turn to create parallel flow-to-stem measurement.
   a. Stem length: 300 mm.
   b. Piping well length: 350 mm.
   c. Size piping well and tee based on pipe size as indicated below:
      (1) DN15 and DN20 pipe: DN32 well and tee.
      (2) DN25 pipe: DN40 well and tee.
      (3) DN32 and DN40 pipe: DN50 well and tee.
      (4) DN50 pipe: DN65 well and tee.
      (5) DN65 and DN75 pipe: DN100 well and tee.

C. Provide test gauge connection adjacent to each point where a pressure sensor is required by control specifications or where piping schematics indicate pressure gauges.

3.06 THERMOMETERS

A. Provide at inlet and outlet of each heat exchanger and each chiller and where indicated on drawings.

3.07 WYE STRAINERS

A. Provide wye strainers as indicated in piping-system specification sections.

B. Connections to suit piping system.

C. Provide blow-down valves:
   1. Strainers DN150 and larger: DN40 blow-down valve.
      a. Pipe blow down to drain.
   2. Strainers DN50 to DN125: DN25 blow-down valve with DN20 hose end connection and brass cap.
   3. Strainers DN40 and smaller: DN15 blow-down valve with DN20 hose end connection and brass cap.

END OF SECTION

SECTION 15140

SUPPORTS, ANCHORS, GUIDES, AND SLEEVES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definitions:
1. Rated: Fire or fire/smoke rated.
2. Industrial strength glue: Minimum peel strength of 400 kN per 100 mm width.
3. Metallic piping: Steel, iron, and copper piping.

1.02 QUALITY ASSURANCE

A. Standards for pipe supports:
1. ASME/ANSI B31.1.
2. Manufacturers Standardization Society (MSS) SP-58, SP-89 and SP-69.

B. Performance standards for sleeve assemblies at rated penetrations: Listed under ASTM E814 (ANSI/UL1479) by UL.

1.03 SUBMITTALS

A. Shop drawings:
1. For pipe DN200 and larger, indicate layout of support, anchor, and guide locations and method of attachment to structure.
2. Service galley piping trapeze hanger arrangement.

B. Product data:
1. Supports for copper piping.
2. Pre-insulated pipe supports, pipe-support inserts, pipe anchors, and pipe guides.
a. Model numbers.
b. Materials of construction.
c. Load ratings (kN).
3. Manufacturer's UL-classified piping-penetration installation details.
a. Penetrations at rated walls, partitions and floors.
b. Obtain approval from NIST Fire and Safety Authorities.

C. Samples: Insulation shields, one of each type.

D. Project information:
1. Provide prototypical installation of each fire rated penetration assembly as part of the work or as

mock-up.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Post-pour concrete inserts:
a. Base:
(1) Hilti.
b. Optional:
(1) Phillips Drill Co.
2. Pre-pour concrete inserts:
a. Base:
(1) B-Line Systems, Inc.
b. Optional:
(1) Grinnel Corp.
3. C-clamps, beam clamps, and pipe supports:
a. Base:
(1) B-Line Systems, Inc.
b. Optional:
(1) Carpenter and Paterson, Inc.
(2) Grinnel Corp.
(3) PHD Manufacturing, Inc.
4. Universal channel framing system for pipe and ductwork:
a. Base:
(1) Unistrut.
b. Optional:
(1) B-Line Systems, Inc.
(2) Grinnel Corp.
5. Pre-insulated pipe anchors, pipe guides, pipe supports, and pipe-support inserts:
a. Base:
(1) Pipe Shields, Inc.
b. Optional:
(1) Power Piping.
(2) B-Line Systems, Inc.
(3) Rilco Manufacturing Company, Inc.
6. Spider-type pipe guides:
a. Base:
(1) B-Line Systems, Inc.
b. Optional:
(1) Grinnel Corp.
7. Insulation protection devices:
a. Base:
(1) B-Line Systems, Inc.

b. Optional:
(1) Carpenter and Paterson, Inc.
(2) Grinnell Corp.
(3) PHD Manufacturing, Inc.
(4) Shop Fabricated.

8. Factory-fabricated pipe supports at plumbing fixtures:
a. Base:
(1) Sioux Chief.
b. Optional:
(1) B-Line Systems, Inc.
(2) Sumner.

9. Sleeve assemblies, premanufactured:
a. Base:
(1) Pipe Shields, Inc.
b. Optional:
(1) CSD.
(2) Hilti.
(3) Proset Systems.

10. Sleeves:
a. Base:
(1) Shop or field fabricated.
b. Optional:
(1) Shamrock Industries.
(2) Proset Systems.

11. Firestopping and sealants:
a. Base:
(1) 3M Co.
b. Optional:
(1) Nelson.
(2) General Electric.
(3) Pipe Shields, Inc.
(4) International Protective Coatings, Flamesafe.
(5) Flammadur Corporation of America.
(6) Proset Systems, Inc.

12. Synthetic-rubber seals:
a. Base:
(1) Thunderline Corporation, "Link Seal".
b. Optional:
(1) Calpico, Inc.

13. Other manufacturers desiring approval comply with Section 01640.

2.02 ATTACHMENTS TO STRUCTURE

A. Attachments to structure:
1. Welded steel brackets for attaching bare and insulated piping supports, anchors, and guides to vertical structure:
a. MSS SP-69 Type 31, 32, or 33: Appropriate for loading condition.
2. Attachments to concrete structure: Concrete inserts.

a. Pre-pour concrete inserts:
(1) Provide concrete inserts in time for installation with concrete placement.
(2) Provide individual or continuous slot concrete inserts for use with supports for piping and equipment exposed in labs and as required.
(3) Individual inserts: Grinnel Figure 282, 281.
(4) Continuous slot inserts: B-Line Figure B22I, B32I, B42I, B52I.
b. Post-pour concrete inserts:
(1) Hard-metal, self-drilling wedging anchors tapped for threaded rods and designed not to depend on lead or wood for their holding power.

3. Attachments to structural steel:
a. Pipe size DN75 and smaller:
(1) Steel C-clamp with lock nut: MSS SP-69 Types 19 or 23.
b. Pipe size larger than DN75:
(1) Malleable-iron beam clamp: MSS SP-69 Types 28 or 30.
(2) Steel beam clamp: B-Line B3055.

4. Strap iron attachments are not acceptable.

2.03 UNIVERSAL CHANNEL FRAMING SYSTEM FOR PIPE AND DUCTWORK

A. Universal channel framing system for pipe and ductwork:
1. Factory-fabricated modular components.
2. Channel strut: Pre-galvanized steel (ASTM A525).
3. Struts, hardware, fittings, angles, gussets, knee braces, supports, bases, end caps, and other required components shall be modularly designed as a coherent system.

2.04 PIPE ANCHORS

A. Pipe anchors:
1. Prevent pipe movement in all directions.
2. Bare piping: Shop, field, or factory fabricated anchors.
a. Welded tees.
b. Friction clamps with angle iron and rods with turnbuckles.
(1) Friction clamps: MSS SP-69 Type 42 (4-bolt style).

3. Insulated piping: Pre-insulated pipe anchors (friction clamp type).
a. General:
(1) Catalogued load rating: Based on Pipe Shields C3000 Series.

b. Non load-bearing insulation:
(1) Fully enclose entire pipe circumference with 700 kPa, waterproofed calcium silicate.
(2) Thickness: Same as adjoining pipe insulation.
(3) Length: Same as insulation shield except extend insert 25 mm beyond shields on cold systems.
c. Load-bearing insulation insert:
(1) Fully enclose entire pipe circumference with 4100 kPa waterproofed calcium silicate.
(2) Thickness: Same as non load-bearing insulation insert.
(3) Length: Same as friction clamp width.
d. Insulation shield:
(1) Fully encase insulation with 360 degree, overlapping galvanized sheet-metal shield.
(2) Secure shield to insulations with industrial strength glue.
(3) Nominal length: 230 mm.
e. Clamp:
(1) Primed ASTM A-36 Carbon Steel.
(2) Bolt pattern: 2-bolt, like MSS SP-69 Type 8.
(3) Bolts: ASTM A-307.
f. Base plate:
(1) Primed ASTM A-36 Carbon Steel.
(2) Factory welded to clamp.
(3) Field weld base plate to structure.

4. Insulated piping: Pre-insulated positive pipe anchors (welded-lug clamp type).
a. General:
(1) Catalogued load rating: Based on Pipe Shields C4000 Series.
b. Load-bearing insulation:
(1) Fully enclose entire pipe circumference with 4100 kPa, waterproofed calcium silicate.
(2) Thickness: Same as adjoining pipe insulation.
(3) Nominal length: 110 mm.
c. Insulation shield:
(1) Fully encase insulation with 360 degree, overlapping galvanized sheet-metal shield.
(2) Secure shield to insulation with industrial strength glue.
(3) Length: Same as insulation.
d. Clamp with factory welded thrust lugs:
(1) Primed ASTM A-36 Carbon Steel.
(2) Bolt pattern: 2-bolt, like MSS SP-69 Type 8.
(3) Bolts: ASTM A-307.
(4) Nominal clamp width: 180 mm.
e. Base plate:

(1) Primed ASTM A-36 Carbon Steel.
(2) Factory welded to clamp.
(3) Field weld base plate to structure.

f. Pipe lugs:
(1) Ship loose for field welding to piping.
(2) Material: Same as piping material.

g. Piping thrust lugs:
(1) Compatible with piping material, and shipped loose for field welding to piping.

B. Weight supports (apply only to vertical piping):
1. Prevent pipe movement in lateral and downward directions.
2. Bare piping: MSS SP-69 Type 8 or 42.
3. Insulated piping: Pre-insulated positive pipe anchors (welded-lug clamp type).

2.05 PIPE GUIDES

A. Pipe guides, general:
1. Restrict pipe movement in lateral direction; allow pipe movement in axial direction.

B. Bare piping:
1. Horizontal:
a. Spider-type pipe guides: Cylinders with metal web spacers.
2. Vertical:
a. MSS SP-69 Type 8 friction clamp.
(1) Guide ears of friction clamp with channel clips attached to structure.

C. Insulated piping:
1. Horizontal:
a. Pre-insulated pipe guides: Pipe support with laterally guided sliding base.
(1) Same as pre-insulated pipe anchor (friction clamp type) except with sliding base and mounting plate.
(2) Sliding base: Stainless steel surface on underside of base.
(3) Mounting plate: Factory mounted UHMW polyethylene slide pad on steel mounting plate with guide angles. Field weld mounting plate to structure.
(4) Travel distance, lateral: 0 mm.
(5) Travel distance, axial: +/-40 mm.

2.06 PIPE SUPPORTS

A. Pipe supports - General:

1. Materials, design and manufacturer: MSS SP-58.
2. Fabrication and installation: MSS SP-89.
3. Selection and application: MSS SP-69.
4. Supports and hardware exposed to weather: Electro-galvanized.
5. Supports and hardware in mechanical rooms and fan rooms: Electro-galvanized.
6. Supports and hardware in other locations: Electro-galvanized.
7. Supports for copper piping.
   a. Supports used on bare copper piping: Copper plated or electro-galvanized supports with felt or plastic padding to eliminate contact between support and copper pipe.
   b. Felt and plastic padding shall be integral parts of factory-fabricated support systems.
8. Threads on supports and fittings: Conform to Class 2A and 2B of ANSI-B1.1.
9. Strap-iron hangers are not acceptable.

B. Supports for horizontal piping:
   1. Bare piping:
      a. Independent supports: MSS SP-69 types 1, 3, 4, 5, 7, 9, 10, 11, 12, 24, 41, 43, 44, 45, or 46.
         (1) Use types 7 and 10 only on pipe sizes DN150 and smaller.
      b. Supports used with trapeze hangers:
         (1) MSS SP-69 types 24 or 26.
         (2) Supports designed as part of modular support system for pipe and ductwork.
   2. Insulated piping:
      a. Independent supports: MSS SP-69 types 1, 3, 7, 9, 10, 41, 43, 44, 45, or 46.
      b. Supports used with trapeze hangers:
         (1) Pipe sizes DN50 and smaller: MSS SP-69 type 26.
         (2) Pipe sizes DN65 and larger: MSS SP-69 types 24 or 26.
         (3) Supports designed as part of modular support system for pipe and ductwork.
   3. Insulation protection shields: MSS SP-69 Type 40.
   4. Pre-insulated pipe-support inserts:
      a. Insulation insert:
         (1) Fully enclose entire pipe circumference with 700 kPa waterproofed calcium silicate.
         (2) Thickness: Same as adjoining pipe insulation.
         (3) Length: Same as shield except extend inserts 25 mm beyond shields on cold systems.
         (4) Where indicated in Part 3, provide structural insulation inserts: 4100 kPa, waterproofed

calcium silicate supporting bottom 0.25 of pipe circumference.

b. Insulation shield:
(1) Fully encase insulation insert with 360-degree overlapping galvanized sheet-metal shield.
(2) Secure shield to insulation with industrial strength glue.
(3) Minimum lengths and thicknesses:

Pipe Size DN	Shield Length mm	Minimum Thickness mm
65 - 150	150	1.00
200 - 250	230	1.60
300 - 450	300	1.60

c. Where indicated in Part 3, provide load bearing plate:
(1) Inside diameter of plate shall match outside diameter of shield.
(2) Plate width: 0.33 of outside circumference of shield.
(3) Secure plate to bottom of insulation shield by tack welding, and field paint in accordance with Section 09900.
(4) Minimum lengths and thicknesses:

Pipe Size DN	Shield Length mm	Minimum Thickness mm
65 - 250	150	6.4
300 - 350	230	9.5
400 - 500	230	12.7

5. Trapeze hangers:
a. Field or shop constructed trapeze hangers of galvanized angle iron, strut channels or other structural shapes with flat surfaces for attaching pipe supports.
b. Modular support system for pipe and ductwork.

6. Coordinate with Section 15240.

C. Supports for vertical piping:
1. Bare piping supports: Friction Clamps.
a. Clamps resting directly on concrete:
(1) MSS SP-69 Type 8 (2-bolt style).
b. Clamps supports by springs, bolts, brackets or rods:
(1) MSS SP-69 Type 42 (4-bolt style).

2. Insulated piping supports: Pre-insulated pipe supports (pipe-riser clamps with lugs).
    a. General:
        (1) Catalogued load rating: Based on Pipe Shields Series E1100.
        (2) Support downward loads.
        (3) Attachable to structure from above or below.
        (4) Bolt pattern: 4-bolt, like MSS SP-69 Type42.
        (5) Bolts: ASTM A-325.
    b. Insulation insert:
        (1) Fully enclose entire pipe circumference with 4100 kPa, waterproofed calcium silicate.
        (2) Thickness: Same as adjoining pipe insulation.
        (3) Length: Same as shield.
        (4) Secure insulation to shield with industrial strength glue.
    c. Insulation shield:
        (1) Fully encase insulation insert with 360-degree galvanized steel shield.
        (2) Length: Same as clamps less thrust-plate thicknesses.
    d. Clamps:
        (1) Primed ASTM A-36 Carbon Steel.
    e. Thrust lugs:
        (1) Top: Compatible with piping material, and shipped loose for field welding to piping.
        (2) Bottom: Integral with clamps.

D. Pipe supports in other situations: MSS SP-69.

E. Pipe supports at plumbing fixtures:
    1. Factory-fabricated metal brackets.
        a. Provide plastic grommets/inserts factory fabricated for specific pipe diameters and materials. Metal to metal contact between pipe and bracket is not acceptable.
    2. Factory-fabricated PVC pipe supports and pipe fasteners.
        a. Fastening method: Stainless-steel bands and screws.
        b. PVC: Fire retardant.

2.07 SLEEVE ASSEMBLIES

A. Sleeve assemblies, general:
    1. Sleeve assembly, definition: Combination of sleeve and firestopping or sealant.
        a. Seal annular space around piping with firestopping or sealant as specified.
        b. Use materials and methods specified in Section

07900.

2. Sleeve assembly types:
    a. Premanufactured:
        (1) UL-classified, factory-designed system that includes pouring sleeve and fire-proof packing.
        (2) Sleeve assemblies for plastic and insulated piping: Also provide fire-proof insulation and insulation shield.
        (3) Sleeve assemblies in floors shall be waterproof.
    b. Field-fabricated:
        (1) Steel pipe: Primer-protected, Schedule-40 or standard-weight pipe with firestopping or sealant.
        (2) Water-stop pipe: Primer-protected, Schedule-40-steel, standard-weight-steel, or ductile-iron pipe with full-circle continuously welded (or cast in place) water-stop plate with firestopping or sealant.
        (3) Polyethylene, thin-wall sleeve/cap combination with firestopping or sealant.
        (4) Box out: Formed-out opening in poured concrete with firestopping or sealant.
        (5) Sheet metal, 1.2 mm galvanized, with firestopping or sealant.
        (6) Spiral duct, 0.6 mm, with firestopping or sealant.

B. Sleeve assemblies at rated penetrations.
    1. General:
        a. Sleeve assemblies: UL classified.
    2. Acceptable sleeve assembly types:
        a. For metallic piping at locations other than floor penetrations in wet areas.
            (1) Premanufactured.
            (2) Field-fabricated steel pipe.
            (3) In concrete floors only: Field-fabricated polyethylene, sheet metal, or spiral duct.
        b. For metallic piping at floor penetrations in wet areas.
            (1) Field-fabricated steel pipe.
        c. Wet areas:
            (1) Mechanical rooms and similar areas.
        d. For plastic piping (e.g., PVC, CPVC, polypropylene):
            (1) Premanufactured.
    3. At locations exposed to weather, provide firestopping and sealant:
        a. Sealants:
            (1) Bolt-tightened synthetic-rubber seals.

(2) Caulked lead and oakum stop.
b. Install sealant at exterior side of sleeve.

C. Sleeve assemblies at non-rated penetrations.
1. Acceptable sleeve assembly types:
a. For locations other than below-grade exterior-wall pipe penetrations.
(1) Field-fabricated steel pipe.
(2) Field-fabricated box out for openings larger than 350 mm.
b. For below-grade exterior-wall pipe penetrations.
(1) Field-fabricated water-stop pipe.
2. Sealants:
a. Interior exposure:
(1) Mineral or glass fiber insulation.
b. Exterior walls above and below grade:
(1) Bolt-tightened synthetic-rubber seals.
(2) Caulked lead and oakum stop.

D. Sizes of field-fabricated sleeve assemblies for metallic piping (rated and non-rated installations), and for plastic piping (non-rated installation only):
1. Diameters, 80 mm minimum:
a. Minimum clearance between ID of sleeve and OD of pipe in materials other than concrete:
(1) 25 mm larger than pipe and pipe insulation.
(2) 50 mm larger than glass pipe.
b. Minimum clearance between ID of sleeve and OD of pipe in concrete:
(1) 40 mm larger than pipe and pipe insulation.
(2) 50 mm larger than glass pipe.
c. Size suitable for construction tolerances and to receive sealant.
2. Lengths:
a. Walls and partitions:
(1) Cut to length so that ends are flush with finished surfaces of wall or partition.
b. Roofs and structural concrete members:
(1) Cut to length so that ends are flush with unfinished surfaces of roof or concrete member.
c. Floors in dry areas:
(1) Cut to length so that ends are flush with unfinished surfaces of floor.
d. Floors in wet areas:
(1) Cut to length so that bottom of sleeves are flush with unfinished surfaces of floor.
(2) Cut to length so that top of sleeves protrude 100 mm above finished floor if opening is not protected by concrete curb.

E. Sizes of premanufactured sleeve assemblies:
   1. Size according to manufacturer's instructions.

F. Sleeves for future work: Same as for this work.

PART 3 - EXECUTION

3.01 GENERAL

A. Install components as indicated and as instructed by manufacturers.
   1. Comply with manufacturer's recommended loading capacities.

B. Begin installation of mechanical system after prototypical installation of each fire rated penetration assembly is approved by COTR.

3.02 ATTACHMENTS TO STRUCTURE

A. General:
   1. Do not attach supports, anchors, or guides to walk-on ceiling or to steel roof deck.
   2. Do not attach supports, anchors or guides to concrete filled floor deck except by permission of COTR.
   3. Attach supports, anchors and guides to beams where ever possible.
   4. Provide protective plastic end caps for ends of all threaded rods which occur within 2100 mm of floor or walk-on ceiling.

B. Attach pipe supports to structure with specified attachment devices.

C. Attach ductwork and equipment supports to structure with attachment devices specified for pipe sizes DN75 and larger.

D. Attach pipe anchors and guides to structure:
   1. Concrete structure:
      a. Where anchor or guide directly abuts structure, use concrete inserts.
      b. Where anchor or guide does not directly abut structure, provide MSS SP-69 bracket or shop or field-fabricated anchor extension made of angle iron and rods with turnbuckles.
   2. Steel structure: Weld or bolt to structure directly or through shop or field-fabricated anchor extension made of angle iron and rods with turnbuckles.

3.03 UNIVERSAL CHANNEL FRAMING SYSTEM

A. Provide complete system where indicated.

B. Provide end caps for channel struts when they occur within 2100 mm of floor or walk-on ceiling.

3.04 PIPE SUPPORTS, ANCHORS, AND GUIDES

A. General:
   1. Begin installation of mechanical systems only after steel or concrete roof/floor system including slabs and roof deck are in place and complete.
   2. Space supports so maximum individual support load will not exceed values listed in paragraph "Hanger rod loading".
   3. Adjust supports so that load is evenly distributed among supports.

B. Metallic piping, horizontal:
   1. Bare piping: Size supports to fit outside diameter of piping.
   2. Insulated piping: Size supports to fit outside diameter of insulation:
      a. Pipe sizes DN50 and smaller:
         (1) Provide insulation protection shield at each support.
      b. Pipe sizes DN65 to DN150.
         (1) Provide pre-insulated pipe support insert at each support. Where support is flat surface or roller, provide load bearing plates.
      c. Pipe sizes DN200 and larger (other than steam):
         (1) Provide pre-insulated pipe support insert at each support. Where support is flat surface or roller, provide load bearing plates and structural insulation inserts.
      d. Steam pipe sizes DN200 and larger:
         (1) Provide pre-insulated pipe support (with load bearing plate and structural insulation insert) with MSS SP-69 Type 41, 43, 44, or 46 support.
         (2) Provide pre-insulated pipe guide with laterally guided sliding base: See PIPE GUIDES.
   3. Support spacing for steel and copper piping:
      a. Support spacing for plumbing and laboratory supply and drainage piping specified in Section 15410 and 15411 shall be in accordance with the referenced plumbing code.
      b. Support spacing for natural gas piping shall be in accordance with the referenced gas fitting code.

c. Support spacing for laboratory gas and vacuum piping shall be in accordance with the referenced codes.
d. Support spacing for fire protection piping shall be in accordance with the referenced codes.
e. Unless noted otherwise, provide supports at each change of direction and space at or within following maximum limits:

Pipe Size DN	Standard Steel Fluid m	Standard Steel Vapor m	Copper Fluid m	Copper Vapor m
15 - 25	2.100	2.400	1.800	1.800
32 - 50	2.100	2.700	2.100	1.800
65 - 75	3.300	4.200	2.700	3.900
90 - 100	3.900	4.800	3.300	4.500
125 - 150	4.800	5.800	3.900	5.500
200 - 350	4.800	7.300	-	-

f. For pipe sizes DN400 and larger, see mechanical drawing for location of support attachments to structure.
(1) If not indicated on drawings, submit shop drawings for approval indicating location of supports and method of attachment to structure.

4. Maximum support spacing for cast iron soil piping: 3 m oc.
a. Provide minimum of one support per pipe section on barrel close to joint.
b. Provide support at branch connections.

C. Metallic piping, vertical:
1. Bare piping:
a. Drainage piping (See Section 15410 for definition):
(1) Support weight at least every 3 m with friction clamp.
b. Other piping:
(1) Support weight at least every story with friction clamp.
c. In chases without floors, use combination of welded steel brackets and friction clamps.
2. Insulated piping:
a. Insulated piping weight support:
(1) Pipe sizes DN40 and smaller: Friction clamp and pre-insulated pipe-support insert.
(2) Pipe sizes DN50 and larger: Pre-insulated pipe support (pipe-riser clamps with lugs).
b. Insulated piping guides:

(1) Pipe sizes DN40 and smaller: Friction clamp and pre-insulated pipe-support insert.
(2) Pipe sizes DN50 and larger: Pre-insulated pipe support (pipe-riser clamps with lugs).
(3) Provide channel clips attached to structure to guide ears of clamp.

D. Other piping materials:
1. Follow pipe manufacturer's recommendations for spacing and service conditions.

E. Trapeze hangers:
1. Suspended pipes running parallel may be supported on trapeze hangers.
2. When supporting bare copper piping isolate copper pipe from trapeze hanger with rubber or elastomeric material.
3. When any combination of cold, hot, and ambient piping exists on same trapeze system, coordinate anchoring and guiding of systems to allow axial movement and to prevent binding and twisting.

F. Pipe guides:
1. Provide two guides on each side of each expansion joint.
a. Install one pair of guides four pipe diameters on either side of the expansion joint.
b. Install a second pair of guides eighteen pipe diameters on either side of the expansion joint.
2. Install guides in their sprung position in accordance with manufacturer's guidelines.

G. Hanger rod loading:
1. If manufacturer's loading capacities are not available, use maximum loads tabled below:

Nominal Rod Diameter mm	Maximum Load kN
10	2715
13	5030
16	8055
19	12 000

2. Total hanger rod load (including piping, insulation, and piping contents) shall not exceed maximum load.

H. Pipe supports at plumbing fixtures:
1. General: Fasten piping to supports within 200 mm of final fixture connection point (valve).
2. Factory-fabricated brackets:

a. Fasten brackets to studs with screws.
b. Galvanized brackets:
(1) Fasten piping to brackets with plastic grommets/inserts.
c. Copper-clad brackets:
(1) Fasten piping to brackets with plastic grommets/inserts.

3. Factory-fabricated PVC supports:
a. Fasten brackets to waste piping, fixture carriers, or studs.

3.05 SLEEVE ASSEMBLIES

A. Provide sleeve assemblies for piping passing through following building elements (rated and non-rated):
1. Walls.
2. Partitions.
3. Floors (except slabs on grade).
4. Roofs.
5. Structural concrete member (e.g., foundations, footings, beams).
6. Ceilings.

B. Install sleeves integrally with concrete pour. Coordinate with concrete contractor.

C. Install sleeves to allow free movement of piping and insulation through entire sleeve assembly.
1. Pressurized piping systems: Piping and insulation shall move freely when pressurized.

D. Coordinate with structural system:
1. Coordinate locations of openings in structural systems with COTR.
2. Do not install sleeve assemblies in concrete structural elements (including drop panels) unless sleeve locations are specifically indicated on structural drawings or unless prior, written approval is obtained from COTR.

E. Maintain rating of fire and smoke rated construction.

F. Set sleeves plumb or level, in proper position, tightly fitted into work.

G. Set sleeves in positions relative to building elements as described in SLEEVE ASSEMBLIES in PART 2.

H. Field-fabricated water-stop pipe sleeves:
1. Tie back at exterior-wall service entrances:
a. Structurally secure pipe to withstand water hammer

force.

(1) Extend exterior piping into building a minimum of 300 mm.

(2) Provide a mechanical joint on interior end of pipe, and mechanically tie hub back through adjoining structural (exterior) wall.

I. Use firestopping at mechanical penetrations through floors and at each floor level in vertical mechanical service shafts.

J. Seal around pipes and sleeves.

K. Fill openings made by others for piping penetrations with same type of construction that has equivalent fire and smoke rating.

L. Provide typical, prototype installation of sleeve assemblies for pipes penetrating different walls, partitions, floors, roofs, and ceilings. Obtain approval of COTR before proceeding with the remainder of the installation.

END OF SECTION

SECTION 15190

MECHANICAL IDENTIFICATION SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of work:
   1. Piping, valve, duct and equipment identification.

1.02 QUALITY ASSURANCE

A. Piping system identification:
   1. ANSI-A13.1, "Scheme for the Identification of Piping Systems".

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
   1. Pipe markers.
   2. Valve tags.
   3. HVAC duct markers.
   4. Equipment name plates.
   5. Access panel markers.
   6. Underground marking tape.

C. Samples: Not required for COTR review.

D. Project information:
   1. Sample of proposed format for Equipment Chart having at least one entry for each type of equipment. This will be used to verify acceptable data presentation and equipment numbering format.

E. Contract closeout information:
   1. Valve Chart indicating valve numbers, type, size, manufacturer, model number, system, and location.
   2. Equipment Data Sheets.
      a. Provide an equipment data sheet for each piece of equipment installed on the project.
      b. Data sheet shall have all appropriate fields filled in by typing, computer word processing, or neatly hand printed.
      c. Equipment number shall match number on Equipment Chart and on Equipment Name Plate.
   3. Equipment Chart.
      a. Equipment Chart shall be in spread sheet format.
      b. Provide a line item entry on the Equipment Chart

for each piece of equipment installed on the project.
c. Entry shall indicate building number, room number, equipment number (similar to identification on project drawing schedule sheets), and short verbal description.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Pipe, valve and equipment markers:
a. Base:
(1) Seton Name Plate Corp.
b. Optional:
(1) W H Brady Co.
(2) EMED Company, Inc.
(3) Kolbi Industries, Inc.
(4) 3M Co.
(5) Craftmark Identification Systems.
(6) Marking Services, Inc.
(7) Carlton Industries, Inc.
2. Underground marking tape:
a. Base:
(1) Reef Industries, Inc.
b. Optional:
(1) Seton Name Plate Corp.
(2) EMED Company, Inc.
3. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPE MARKERS

A. Pipe markers: Conform to ANSI-A13.1.
1. Pressure sensitive vinyl (self-adhesive) material.
2. Mechanically fastened type: Snap on or strap on.
a. For dirty greasy, oily pipe where pressure sensitive markers may not perform satisfactorily.
3. Provide with arrows indicating direction of flow.
4. Letter sizes: In accordance with table in Part 3.

2.03 VALVE TAGS

A. Valve tags: Brass or anodized aluminum type.
1. Brass: Minimum 1.2 mm gauge, polished, 40 mm diameter with following lettering:
a. Service: 6 mm stamped black filled letters.
b. Valve numbers: 12 mm stamped black filled letters.

2. Aluminum: 50 mm, 0.81 mm thick, with following lettering:
   a. Service: 6 mm engraved letters.
   b. Valve numbers: 12 mm engraved letters.
3. Valve number shall match that used on Valve Chart.

B. Valve tag fasteners:
1. 4 ply 0.457 mm copper or monel wire meter seals, brass "S" hooks or No.16 brass jack chain.

2.04 HVAC DUCT MARKERS

A. HVAC duct markers:
1. Individually worded marker with colored border indicating system number (e.g., AHU-101, RF-301, EF-501), type (supply, return, exhaust) and flow direction. Label exhaust ducts for the type of fumes as indicated.
   a. Border color determined by component function:
      (1) Yellow for heating.
      (2) Green for cooling.
      (3) Blue for return, exhaust and outside air.
   b. Seton Ventmark HVAC markers.

2.05 EQUIPMENT NAME PLATES

A. Equipment name plates:
1. 1.6 mm rigid plastic, "Setonply", "Emedolite" or bakelite with 4 edges beveled; or engraved aluminum with black enamel background and natural aluminum border and letters.
   a. Two 10 mm mounting holes.
   b. Lettering size: Minimum 12 mm high.
   c. Fasteners: Commercial quality, rust resisting nuts and bolts with backwashers, self-tapping screws or rivets.
   d. Equipment identification shall match that used on Equipment Data Sheet and Equipment Chart.

2.06 ACCESS PANEL MARKERS

A. Access panel markers:
1. Metal tack style: Use on acoustical tile ceilings.
   a. Seton style BCM or ECM.
2. Engraved plastic style.
   a. 20 mm square with center hole for small screw.
   b. Seton style CM75.

2.07 UNDERGROUND MARKING TAPE

A. Underground detectable marking tape (for use with

non-metallic pipe):
1. Lamination bond of 1 layer of aluminum foil between 2 layers of inert plastic film.
   a. Aluminum foil: Minimum 0.009 mm thick.
   b. Inert plastic film: Minimum 0.11 mm thick.
2. Resistant to alkalis, acids and other destructive agents found in soil.
3. Minimum tensile strength: 38 kg per 100 mm width.
4. Minimum elongation: 500 percent.
5. Provide continuous printed message repeated every 400 to 1000 mm warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
6. Tape to be inductively locatable and conductivity traceable using a standard pipe and cable device for minimum of 8 years after burial.
7. Color code:
   a. Yellow: Diesel fuel oil systems.
8. Reef Industries, Inc., Detectable Terra Tape.

2.08 CHART AND DIAGRAM FRAMES

A. Chart and diagram frames:
   1. Extruded aluminum with plexiglass or glass windows.

PART 3 - EXECUTION

3.01 VALVE IDENTIFICATION

A. Identify all valves, with appropriate service designation and valve number designation on valve tags.
   1. Tagging of valves at unit heaters, fan coil units, air terminal unit reheat coils and plumbing fixture stops are not required.

B. Install tags on valves using valve tag fasteners in manner for easy reading.

C. Furnish 4 charts including valve identification number, location (room number, department) and purpose. See also Contract Closeout Information.
   1. Mount 1 chart in frame and secure on wall in location directed by COTR.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals".

3.02 PIPE IDENTIFICATION

A. Natural gas piping:
   1. Painting required.
      a. Color: Yellow.

(1) Paint specification: Section 09900.

b. Stencil on identification lettering and arrows indicating direction of flow.

B. Identify piping systems with indicated lettering:

Drawing Symbol	Pipe Identification Lettering
UPW	Ultra Pure Water - ASTM E-1
UPWC	Ultra Pure Water Circulating
PW	Pure Water - CAP II
PWC	Pure Water - Circulating
CW	Domestic Cold Water
HW	Domestic Hot Water Supply
HWC	Domestic Hot Water Circulating
S	Sanitary Drain
LD	Laboratory Drain
SD	Storm Drain
OFSD	Overflow Storm Drain
V	Vent
LVT	Laboratory Vent
DR	Drain: Storm/Condensate
PD(S)	Pressure Drainage (Sanitary)
PD(SD)	Pressure Drainage (Storm Drainage)
PD(LD)	Pressure Drainage (Laboratory Drainage)
CWS	Chilled Water Supply
CWR	Chilled Water Return
LCW	Laboratory Cold Water - Nonpotable
LHW	Laboratory Hot Water Supply - Nonpotable
LHWC	Laboratory Hot Water Circulating - Nonpotable
CPD	Condensate Pump Discharge
CCPD	Clean Condensate Pump Discharge
COILCPD	Cooling Coil Condensate Pump Discharge
CD	Cooling Coil Condensate Drain
LPS	Low Pressure Steam Supply (under 210 kPa)
LPR	Low Pressure Steam Return (under 210 kPa)
MPS	Medium Pressure Steam Supply (210 to 560 kPa)
MPR	Medium Pressure Steam Return (210 to 560 kPa)
HPS	High Pressure Steam Supply (over 560 kPa)
HPR	High Pressure Steam Return (over 560 kPa)
G	Natural Gas
A	General Compressed Air
IA	Instrument Compressed Air
LA	Laboratory Compressed Air
LV	Laboratory Vacuum
N	Gaseous Nitrogen
N(HP)	Gaseous Nitrogen (High Purity)
LN	Liquid Nitrogen
CTS	Cooling Tower Supply
CTR	Cooling Tower Return

S	Sprinklers
F	Fire Protection
FOS	Fuel Oil Supply
FOR	Fuel Oil Return
HWS	Heating Hot Water Supply
HWR	Heating Hot Water Return
GWS	Glycol Water Supply
GWR	Glycol Water Return
CLPS	Clean Low Pressure Steam Supply (Under 210 kPa)
CLPR	Clean Low Pressure Steam Return (Under 210 kPa)
LTGWS	Low Temperature Glycol Water Supply
LTGWR	Low Temperature Glycol Water Return
CHRWS	Chiller Heat Recovery Water Supply
CHRWR	Chiller Heat Recovery Water Return
SCWS	Secondary Chilled Water Supply
SCWR	Secondary Chilled Water Return
PCWS	Process Cooling Water Supply
PCWR	Process Cooling Water Return
LSWS	Laboratory Slab Conditioning Water Supply
LSWR	Laboratory Slab Conditioning Water Return

C. Locate identification lettering as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take off.
   3. At each passage through walls, floors and ceilings.
   4. At each pipe passage to underground.
   5. On horizontal pipe runs every 6000 mm, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.
   7. Identification shall be readable from access panels and not obscured by other work.

D. Size lettering, marker color fields, and arrows as follows:

Outside Diameter of Pipe or Pipe Covering mm	Length of Color Field (Markers) mm	Size of Letters and Arrows mm
20 to 32	200	12
40 to 50	200	20
65 to 150	300	32
200 to 250	600	65
Over 250	800	90

E. Pipe markers:
   1. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.03 DUCTWORK IDENTIFICATION

A. Locate duct markers as follows:
   1. At each branch or riser take-off.
   2. Next to equipment.
   3. In distribution space, in horizontal runs every 6000 mm.

B. Label ductwork or exterior surface of insulation.

3.04 EQUIPMENT IDENTIFICATION

A. Attach equipment nameplates in conspicuous location, directly on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

B. For unsuitable surfaces, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

3.05 ACCESS PANEL MARKERS

A. Identify devices located above ceilings with additional identification.
   1. Use access panel markers (metal tack style) for acoustical tile ceilings, or engraved plastic style, 20 mm square, for mounting on panel door; or equipment nameplates.
   2. Coordinate with COTR on identification method and color codes.
   3. Provide markers on all removable ceilings and ceiling access panels to indicate locations of valves, dampers, smoke detectors, etc., and other mechanical

items that may need servicing or adjustment. Glue marking tacks in place to prevent their falling out.

4. Where fire protection devices are located inside ductwork, provide an additional tag on the duct access door identifying device inside.
   a. Identification letter size: 40 mm high minimum.
5. Color code access panel markers as follows:
   a. Red: Fire dampers, smoke detectors, duct type smoke detectors, and fire protection/sprinkler system valves.
      (1) Notation:

          D - Damper
          V - Valve
          S - Smoke Detector
          H - Heat Detector

   b. Yellow: Valves: Fluid systems other than fire protection/sprinkler system.
      (1) Notation:

          V - Valve

   c. Gold: Dampers and valves: Automatic and balancing in any system.
      (1) Notation:

          V - Valve
          D - Damper

   d. Blue: Valves: Gases, compressed air, and vacuum systems.
      (1) Notation

          V - Valve

3.06 UNDERGROUND MARKING TAPE

A. Place tape in center of pipe trench 300 mm below the surface.

END OF SECTION

SECTION 15240

VIBRATION ISOLATION OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide vibration control devices, materials, and related items. Perform all work as indicated on drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.02 MATERIAL AND EQUIPMENT

A. All vibration isolation mounts shall be supplied by one of the following approved manufacturers.
   1. Amber/Booth Co. (Houston, TX) - A.B.
   2. Korfund Dynamics Corp. (Westbury, NY) - K.D.
   3. Mason Industries Inc. (Hauppauge, NY) - M.I.
   4. Kinetics Noise Control Inc. (Dublin, OH) - K.N.C.
   5. Vibration Mountings & Controls Inc. (Butler, NJ) - V.M.&C.

B. Unless otherwise specified, supply only new equipment, parts and materials.

C. The intent of this specification is to ensure the highest standard of vibration isolation for this project. For this reason, all vibration isolation products and materials shall be furnished by a single manufacturer, who will be responsible for the proper installation and operation of all vibration isolation equipment and systems. The only exception will be internal vibration isolation that is integral with the equipment, such as internal isolators on air handling units.

1.03 REQUESTS FOR CHANGE

A. Any requests for changes to Specifications must be submitted in writing at least ten days prior to offer closing. Approval will be given through a written addendum.

1.04 CONTRACTOR'S GENERAL RESPONSIBILITIES

A. The Contractor shall bring to the Architect's attention prior to installation any conflicts which will result in unavoidable contact between the building structure and the isolated equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by

conflicts after installation shall be at the expense of the responsible Contractor.

B. The Contractor shall bring to the Architect's attention prior to installation any discrepancies between the requirements of this specification and field conditions, changes required due to specific equipment selection, etc. Corrective work necessitated by discrepancies after installation shall be at the expense of the responsible Contractor.

1.05 DESIGN CRITERIA

A. Equipment, ductwork, piping and conduit shall not be installed which makes rigid contact with the structure unless it is allowed by this specification.

B. Pipe Anchors and Supports: Piping supports and anchors shall not interfere with free operation of vibration isolation systems. Stiff-leg support of piping supported on Type HS, or Type FSN isolators is not acceptable.

C. Ductwork: Ductwork isolation requirements are based on duct equivalent diameters. For rectangular ductwork, the equivalent diameter is the diameter of duct having the same cross-sectional area.

D. Equipment Isolation Frames and Bases: Frames and bases used to support vibration isolated pumps shall be sized to provide support for pipe elbows.

E. Isolation/Absorption Products: The completed installation must be free of vibration and noise. Systems, equipment, or parts which vibrate or generate vibration unduly, or which generate or emit undue noise while in operation, shall: (1) be adjusted, repaired, or replaced as appropriate to obtain acceptable levels of vibration or noise, or (2) be supported on, or fitted with, suppression or absorption devices, or other means, which effectively prevent the transmission of vibration or noise beyond the offending item.

F. Resilient Wall, Ceiling, and Floor Penetrations: Provide resilient wall and ceiling penetrations for all piping, conduit, ductwork, etc., supported on Type HS or Type FSN isolators. Refer to resilient penetration details on the drawings.

1.06 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of

vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.

C. Provide any incidental materials needed to meet the requirements stated herein, even if not expressly specified or indicated on drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

E. Should any rotating equipment cause excessive noise or vibration; rebalance, realign, or Provide other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding these Specifications or the manufacturer's specifications for the unit in question.

F. Upon completion of the work, the COTR or COTR's representative shall inspect the installation and shall inform the installing Contractor of any further work that must be completed. Make all adjustments as directed by the COTR that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.07 SUBMITTALS

A. Shop drawings: Prior to ordering any products, submit shop drawings of the items listed below. The shop drawings must be complete when submitted and must be presented in a clear, easily understood form. Incomplete or unclear presentation of shop drawings may be reason for rejection of the submittal.
   1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
   2. Detailed selection data for each vibration isolator supporting equipment, including:
      a. The equipment identification mark.
      b. The isolator type.
      c. The actual load.
      d. The static deflection expected under the actual load.
      e. Specified minimum static deflection.

f. The additional deflection-to-solid under load.
g. The ratio of spring height under load to spring diameter.

3. Steel rails, steel base frames, and concrete inertia bases indicating all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Written approval of the frame design to be used shall be obtained from the equipment manufacturer.
5. Drawings showing methods for suspension, of support, and guides.
6. Drawings showing methods for isolation of piping, at penetrations of walls, slabs, and beams.
7. Special details necessary to convey complete understanding of the work to be performed.
8. Isolated trapeze hangers within the service galleys.

B. Product data: Not required for COTR review.

C. Samples: None required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATION MOUNT TYPES

A. General:
1. All metal parts of vibration isolation units installed out-of-doors shall be cold-dip galvanized, cadmium plated, or neoprene coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards.
2. All isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.
4. Static deflection of isolators shall be as provided in SECTION 3 - EXECUTION and as indicated on drawings. All static deflections stated are the minimum

acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

B. Type FSN (Floor Spring and Neoprene):

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Springs shall have a minimum additional travel-to-solid equal to 50 percent of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). All mounts shall have leveling bolts.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type DNP (Double Neoprene Pad) isolator. If the DNP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range.
3. If the basic spring isolator has a neoprene friction pad on its base and a DNP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the DNP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The DNP isolator, separator plate and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
4. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.
5. Type FSN isolators shall be one of the following products with the appropriate neoprene pad (if used) selected from Type DNP:

Type SW	A.B.
Type WSL	K.D.
Type SLF	M.I.
Type FDS	K.N.C.
Type AC or AD	V.M.&C.

C. Type FSNTL (Floor Spring and Neoprene Travel Limited):

1. Spring isolators shall be freestanding and laterally stable without any housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring shall have a minimum additional travel-to-solid equal to 50 percent of the rated deflection. Springs shall be so designed that the ratio of horizontal stiffness to vertical stiffness is approximately 1 (one). All mounts shall have leveling bolts. All mounts shall have vertical travel limit stops to control extension when weight is removed. The travel limit stops shall be capable of serving as blocking during erection of the equipment. A minimum clearance of 6.5 mm shall be maintained around restraining bolts and between the limit stops and the spring to avoid interference with the spring action.
2. Either the spring element in the isolator shall be set in a neoprene cup and have a steel washer to distribute the load evenly over the neoprene, or each isolator shall be mounted on a Type DNP (Double Neoprene Pad) isolator. If the DNP isolator is used, provide a rectangular bearing plate of appropriate size to load the pad uniformly within the manufacturer's recommended range. If the basic spring isolator has a neoprene friction pad on its base and a DNP isolator is to be added to the base, a galvanized steel, stainless steel or aluminum plate shall be used between the friction pad and the DNP isolator. If the isolator is outdoors, the plate shall not be made of galvanized steel. The DNP isolator, separator plate, and friction pad shall be permanently adhered to one another and to the bottom of the bearing plate.
3. If the isolator is to be fastened to the building structure and a Type DNP isolator is used under the bearing plate, neoprene grommets shall be provided for each bolt hole in the base plate. Bolt holes shall be properly sized to allow for grommets. Hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers are to be galvanized.
4. Type FSNTL isolators shall be one of the following products, with the appropriate neoprene pad (if used) selected from Type DNP:

Type CT	A.B.
Type WSCL	K.D.
Type SLR	M.I.
Type FLS	K.N.C.
Series AWR-1	V.M.&C.

D. Type FN (Floor Neoprene):

1. Neoprene isolators shall be neoprene-in-shear type with steel reinforced top and base. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed. Bolt holes shall be provided in the base and the top shall have a threaded fastener. The mounts shall include leveling bolts that may be rigidly connected to the equipment.
2. Type FN isolators shall be one of the following products:

Type RVD	A.B.
Type F	K.D.
Type ND	M.I.
Type RD	K.N.C.
Series R/RD	V.M.&C.

E. Type PCF (Precompressed Fiberglass):
1. Precompressed fiberglass blocks shall be made of molded inorganic glass fiber that is individually coated and sealed with an impervious elastomeric membrane. Fiberglass shall be severely overloaded during manufacture to stabilize the material into a product that is permanent and has consistent, predictable dynamic properties.
2. Type PCF isolators shall be one of the following products.

Type KIP	K.N.C.

F. Type NP (Neoprene Pad):
1. Neoprene pad isolators shall be one layer of 6.5 to 9.5 mm thick ribbed or waffled neoprene. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type NP isolators shall be one of the following products:

Type NR	A.B.
Type Korpad	K.D.
Type W	M.I.
Type NPS	K.N.C.
Series Shear-Flex or Maxi-Flex	V.M.&C.

G. Type DNP (Double Neoprene Pad):
1. Neoprene pad isolators shall be formed by two layers of 6.5 to 9.5 mm thick ribbed or waffled neoprene, separated by a galvanized steel, stainless steel or aluminum plate. If the isolator is outdoors, the plate shall not be made of galvanized steel. These layers shall be permanently adhered together. Neoprene shall be 40 to 50 durometer. The pads shall

be sized so that they will be loaded within the manufacturer's recommended range.

2. Type DNP isolators shall be formed from one of the following products:

Type NR	A.B.
Type Korpad	K.D.
Type WSW	M.I.
Type NPS	K.N.C.
Multiple Layers of Series Shear-Flex or Maxi-Flex	V.M.&C.

H. Type HSN (Hanger Spring and Neoprene):

1. Vibration isolation hangers shall consist of a free standing and laterally stable steel spring and a neoprene element in series, contained within a steel housing. Spring diameters and hanger housing lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the housing. Spring diameter shall be not less than 0.8 of the compressed height of the spring at the rated load. Spring elements shall have a minimum additional travel-to-solid equal to 50 percent of the rated deflection. The neoprene element shall be designed to have a 7.5 mm minimum static deflection. The deflection of both the spring element and the neoprene element shall be included in determining the overall deflection of Type HSN isolators.
2. Type HSN isolators shall be one of the following products:

Type BSRA	A.B.
Type VSX-30	K.D.
Type 30N	M.I.
Type SRH or SFH	K.N.C.
Type RSH or RFH	V.M.&.C.

I. Type HN (Hanger Neoprene):

1. Vibration isolation hangers shall consist of a neoprene-in-shear element contained within a steel housing. A neoprene neck bushing shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30 degree arc before contacting the hanger housing.
2. Type HN isolators shall be one of the following products:

Type BRD-A	A.B.
Type H	K.D.
Type HD	M.I.

Type RH or FH	K.N.C.
Type RHD or RFD	V.M.&.C.

2.02 EQUIPMENT BASES

A. Type BSR (Base - Steel Rail):
1. Steel rail bases shall consist of structural steel sections sized to provide a rigid beam which will not twist, deform, or deflect in any manner which will negatively affect the operation of the supported equipment or the vibration isolation mounts. Rail bases shall include side mounting brackets for attachment of vibration isolators.
2. Type BSR bases will be supplied by the isolator manufacturer and shall be one of the following products:

Type C or CIS	A.B.
Type Steel Base Rail	K.D.
Type R or ICS	M.I.
Type KRB or KFB	K.N.C.
Type WFR or AR	V.M.&C.

B. Type BSF (Base - Steel Frame):
1. Steel base frames shall consist of structural steel sections sized, spaced, and connected to form a rigid base which will not twist, rack, deform, or deflect in any manner which will negatively affect the operation of the supported equipment or the vibration isolation mounts. Frames shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. The depth of steel frame bases shall be at least 0.1 times the longest dimension of the base, but not less than 150 mm nor more than 305 mm. The base footprint shall be large enough to provide stability for supported equipment.
2. Frame bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
3. Type BSF bases shall be supplied by the isolator manufacturer and shall be one of the following products:

Type WX	A.B.
Type Steel Base	K.D.

Type WFSL	M.I.
Type SFB or SRB	K.N.C.
Series WFB	V.M.&C.

C. Type BIB (Base - Inertia Base):
   1. Concrete inertia bases shall be formed of stone-aggregate concrete 2400 kg/m3 and appropriate steel reinforcing cast between welded or bolted perimeter structural steel channels. Inertia bases shall be built to form a rigid base which will not twist, rack, deform, deflect, or crack in any manner which would negatively affect the operation of the supported equipment or the vibration isolation mounts. Inertia bases shall be adequately sized to support basic equipment units and motors plus any associated pipe elbow supports, duct elbow supports, electrical control elements, or other components closely related and requiring resilient support in order to prevent vibration transfer to the building structure. Inertia base depth shall be at least 0.083 times the longest dimension of the inertia base, but not less than 150 mm nor more that 305 mm. The base footprint shall be large enough to provide stability for supported equipment.
   2. Inertia bases shall include side mounting brackets for attachment to vibration isolators. Mounting brackets shall be located on the sides of the base that are parallel to the axis of rotation of the supported equipment.
   3. The steel frame and reinforcement shall be supplied by the vibration isolator manufacturer. Provide concrete in accordance with requirements of Division 3.
   4. Frame and reinforcement for Type BIB bases shall be one of the following products:

Type CPF	A.B.
Type RCPF	K.D.
Type KSL	M.I.
Type CIB-L or CIB-H	K.N.C.
Series WPF	V.M.&C.

2.03 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals shall be field-fabricated from a pipe or sheet metal section that is 15 to 20 mm larger than the penetrating element in all directions around the element, and shall be used to provide a sleeve through the construction penetrated. The sleeve shall extend 25 mm beyond the penetrated construction on each side. The space between the sleeve and the penetrating element shall be packed with glass

fiber or mineral wool to within 6.5 mm of the ends of the sleeve. The remaining 6.5 mm space on each end shall be filled with acoustical sealant to form an airtight seal. The penetrating element shall be able to pass through the sleeve without contacting the sleeve. Alternatively, prefabricated sleeves accomplishing the same result are acceptable.

2.04 RESILIENT LATERAL GUIDES

A. These units shall either be a standard product of the vibration isolation mounting manufacturer, or be custom fabricated from standard components. These units shall incorporate neoprene isolation elements similar to Type FN which are specifically designed to provide resilient lateral bracing of duct or pipe risers.
   1. Resilient lateral guides shall be one of the following products:

Type Custom	A.B.
Type Custom	K.D.
Type ADA	M.I.
Type RGN	K.N.C.
Type MDPA	V.M.&C.

2.05 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be made from coated fabric (or loaded vinyl if called for on drawings). The clear space between connected parts shall be a minimum of 50 mm and the connection shall have 38 mm minimum of slack material. Material width shall be 150 percent of clear dimension in addition to width required for attachment. Flexible duct connections shall result in a loose and highly compliant connection.

2.06 FLEXIBLE PIPE CONNECTIONS

A. Flexible pipe connections shall be fabricated of multiple plys of Kevlar or nylon cord, fabric, and neoprene; and shall be vulcanized so as to become inseparable and homogeneous. Flexible connections shall be formed in a double sphere shape, and shall be able to accept compressive, elongative, transverse, and angular movements.
   1. The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure, and fluid type. In addition, suitable flexible connections should be selected which do not require rods or cables to control extension of the connector.

2. Connectors for pipe sizes DN50 or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.
3. Flexible pipe connections shall be Mason Industries Type SFDEJ; Metraflex Double Sphere (Type DS); V.M.C. Type VMT; or Amber/Booth Type 2600 or 2655.

2.07 RESTRAINTS

A. Thrust Restraints:
1. Thrust restraints shall consist of a spring element in series with a neoprene pad. The unit shall be designed to have the same deflection due to thrust-generated loads as specified for the isolators supporting the equipment. The spring element shall be contained within a steel frame and be designed so it can be precompressed at the factory to allow for a maximum of 6.5 mm movement during starting or stopping of the equipment. Allowable movement shall be field-adjustable.
2. The assembly shall be furnished complete with rods and angle brackets for attachment to both the equipment and the adjacent fixed structural anchor.
3. The thrust restraints shall be installed on the discharge of the fan so that the restraint rods are in tension. Assemblies that place the rods in compression are not acceptable.
4. The holes in the spring restraint brackets through which the restraint rods pass must be oversized to prevent contact between the brackets and rods.
5. Thrust restraints shall be Mason Industries Type WBI or WBD, Kinetics Noise Control Type HSR, Amber/Booth Type TRK.

2.08 GROMMETS

A. Grommets shall either be custom made by combining a neoprene washer and sleeve, be Isogrommets as manufactured by MBIS, Inc. (Bedford Heights, Ohio), or be Series W by Barry Controls (Watertown, Mass.). Grommets shall be sized so that they will be loaded within the manufacturer's recommended load range. Grommets shall be specially formed to prevent bolts from directly contacting the isolator base plate.

2.09 ACOUSTICAL SEALANT

A. Sealants for acoustical purposes as described in this Specification shall be silicone or one of the nonsetting sealants indicated below:

Acoustical sealant	D.A.P.
Acoustical sealant	Pecora
Acoustical sealant	Tremco
Acoustical sealant	U.S.G.

B. Coordinate acoustical performance with fire rated assemblies and vibration isolation assemblies, when applicable.

PART 3 - EXECUTION

3.01 APPLICATION

A. General:
   1. Refer to SECTION 2 - PRODUCTS of this Specification for vibration isolation devices identified on drawings or specified herein.
   2. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected solely on the basis of rated deflection are not acceptable and will be disapproved.

B. Major Equipment (see schedule under 3.02 H):
   1. Types and minimum static deflections of vibration isolation devices for major equipment items shall be as scheduled on drawings or specified hereunder.
   2. Provide flexible duct connections at all fan unit intakes, fan unit discharges, and wherever else indicated on drawings.
   3. Provide flexible pipe connections at all pipe connections to vibration-isolated equipment and as indicated on drawings.
   4. Provide thrust restraints on all floor-mounted fans developing 1000 Pa or more of static pressure, all suspended fans, and wherever else indicated on drawings.

C. Miscellaneous Mechanical Equipment:
   1. Miscellaneous pieces of mechanical equipment such as heat exchangers, pressure reducing stations, dryers, water heaters, steam generators, strainers, storage tanks, condensate receiver tanks, flash tanks and expansion tanks which are connected to isolated piping systems shall be vibration-isolated from the building structure by Type NP or Type HN isolators (selected for 2.5 mm static deflection) unless their position in the piping system requires a higher degree of isolation as called for under Pipe Isolation.

D. Pipes:
   1. All pipes shall be isolated from the building structure as follows:
      a. Within mechanical rooms.
      b. Within 15.0 m total pipe length of connected vibration-isolated equipment.
      c. All piping that is DN100 or larger shall be isolated throughout the building.
      d. Piping serving labs mounted on isolated trapeze hangers within the service galleys.
   2. Piping shall be isolated from the building structure by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
   3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 10 mm, Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 10 mm, Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least 5 mm static deflection.
   4. Where lateral support of pipe risers is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
   5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
   6. Provide flexible pipe connections as called for under Major Equipment above and wherever indicated on drawings.

E. Ductwork:
   1. All sheet metal ducts and air plenums that are within mechanical rooms or within a distance of 15.0 m total duct length of connected vibration-isolated equipment (whichever is longer) shall be isolated from the building structure by Type FN or HN isolators. All isolators shall achieve 2.0 mm minimum static deflection.
      a. All ducts, air plenums, and air terminal units within metrology areas (Building 218 and 219) shall be isolated from the building structure by Type FSN or HSN isolators at 20 mm minimum static deflection.
   2. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration

sleeve/seals.

3. Provide flexible duct connections as called for above under Major Equipment and wherever indicated on drawings.

3.02 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolation Mounts:

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beams and joists. Provide suitable intermediate support members as necessary.
6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
7. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.

9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment vibration-isolated with Type FSNTL isolators shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 6.5 mm clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases:
1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 25 mm between inertia bases or steel frame bases and the floor beneath the equipment. Position isolator mounting brackets and adjust isolators so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

D. Flexible Duct Connections:
1. Sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections:
1. Provide flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Restraints:
1. Thrust restraints shall be attached on each side of the fan at the vertical centerline of thrust. The two rods of the thrust restraint shall be parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Resilient Penetration Sleeve/Seals:
1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

H. Vibration isolator schedule:

Equipment Description	Base Type	Isolator Type	Minimum Static Defl.(mm)	Restraint Type	Flexible Pipe Conn.	Note:
Air handling units, custom packaged, floor mounted		PCF	7		Yes	1
Air handling units, cleanroom, custom packaged, floor mounted		PCF	7		Yes	1
Exhaust fume scrubber floor mounted		DNP	5			2
Fan, inline, suspended		HSN	40	Thrust		
Fan, inline, floor mounted, interior		FSN	40			
Fan, inline, floor mounted, exterior		FSNTL	40			
Fan, centrifugal in AHU above 3.7 kW, except metrology	BSF	FSN	60	Thrust		

Equipment Description	Base Type	Isolator Type	Minimum Static Defl.(mm)	Restraint Type	Flexible Pipe Conn.	Note:
Fan, centrifugal in AHU 3.7 kW or less, except metrology	BSF	FSN	40			
Fan, centrifugal in AHU, in metrology	BSF	FSN	60	Thrust		
Fan, centrifugal, outdoors, above 3.7 kW		FSNTL	60			
Fan, centrifugal, outdoors, 3.7 kW or less		FSNTL	40			
Fan, centrifugal, indoor, above 3.7 kW		FSNTL	60			
Fan, centrifugal, indoor, 3.7 kW or less		FSN	40			
Air shower fan unit		HSN	40			
Pumps, floor mounted	BIB	FSN	40		Yes	3
Pump, in line, suspended		HSN	20		Yes	
Pump, in line suspended from pipe, 1 L/s or less		HN	10			4
Air Conditioning Units		FN	10		Yes	
Pump, condensate, floor mounted		FN	10		Yes	
Unit heaters, suspended		HN	10			
Vacuum pump, rotary floor mounted	BSF	FSN	20		Yes	
Cooling towers	Custom	FSNTL	90		Yes	5

Equipment Description	Base Type	Isolator Type	Minimum Static Defl.(mm)	Restraint Type	Flexible Pipe Conn.	Note:
Cooling tower cleaning system		FN	6		Yes	
Chillers		FSN	40		Yes	
Propeller fans		HSN	40			
Fan coil units, suspended		HN	10			
Fan coil units, floor mounted						Internal neoprene grommets
Air compressors	BIB	FSN	60		Yes	

NOTES:

1. Place beneath base rails of AHU to completely support unit.
2. Bolt to structure using grommets in oversized holes.
3. Provide 60 mm minimum static deflection isolator spring for pumps: P-101, P-102, P-103, P-104.
4. Supporting piping adjacent to pumps.
5. Custom base frame designed and provided by mechanical contractor.

END OF SECTION

SECTION 15250

PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of systems:
1. Pipe insulation, non-flexible and flexible.
2. Duct insulation, non-flexible and flexible.
3. Equipment insulation.
4. Insulation jacketing and prefabricated fitting covers.
5. Insulation fasteners:
a. Adhesives, mastics, and caulking.

B. Definitions:
1. Concealed: Outside surfaces are isolated from room ambient air conditions by physical barrier(s).
a. Concealed items are typically accessed through suspended ceilings, through access doors, or by cutting and patching.
b. Listed below are examples of spaces that typically contain concealed items:
(1) Walls.
(2) Partitions.
(3) Chases.
(4) Shafts.
(5) Ceiling spaces.
2. Exposed: Outside surfaces are not isolated from room ambient air conditions by physical barrier(s).
a. Exposed items are typically accessed directly from within a room or space.
b. Listed below are examples of rooms/spaces that typically contain exposed items:
(1) Mechanical rooms.
(2) Rooms without ceilings.
(3) Distribution levels.
3. Exposed to weather: Outside surfaces are not isolated by physical barrier(s) from weather or outside ambient air conditions.
4. Runouts: Piping not more than 3660 mm in length.

1.02 QUALITY ASSURANCE

A. Comply with the following fire and smoke hazard ratings:
1. Test products by procedure ASTM-E84, NFPA-255 and UL-723.
2. Rating requirements:
a. Maximum Flame Spread: 25.
b. Maximum Smoke Developed:

(1) Fiberglass, phenolic, PVC: 50.
(2) Elastomeric: 50.

3. Properly identify products for flame and smoke ratings.
   a. Shipping cartons may be labeled instead of product.
4. Identification:
   a. External duct insulation and factory insulated flexible duct shall be identified at intervals not greater than 914 mm with:
      (1) Name of the manufacturer.
      (2) Thermal resistance (R-value) at specified installed thickness.
      (3) Flame spread and smoke-developed index.
   b. R-values based on insulation only, excluding air films, vapor retarders, or other duct components.

B. Comply with requirements of the following specifications:
1. ASTM C 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation."
2. ASTM C 533, "Standard Specification for Calcium Silicate Pipe and Block Insulation."
3. ASTM C 553, "Standard Specification for Mineral Fiber Blanket and Felt Insulation."
4. ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)."
5. ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation."
6. ASTM C 1136, "Standard Specification for Barrier Material, Vapor."
7. ASTM C 795, "Thermal Insulation for Use Over Austenitic Stainless Steel."
8. Federal Specification HH-I-558B, "Mineral Fiber Boards, Blankets, Pipe Covering."

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Pipe insulation.
2. Ductwork insulation.
3. Insulation for hot equipment.
4. Insulation for high-temperature equipment.
5. Insulation for cold equipment.
6. Jacketing and prefabricated fitting covers, including attachment methods.
7. Insulation fasteners.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information: Not required for COTR review.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Acceptable manufacturers:
1. Insulation materials:
a. Base:
(1) Armstrong.
(2) Kooltherm Insulation Products.
(3) Owens-Corning.
(4) Pittsburgh Corning.
b. Optional:
(1) Certainteed.
(2) Knauf.
(3) Schuller International (Manville).
(4) PPG Industries.
2. Jacketing:
a. Base:
(1) Childers.
b. Optional:
(1) Ceel Co.
(2) Schuller International (Manville).
(3) RPR Metals.
(4) Pabco Metals.
(5) Truebro.
3. Prefabricated fitting covers:
a. Base:
(1) Childers.
b. Optional:
(1) Ceel Co.
(2) Certainteed.
(3) Knauf.
(4) Schuller International (Manville).
(5) Proto Corporation.
(6) RPR Metals.
(7) Pabco.
4. Adhesives, mastics, caulkings, and finishes:
a. Base:
(1) Foster (B.F.).
(2) Armstrong.
(3) Childers.
(4) Dow.
(5) Halstead.
b. Optional:

(1) Chicago (CMC).
(2) Schuller International (Manville).

5. Other manufacturers desiring approval comply with Section 01640.

B. Insulation - General:
1. Do not use material that exceeds specified flame and smoke ratings.
2. Use permanent treatments to jacketings and facings to impart specified fire ratings.
3. Use of water soluble treatments is prohibited.
4. At hangers and bracing: See Section 15140.

2.02 PIPE INSULATION, NON-FLEXIBLE

A. Pipe insulation, non-flexible:
1. Material: Preformed commercial-grade fiberglass and phenolic thermal insulation.
2. Designed for application on systems operating at temperatures between -20 and 460 degC.
3. Thermal conductivity at mean temperature (fiberglass):

k W/(m.K)	Mean Temperature degC
0.033	24
0.042	100
0.078	260

4. Thermal conductivity at mean temperature (phenolic type high efficiency insulation):

k W/(m.K)	Mean Temperature degC
0.0188	24

5. Acceptable products:
a. Owens-Corning Fiberglas ASJ/SSL-II.
b. Kooltherm Insulation Products Koolphen K phenolic pipe insulation with ASJ.
6. Facing:
a. All service jacket.
(1) Temperature range: -30 to 70 degC.
(2) Provide with integral vapor barrier where indicated in Part Three.
7. Seams, longitudinal: 50 mm self-sealing facing tabs.
a. Provide adhesive on both contacting surfaces.
b. Designed to perform without stapling.

2.03 PIPE INSULATION, FLEXIBLE

A. Pipe insulation, flexible:
1. Material: Commercial-grade closed-cell elastomeric thermal insulation.
2. Designed for application on systems operating at temperatures between 4-90 degC.
3. Thermal conductivity at mean temperature:

k W/(m.K)	Mean Temperature degC
0.039	24
0.040	32

4. Acceptable products:
a. Armstrong Armaflex 2000.
5. Seams, longitudinal: Factory-cut and self-sealing.

2.04 DUCTWORK INSULATION, NON-FLEXIBLE

A. Ductwork insulation, non-flexible:
1. Material: Commercial-grade fiberglass thermal insulation formed with a thermosetting resin into semi-rigid boards.
2. Designed for application on systems operating at temperatures between -20 and 230 degC.
3. Minimum density:
a. Semi-rigid: 48 kg/m3.
4. Thermal conductivity at mean temperature:
a. Semi-rigid:

k W/(m.K)	Mean Temperature degC
0.032	24
0.039	70
0.055	150

5. Acceptable products:
a. Owens-Corning Fiberglas Type 703 industrial insulation.
6. Facing:
a. Unfaced, foiled-reinforced-kraft (FRK), or all-service-jacket (ASJ) depending on applications as specified in Part Three.
(1) Temperature range: -30 to 70 degC.

B. Offer Option: High efficiency ductwork insulation, non-flexible Kooltherm Insulation Products Koolphen K phenolic foam insulation with ASJ vapor barrier jacket.
1. Thermal conductivity (k value): Not greater than 0.0188 W/(m.K).

2.05 DUCTWORK INSULATION, FLEXIBLE

A. Ductwork insulation, flexible:
1. Material: Commercial-grade fiberglass thermal insulation.
2. Designed for application on systems operating at temperatures between 4 and 120 degC.
3. Thermal conductivity at mean temperature:
a. k less than or equal to 0.039, 24 degC.
4. Acceptable products:
a. Owens-Corning Fiberglas commercial-grade all-service duct wrap.
5. Facing: Foiled, reinforced-kraft vapor-retarding.
6. Seams: 50 mm facing tab.

2.06 INSULATION FOR HOT EQUIPMENT

A. Same as Pipe Insulation, Non-flexible.

2.07 INSULATION FOR HIGH-TEMPERATURE EQUIPMENT

A. Insulation for high-temperature equipment:
1. Material: Calcium silicate.
a. Asbestos free.
b. Designed for application on systems operating at temperatures up to 650 degC.
c. Minimum density: 240 kg/m3.
d. Thermal conductivity at mean temperature:

k W/(m.K)	Mean Temperature degC
0.058	100
0.065	210
0.079	320

2. Acceptable types:
a. Owens-Corning Kaylo pipe and block insulation.

B. Insulation for high-temperature equipment:
1. Material: Thermal insulating wool batts.
a. Designed for application on systems operating at temperatures up to 540 degC.
b. Thermal conductivity at mean temperature:

k W/(m.K)	Mean Temperature degC
0.043	100
0.055	210
0.069	320

2. Acceptable types:
   a. Owens-Corning Thermal Insulating Wool Type II.

2.08 INSULATION FOR COLD EQUIPMENT AND GAUGES

A. Insulation for cold equipment and gauges:
   1. Material: Commercial-grade elastomeric thermal insulation.
   2. Designed for application with complete adhesive coverage on systems operating at temperatures between -40 and 90 degC.
   3. Thermal conductivity at mean temperature:

k W/(m.K)	Mean Temperature degC
0.039	24
0.040	32

   4. Acceptable products:
      a. Armstrong Armaflex II sheet insulation.

2.09 JACKETING AND PREFABRICATED FITTING COVERS

A. Jacketing and fitting covers, general:
   1. Fitting covers:
      a. Designed to fit over precut insulation inserts.
      b. Designed specifically for fitting being covered.
         (1) 2-gore covers are not acceptable.

B. Jacketing and fitting covers, PVC:
   1. High impact: Minimum 0.71 mm thick.
   2. Resistant to bacterial growth, mildew, and corrosion.
   3. Installations exposed to weather:
      a. Resistant to ultra-violet rays.
      b. Designed for direct exposure to weather exposure without painting.
   4. Minimum 25 mm overlap at joints.

C. Jacketing and fitting covers, metal:

1. Material: As indicated in Part Three.
2. On cold systems and equipment, provide factory moisture barrier.
3. Attaching method:
   a. 0.50 x 9 mm bands on 225 mm centers unless indicated otherwise in Part Three.
   b. Band material: Same as jacketing and covers.
4. Minimum 50 mm overlap at joints.
5. Tubular jacketing: Locking longitudinal seams.

D. Jacketing and fitting covers, vinyl:
1. Material: Molded closed cell vinyl.
2. Thermal conductivity at mean temperature:
   a. k less than or equal to 0.169, 24 degC.
3. Attaching method:
   a. Nylon ties.
4. Factory cut longitudinal seams.

2.10 INSULATION FASTENERS

A. Insulation adhesive:
1. Armstrong 520.
2. Childers CP-82.
3. Foster 30-36.
4. Halstead 77-198.

B. Insulation mastic:
1. Childers CP-30.
2. Foster 35-00-GPM.

C. Insulation caulking:
1. Dow No.11.

PART 3 - EXECUTION

3.01 APPLICATION - GENERAL

A. Apply products per manufacturer's recommendations and as specified.
1. Allow for thermal expansion and contraction.

B. Do not insulate piping until satisfactory completion of required pressure tests.

C. Do not insulate piping until heat tracing cable has been installed, tested with tests witnessed by Government Construction Inspector. Coordinate with cable installer.

D. In general, do not insulate piping below ground.
1. Specific exceptions may exist under "Pipe insulation,

flexible."

E. Apply insulation to clean, dry surfaces with pipe, duct, and equipment surfaces at room temperature.

F. Butt edges of insulation firmly together, and seal joints with compatible jackets, facings and adhesives as specified.

G. On cold systems and equipment, apply insulation with a continuous, unbroken vapor barrier.
   1. To prevent condensation, provide insulation and vapor seals on hangers, supports, and anchors that are secured directly to cold surfaces.

H. Continue insulation through sleeves and wall and ceiling openings.

I. Insulate fittings, valve bodies, flanges and other pipeline accessories.

J. Insulation at piping supports: Coordinate with Section 15140.

K. Rectangular and flat-oval ductwork exposed to weather:
   1. Apply insulation and jacketing so that top of ductwork has crown that effectively prevents pooling of water.
      a. Minimum crown slope: 20 mm/m.

L. Insulation installed in multiple layers: Stagger joints between layers.

M. Do not insulate supply ducts serving cleanrooms, (AHU-101, 102, 108-115).

3.02 PIPE INSULATION, NON-FLEXIBLE

A. General:
   1. Provide either type of lap seal at joints:
      a. Self-sealing facing tabs.
      b. 80 mm wide pressure-sensitive joint-sealing tape that matches facing.
         (1) Manufacturer: Same as insulation.
   2. Fittings:
      a. On non-serviceable items, use either the built-up system or prefabricated fitting covers.
      b. On serviceable items, use prefabricated fitting covers attached with bands.
         (1) Exception: On systems exposed to weather, attach with method described as best by manufacturer.

c. On exposed fittings, flanges, valves, and pipe terminations, use prefabricated fitting covers.
(1) Example: Mechanical rooms.
d. Built-up system:
(1) DN50 and smaller: Finish with mineral fiber cement to thickness of adjoining pipe insulation.
(2) DN65 and larger: Insulate with mitered pipe insulation segments or preformed fiberglass fittings. Secure with vinyl faced insulation strapping tape or 20 AWG galvanized annealed wire finished with one coat of mineral fiber cement.
(3) After mineral fiber cement is dry, finish with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.
e. Prefabricated PVC fitting covers:
(1) All sizes: Provide covers over mitered pipe-insulation segments or preformed fiberglass fittings.

B. Provide non-flexible insulation on following piping systems in wall thicknesses indicated:
1. Hydronic systems (supply and return):
a. Chilled water piping: CWS/R, SCWS/R, PCWS/R, make-up water.
(1) Runouts to DN50: 13 mm.
(2) DN200 and smaller: 25 mm.
(3) DN250 and larger: 40 mm.
b. Heating water piping: HWS/R.
(1) Runouts to DN50: 13 mm.
(2) DN50 and smaller: 40 mm for heating water.
(3) DN65 and larger: 40 mm.
c. Glycol heating water piping: GWS/R.
(1) Runouts to DN50: 13 mm.
(2) DN50 and smaller: 40 mm.
(3) DN65 and larger: 40 mm.
d. Glycol chilled water piping: LTGWS/R, glycol make-up to LTGWS system:
(1) Runouts to DN50: 25 mm.
(2) DN200 and smaller: 40 mm.
(3) DN250 and larger: 40 mm.
e. Laboratory slab conditioning water system: LSWS/R.
(1) High efficiency phenolic thermal insulation with ASJ and thickness of 50 mm.
(2) Apply to all piping and fittings as follows: Slab conditioning water supply from final heater through header and as indicated. Slab conditioning water return from point where it leaves slab to temperature sensor and as

indicated.
(3) Flexible insulation on rubber hoses in trenches.
(4) Slab conditioning water piping other than above: Non-flexible insulation 25 mm thick.

f. Cooling tower supply, return, drain, and overflow piping; and tower cleaning assembly piping, CTS/R, TCAS/R:
(1) Outdoors: 50 mm.
(2) Indoors: Not insulated.

g. Other piping: CHRWS/R, make-up water:
(1) DN50 and smaller: 13 mm.
(2) DN65 and larger: 25 mm.

h. Scrubber piping, exposed; and scrubber make-up water and blowdown piping:
(1) Outdoors: 50 mm.

2. Plumbing systems:

a. Domestic and laboratory cold water piping:
(1) DN50 and smaller: 13 mm.
(2) DN65 and larger: 25 mm.

b. Domestic and laboratory hot/circulating water 38-54 øC:
(1) DN100 and smaller: 25 mm.
(2) DN125 and larger: 40 mm.

c. Hot water and waste lines below accessible lavatories and sinks:
(1) All sizes: 13 mm.
(2) Waste lines are hot systems.

d. Horizontal above grade rain leaders (including 600 mm up and down from horizontal and up to underside of roof deck):
(1) All sizes: 25 mm.
(2) Rain leaders are cold systems.

e. Horizontal above grade drain pipe (including 600 mm up and down from horizontal and up to underside of floor slab) from floor drain (FD-3/FD-5) receiving condensate discharge to connection with stack/leader:
(1) All sizes: 25 mm.
(2) This is a cold system.

f. Horizontal above grade compressed air intake and vacuum exhaust (including 600 mm up and down from horizontal and up to underside of roof deck):
(1) All sizes: 25 mm.
(2) These are cold systems.

3. Steam systems:

a. Steam piping (0-100 kPa, 90-120 øC).
(1) Runouts to DN50: 25 mm.
(2) DN50 and smaller: 40 mm.
(3) DN65 to DN150: 50 mm.
(4) Over DN150: 90 mm.

b. Steam piping (100-560 kPa, 120-150 øC):
(1) Runouts to DN50: 40 mm.
(2) DN25 and smaller: 50 mm.
(3) DN32 to DN100: 65 mm.
(4) Over DN100: 90 mm.
c. Steam piping (Over 560 kPa, 150 øC).
(1) Runouts to DN50: 40 mm.
(2) DN25 and smaller: 65 mm.
(3) DN32 to DN50: 65 mm.
(4) DN65 to DN100: 75 mm.
(5) Over DN100: 90 mm.
d. Steam condensate, pumped condensate return, condensate vent, blowdown, and exhaust steam (all temperatures) piping:
(1) DN25 and smaller: 40 mm.
(2) DN32 to DN50: 40 mm.
(3) Over DN50: 50 mm.
(4) Runouts to DN50: 25 mm.

3.03 PIPE INSULATION, FLEXIBLE

A. General:
1. Install by slipping insulation over piping.
2. Do not make longitudinal field cuts.
3. Seal joints with manufacturer approved adhesive.

B. Fittings:
1. Insulate fittings and valve bodies with segments cut from pipe insulation.

C. Provide flexible insulation on following piping systems in wall thicknesses indicated:
1. Hydronic systems:
a. Cooling coil condensate:
(1) All sizes: 13 mm.
b. Chilled water runouts: CWS/R, SCWS/R, PCWS/R, LTGWS/R.
(1) DN50 and smaller: 13 mm.
(2) Included are runouts to fan coil units.
c. Heating water runouts: HWS/R, CHRWS/R, GWS/R.
(1) DN50 and smaller: 13 mm.
(2) Included are runouts to fan coil units, unit heaters, finned tube radiation and air terminal units.
d. Laboratory slab conditioning water system: LSWS/R.
(1) Flexible rubber hose: Pipe insulation, flexible, 25 mm.
2. Plumbing systems:
a. Waste piping from water coolers and drinking fountains to first point of mixing with waste from

a different type of fixture:
(1) All sizes: 13 mm.

3.04 DUCTWORK INSULATION, NON-FLEXIBLE

A. General:
1. Secure insulation to ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.
a. Secure insulation on mechanical fasteners with speed clips.
b. Space mechanical fasteners to hold insulation securely in place.
(1) Maximum spacing: 300 mm centers.
2. Where access is not possible for pin attachment, use adhesive or caulk.
a. Cover entire surface with brush applied adhesive.
b. Apply caulk in continuous bead on 150 mm centers.
3. Seal joints and speed clips with 80 mm wide pressure-sensitive joint-sealing tape that matches facing.
a. Staple corners of tape with outward clinching staples.
4. Cold systems only: Coat staples with mastic.
5. Reinforce edges with metal corner angles.
6. Apply insulation to ductwork from air handling unit housing to ends of duct runs including diffuser necks and register ducts.
7. Do not apply insulation over coil and damper access panels except in ducts serving high accuracy laboratories (0.1 and 0.01 øC).
8. Use FRK facing on concealed ductwork.
9. Use ASJ facing on exposed ductwork including ducts in mechanical rooms, rooms without ceiling, and in distribution levels.
10. Do not apply over internally lined ductwork: Coordinate with Section 15880.

B. Provide non-flexible semi-rigid insulation on following ductwork in thicknesses indicated:
1. Outside-air ductwork (rectangular) including sound attenuators.
a. All sizes: 50 mm.
2. Supply-air and wake-up air ductwork exposed (rectangular):
a. All sizes: 25 mm except as noted below.
3. Outside-air, relief/exhaust-air plenums behind louvers or below roof ventilators (gravity and powered):
a. All sizes: 50 mm.
4. Supply and return ducts serving high accuracy laboratories (0.1 and 0.01 øC):
a. All supply ducts from air handling unit discharge to electric reheat coils: 50 mm.

b. All return ducts and plenums from laboratories to air handling units: 50 mm.
c. All supply ducts and plenums from electric reheat coils (coils included) to distribution plenums, including silencer:
(1) Commercial grade fiberglass insulation. Apply two layers 80 mm plus 100 mm for a total of 180 mm. Stagger all joints.
(2) Offer Option: High efficiency phenolic foam insulation. Apply two 50 mm thick layers for a total of 100 mm. Stagger all joints.
(3) Box around damper operators and other devices to protect the integrity of the duct insulation.
(4) Provide removable insulation plugs at access panels and other devices to maintain duct insulation integrity. Size plugs so that friction fit will hold them in place. Provide tabs for removal.

3.05 DUCTWORK INSULATION, FLEXIBLE

A. General:
1. On ductwork 600 mm wide and less, secure insulation to bottom of ductwork with 100 mm wide bands of brush-applied adhesive on 300 mm centers.
2. On ductwork over 600 mm wide, secure insulation to bottom of ductwork by impaling over welded-pin or adhesive-pin mechanical fasteners.
a. Secure insulation on mechanical fasteners with speed clips.
b. Space mechanical fasteners to hold insulation securely in place.
(1) Maximum spacing: 300 mm centers.
c. Seal speed clips with 80 mm wide pressure-sensitive joint-sealing tape that matches jacket.
(1) Staple corners of tape with outward clinching staples.
(2) Cold systems only: Seal staples with mastic.
3. Provide either type of lap seal at joints:
a. Seal facing tab over adjoining facing with lap adhesive.
(1) Secure lap with outward clinching staples on 150 mm centers.
b. Use 80 mm wide pressure-sensitive joint-sealing tape that matches facing.
(1) Secure both sides of tape with outward clinching staples on 150 mm centers.
c. Cold systems only: Seal staples with mastic.
4. Apply insulation to ductwork from air handling unit

housing to ends of duct runs, including diffuser necks and register ducts.
5. Do not apply insulation over coil and damper access panels.

B. Provide flexible insulation on following ductwork in thicknesses indicated:
1. Outside-air ductwork (round):
a. All sizes: 50 mm.
2. Supply-air ductwork (including downstream of terminal units) except where specified to be covered by non-flexible insulation:
a. All sizes: 40 mm.

3.06 INSULATION FOR HOT EQUIPMENT

A. General:
1. Secure insulation to bottom of flat surfaces wider than 600 mm by impaling over adhesive-pin mechanical fasteners.
a. Secure insulation on mechanical fasteners with speed clips.
b. Space mechanical fasteners to hold insulation securely in place.
(1) Maximum spacing: 300 mm centers.
2. Seal joints and speed clips with 80 mm wide pressure-sensitive joint-sealing tape that matches facing.
a. Secure both sides of tape with outward clinching staples on 80 mm centers, 5 mm from edge.
3. Insulate flanges and fittings as indicated under "Pipe insulation, non-flexible."
4. Reinforce ends and irregular surfaces with Glass Fab embedded in 2 coats of Foster 30-36 adhesive.

B. Provide hot-equipment insulation on following equipment in thicknesses indicated:
1. Air separators: 50 mm.
2. Condensate receivers (above ground): 50 mm.
3. Flash tanks: 50 mm.
4. Heating water expansion tanks: 50 mm.
5. Steam-to-water heat exchangers: 50 mm.
6. Blowdown separators: 50 mm.
7. Feedwater system: 50 mm.

3.07 INSULATION FOR HIGH-TEMPERATURE EQUIPMENT

A. Calcium silicate:
1. Apply blocks in layers over high ribbed lath.
2. Butt block surfaces tightly together.
3. Secure with 16 AWG galvanized annealed wire or 0.38 x

12 mm wide galvanized bands on 300 mm maximum centers.
4. Anchor wire and bands to welded pins, clips or angles.
5. Apply 25 mm hex galvanized wire over insulation.
6. Fill voids with 6 mm insulating cement.

B. Thermal insulating wool batts:
1. Secure insulation to metal surfaces by impaling over weld-pin mechanical fasteners.
a. Secure insulation on mechanical fasteners with speed clips.
b. Space mechanical fasteners to hold insulation securely in place.
(1) Maximum spacing: 400 mm centers.

C. Provide high-temperature equipment insulation on following equipment in number of layers and total thicknesses indicated:
1. Emergency generator catalytic convertor/silencer: 2 layers, 90 mm.
2. Emergency generator exhaust piping inside generator enclosure: 2 layers, 90 mm.
3. Coordinate with Division 16 with respect to catalytic convertor/silencer and exhaust pipe to be insulated.

3.08 INSULATION FOR COLD EQUIPMENT AND GAUGES

A. Apply insulation with manufacturer's approved adhesive.
1. Completely cover joining surfaces (equipment surfaces, and back and butting edges of insulation).
2. Apply with 3 mm overlay pressure on butt joints.
3. Apply 2 coats of manufacturer's approved white latex enamel to outside layer.

B. Provide cold-equipment insulation on following equipment in number of layers and total thicknesses indicated:
1. Water chiller boxes: 2 layers, 40 mm.
2. Evaporator heat exchangers of double shell chillers: 1 layer, 20 mm.
3. Floor drain bodies (FD-3) which receive condensate discharge: Exposed, above grade, 1 layer, 20 mm.
4. Roof drain bodies: 1 layer, 20 mm.
5. Chilled water expansion tanks: 1 layer, 20 mm.
6. Chilled water air separators: 1 layer, 20 mm.
7. Water softeners: 1 layer, 20 mm.
8. Liquid to liquid heat exchangers: 1 layer, 20 mm.
9. Tower cleaning assembly components: 2 layers, 50 mm.
10. Spray water sump-exhaust gas scrubber: 2 layers, 50 mm.

C. Pump insulation:
1. Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming

the bottom and sides using joints which do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with contact adhesive. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable.

2. Exposed insulation corners shall be protected with corner angles.

3.09 JACKETING AND PREFABRICATED FITTING COVERS

A. General:
   1. Stagger jacketing and insulation joints.

B. Systems exposed to weather:
   1. Material:
      a. 0.41 mm smooth aluminum.
   2. Attach with method described as best by manufacturer.
   3. Joints:
      a. Orient joint laps to prevent entry of water.
      b. Seal joints weather tight.

C. Hot equipment:
   1. Material:
      a. 0.41 mm smooth aluminum.
   2. Attach with method described as best by manufacturer.

D. High-temperature equipment:
   1. Material:
      a. 0.25 mm smooth stainless steel.
   2. Attach with stainless-steel screws or 0.50 mm x 20 mm stainless steel bands on 200 mm centers.

E. Hot water and waste lines exposed beneath accessible fixtures:
   1. Material:
      a. PVC jacketing and covers over non-flexible insulation.
         (1) Attach with bands.
      b. Vinyl jacketing and covers.

END OF SECTION

SECTION 15410

PLUMBING PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of systems:
    1. Systems:
        a. Cold, hot, tempered, and circulating domestic water piping systems within building and to 1500 mm outside building wall.
        b. Drainage piping systems:
            (1) Soil, waste, vent, indirect, drain, and storm piping within building and to 1500 mm outside building wall.
        c. Pressure drainage piping.
        d. Exposed piping in finished areas.
    2. Products:
        a. Backflow protection devices.
        b. Cleanouts.
        c. Drains:
            (1) Floor drains.
            (2) Funnels.
            (3) Roof drains.
        d. Flashings.
        e. Traps.
        f. Valves:
            (1) Automatic trap primer valves.
            (2) Balancing valves, constant flow control.
            (3) Check valves.
            (4) Manual valves, potable water.
            (5) Manual valves, waste-water.
        g. Water-hammer arresters.
        h. Downspout nozzles.

B. Definitions:
    1. Caulked: Tamped lead and oakum joint.
    2. Drainage piping: Soil, waste, vent, indirect, and storm piping.
    3. Brazing: High-temperature soldering.
    4. Pressure drainage piping: Branch piping from discharge of sump pump or sewage ejector to connection with gravity drainage piping.

1.02 QUALITY ASSURANCE

A. Code: Washington Suburban Sanitary Commission Plumbing Regulations - June, 1999 Edition.

B. Pipe and fittings standards: See Section 15060.

C. Valve standards: See Section 15100 (for valves labeled "V-__").

D. Standards for sterilization: AWWA-C651 and C652.

E. Water-hammer arresters standard: ASSE-1010.

F. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS

A. Shop drawings:
   1. Piping layout drawings at 1:50 scale.

B. Product data: Model numbers are not specified; include sufficient information to verify compliance with Specifications.
   1. Backflow protection devices.
   2. Drains.
   3. Valves.
   4. Water hammer arresters.
   5. Downspout nozzles.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Pressure test reports.
   2. Disinfection test report.
   3. Operating and maintenance data.
   4. Manufacturer's recommended spare parts list.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
   1. Backflow protection device (Reduced-pressure principle):
      a. Base:
         (1) Watts.
      b. Optional:
         (1) Cla-Val Co.
         (2) Febco.
         (3) Hersey.
         (4) Wilkins.
   2. Backflow protection device (Vacuum breakers):

a. Base:
(1) Watts.
b. Optional:
(1) Febco.
(2) Wilkins.

3. Cleanouts and Drains:
a. Base:
(1) Wade.
b. Optional:
(1) Ancon.
(2) Josam.
(3) Jonespec.
(4) J R Smith.
(5) Zurn.

4. Valves (Automatic trap primer):
a. Base:
(1) Precision Plumbing Products.
b. Optional:
(1) J R Smith.
(2) Wade.

5. Valves (Constant flow control balancing valves):
a. Base:
(1) Autoflow.
b. Optional:
(1) Griswold.
(2) Presco.

6. Water-hammer arresters.:
a. Base:
(1) Wade.
b. Optional:
(1) Precision Plumbing Products.
(2) J R Smith.
(3) Jonespec.
(4) Josam.
(5) Zurn.
(6) Sioux Chief Manufacturing Co.

7. Downspout nozzles:
a. Base:
(1) Ancon.
b. Optional:
(1) Josam-Blucher.

8. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPE AND FITTINGS

A. Domestic water piping:
1. Domestic water piping at service entrance (from 300 mm inside building to 1500 mm outside): Same as Indicated for outside utilities.
2. DN50 and smaller after service entrance:

a. Above grade:
(1) Copper, type L, with solder joints, and wrought copper or cast brass fittings.
(2) T-drilled branch taps with brazed joints are acceptable where the tapped pipe is at least DN25 diameter and where branch is at least 2 pipe sizes smaller.
b. Below grade:
(1) Copper, type K soft, with brazed joints and wrought copper or cast brass fittings.
(2) Where below-grade run of piping is shorter than 15 m, below-grade joints are not acceptable.

3. DN65 and larger after service entrance:
a. Copper, type L, with soldered joints and wrought copper or cast brass fittings.
b. Copper, type L, with roll-groove joints and wrought copper or cast brass fittings.
c. In copper, T-drilled branch taps with brazed joints are acceptable where the tapped pipe is at least DN25 diameter and where branch is at least 2 pipe sizes smaller.

B. Drainage and vent piping (soil, waste, vent, indirect, drain, and storm):
1. Above grade:
a. Cast-iron, hubbed pipe and fittings with lead-and-oakum or elastomeric push joints, as allowed by code.
b. Cast-iron, hubless pipe and fittings with elastomeric sealing sleeves with stainless-steel clamps, or cast iron couplings with elastomeric gaskets and stainless steel bolts and nuts as allowed by code. Provide heavy duty no-hub couplings on all storm piping consisting of an elastomeric sealing sleeve and stainless-steel clamp a minimum of 75 mm long, and a minimum of 4 stainless-steel clamps mounted in series.
c. Copper (type DWV or heavier), with soldered joints and wrought copper or cast brass drainage and vent fittings, as allowed by code.
2. Below grade:
a. DN50 diameter or larger.
b. Cast-iron, hubbed pipe and fittings with lead-and-oakum or elastomeric push joints, as allowed by code.

C. Pressure drainage piping:
1. Galvanized steel, cast-iron drainage fittings with threaded joints.

D. Exposed piping in finished areas:
    1. Chrome or nickel plated brass to wall or floor.
    2. Piping DN50 and larger may be provided with chrome or nickel plated brass sleeves to cover pipe and fittings.
        a. See Section 15010.

2.03 BACKFLOW PROTECTION DEVICES

A. Backflow protection devices, general:
    1. Type and manufacturer as approved by Washington Suburban Sanitary Commission.

B. Reduced-pressure principle backflow preventer (BFP):
    1. Two check valves, test cocks, pressure differential relief valve, isolation valves and accessories assembled as an integral unit, horizontally mounted.
    2. Threaded ends: DN50 and smaller.
    3. Flanged ends: DN65 and larger.
    4. Provide drain line from relief to floor drain. Size of drain line shall be equal to or larger than the relief connection size.
    5. Isolation valves:
        a. DN50 and smaller: Ball valve.
        b. DN65 and larger:
            (1) OS&Y.
        c. Provide No. 1 test cock on inlet valve.
    6. Size BFP's to have a pressure loss less than 90 kPa at flows Indicated below (refer to drawings for pipe sizes):
        a. DN15 pipe: 0.130 L/s.
        b. DN20 pipe: 0.370 L/s.
        c. DN25 pipe: 0.800 L/s.
        d. DN32 pipe: 1.380 L/s.
        e. DN40 pipe: 2.200 L/s.
        f. DN50 pipe: 4.700 L/s.
        g. DN65 pipe: 7.800 L/s.
        h. DN75 pipe: 10.7 L/s.
        i. DN100 pipe: 19.8 L/s.

C. Pressure type vacuum breakers (PTVB):
    1. Designed to protect against back-siphonage in continuous-pressure piping systems.
    2. Bronze body and lightweight internal floats designed to eliminate spillage.
    3. Provide isolation ball valve on inlet and outlet of PTVB.
    4. Provide outlet connection on VB compatible with equipment/fixture being served.
    5. Mount bottom of VB at least 300 mm above the flood-level rim of the equipment/fixture being served.

6. Provide test cocks.
7. Match VB size to pipe size indicated on drawings.

D. Atmospheric vacuum breakers (VB):
1. Bronze body and lightweight internal float designed to eliminate spillage.
2. Provide isolation valve immediately upstream of VB.
3. Provide outlet connection on VB compatible with equipment/fixture being served.
4. Mount bottom of VB at least 150 mm above the flood-level rim of the equipment/fixture being served.
5. Match VB size to pipe size indicated on drawings.

2.04 CLEANOUTS

A. Cleanouts, general:
1. Provide flashing collars and clamps for CO bodies being installed in floors with finishes installed over waterproofing.
a. Coordinate with Division Nine and Room-Finish Contractors.
2. Dimensions are nominal.
3. Body material (unless Indicated otherwise): Coated cast iron.
4. Cleanout plugs:
a. Extra-heavy, threaded, tapered, brass plug with solid hexagonal nut.
b. Comply with Plumbing Code.
c. Provide with American Standard pipe threads.
5. Cleanouts on lines completely accessible from within pipe chases do not require covers.
6. Cleanouts in exposed piping in equipment rooms do not require special covers.

B. Interior, floor-mounted cleanouts:
1. Extra-heavy, flanged, cast-iron ferrule, tapped for cleanout plug with spigot or inside-caulk outlet.
2. Two-piece, threaded, adjustable housing.
3. Top and cover as specified below by floor finish.
a. Resilient tile and sheet finish: Round flange top with scoriated cover.
b. Ceramic tile finish: Square flange top with scoriated cover.
c. Poured finish: Round, wide-flange top with scoriated cover.
d. Carpet finish: Round top with standard top tapped for carpet-marker bolt.
e. Terrazzo finish: Round top with recessed-for-terrazzo cover.
f. Quarry tile finish: Square, heavy-duty top with heavy-duty scoriated cover.

g. Concrete finish (unfinished areas): Heavy, round frame with satin-bronze, scoriated tractor top.

C. Cleanouts in vertical piping:
1. Tapped cleanout tee.
2. Extra-heavy, threaded, brass plug with solid hexagonal nut.

D. Cleanouts in hubs of combination wye and eighth bends or wyes.
1. Tapped spigot.
2. Extra-heavy, threaded, brass plug with solid hexagonal nut.

E. Cleanouts at ends of hubless combination wye and eighth bends or wyes.
1. Blind plug.

F. Covers over cleanouts in concealed vertical piping:
1. Square, nickel-bronze frame with secured, smooth, stainless-steel access cover.
2. 150 x 150 mm for pipe sizes DN100 and less.
3. 230 x 230 mm for pipe sizes DN125 and larger.

G. Exterior cleanouts: See section 15021.

2.05 DRAINS

A. Drains, general:
1. Provide flashing clamps with seepage openings for drain bodies with flashing collars being installed in floors with finishes installed over waterproofing.
a. Coordinate with Division Nine and Room-Finish Contractors.
2. Provide underdeck clamps for drain bodies except those installed in slabs on grade.

B. Area drains:
1. General:
a. Dimensions are nominal.
b. Material (unless Indicated otherwise): Coated cast iron.
2. AD-1:
a. Bottom outlet.
b. Square top.
c. Round hinged and secured grate.
d. Integral ball-float backwater valve.

C. Floor drains:
1. General:
a. Dimensions are nominal.

b. Provide trap-primer taps where trap primer valves are required: See paragraph on trap primer valves.
c. Material (unless Indicated otherwise): Coated cast iron.

2. FD-1:
a. 300 mm diameter flashing collar.
b. Adjustable top.
c. 200 mm diameter, removable, non-tilt tractor grate.

3. FD-2:
a. 250 mm diameter flashing collar.
b. Reversible flashing clamp with seepage openings and tapped opening for strainer body.
c. Threaded strainer body.
d. 150 mm square, secured, satin nickel bronze, removable strainer.

4. FD-3:
a. 300 mm diameter flashing collar.
b. Adjustable top.
c. 200 mm diameter, removable, non-tilt tractor grate.
d. Cast iron oval funnel, 225 mm by 85 mm by 95 mm tall. Secure to grate with screws.
e. Coated cast iron, plastic ball-float, elastomer seat, bronze cage backwater valve.

5. FD-4:
a. 375 mm diameter flashing collar.
b. 300 mm diameter, removable, heavy duty, loose set, ductile iron grate.
c. 250 mm internal depth (underside of grate to top of drain bottom).

6. FD-5:
a. 250 mm diameter flashing collar.
b. Reversible flashing clamp with seepage openings and tapped opening for strainer body.
c. Threaded strainer body.
d. 225 mm round by 35 mm high extended rim strainer, nickel bronze, secured.
e. Coated cast iron, plastic ball-float, elastomer seat, bronze cage backwater valve.

D. Roof drains:
1. General:
a. Dimensions are nominal.
b. Material (unless Indicated otherwise): Coated cast iron.
c. Provide deck clamps.

2. RD-1:
a. Flashing collar diameter: 400 to 500 mm.
b. Flashing clamp with gravel stop.

c. Mushroom dome height: 125 mm.
d. Mushroom dome diameter: 280 to 350 mm.
e. Provide solid or adjustable extension to allow for insulation thickness between concrete deck and waterproof membrane.
(1) Coordinate extension height with roof insulator.

3. RD-2:
a. Flashing collar diameter: 400 to 500 mm.
b. Flashing clamp with gravel stop.
c. Integral 50 mm tall water dam.
d. Mushroom dome height: 125 mm.
e. Mushroom dome diameter: 280 to 350 mm.
f. Provide solid or adjustable extension to allow for insulation thickness between concrete deck and waterproof membrane.
(1) Coordinate extension height with roof insulator.

2.06 FLASHINGS

A. On floors above grade, allow for flashings provided by others at penetrations in floors with finishes installed over waterproofing.
1. Coordinate with Room-Finish Contractors.

2.07 TRAPS

A. Traps, general:
1. Cast brass or cast iron, one piece pattern, 75 mm minimum seal.
2. Same material, coating, and finish as piping system into which they are installed except traps DN50 and under, not buried in earth, shall be cast brass with union and cleanout.
3. Place trap cleanouts in accessible locations.

B. Provide deep-seal traps for drain bodies in ventilation housings: Traps need to maintain seal against static pressure in fan housing.

C. Traps for drains with buried outlet: Extra heavy cast iron P-traps, unless otherwise Indicated.

2.08 VALVES

A. Automatic trap primer valves.
1. General:
a. Rebuildable.
b. Integral vacuum breaker on drain branch.
c. Connections: Soldered or threaded.

d. Provide trap primers as indicated on drawings.

2. Automatic trap primer valve:
   a. Serves one to eight drains.
   b. Integral backflow preventer.
   c. Designed to be installed in supply line with continuation to drain.
      (1) Activated by 20 kPa drop or more in main.
   d. Automatically adjusts to line pressures between 240 and 520 kPa.
3. Trap primer distribution reservoir.
   a. Copper reservoir with brass fittings and clean plastic inspection cover.
      (1) Feeds up to four traps through separate lines.
      (2) Provide mounting brackets.

B. Balancing valves, constant flow control:
1. Factory calibrated, direct acting, automatic pressure compensating.
2. Control flow rates within 5 percent of flow rating over operating pressure differential range.
   a. Unless noted otherwise, set flow rating according to pipe sizes indicated on drawings:
      (1) DN15 pipe: 0.060 L/s.
      (2) DN20 pipe: 0.250 L/s.
      (3) DN25 pipe: 0.600 L/s.
      (4) DN32 pipe: 0.950 L/s.
3. Pressure differential range:
   a. 14-220 kPa.
4. Threaded-brass or copper-sweat body with stainless-steel internal parts.
5. Provide a metal identification tag with chain for each installed valve.
   a. Identify zone or location, valve model number, flow rate, direction of flow, and differential pressure range.
6. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.
7. Provide manual valve upstream and downstream of each valve.

C. Check valves:
1. DN50 and smaller: V-24 or V-25.
2. DN65 and larger: V-28 or V-29.

D. Manual valves, potable-water:
1. DN50 and less: V-13 or V-14.
2. DN65 to DN100:
   a. V-33 or V-35 or V-62.
   b. 10 position locking, manual handle.

3. DN150 and larger:
    a. V-34 or V-35 or V-62.
    b. Totally enclosed gear operator and wheel handle.
    c. At equipment and at service entrance:
        (1) Use lug type valves, V-33.
        (2) Use groove-end type valves, V-62.
4. Balancing cocks:
    a. Constant flow control balancing valves.

E. Manual valves, waste-water:
1. Drainage piping shut off: V-37.
2. Pressure drainage piping:
    a. Shut off: V-3.
    b. Check: V-30.

2.09 WATER-HAMMER ARRESTERS

A. Water-hammer arresters: Engineered, and certified in accordance with American Society of Sanitary Engineering Standard ASSE-1010.

2.10 DOWNSPOUT NOZZLE

A. Stainless steel downspout nozzle, with wall flange and inlet connection.

PART 3 - EXECUTION

3.01 GENERAL

A. General:
1. Provide piping as Indicated and to provide fixtures and items of equipment with proper drainage, vent, and water connections as required by code.
2. Hold piping as close to structure as possible to maintain maximum head room.
3. Run piping concealed wherever possible.
4. Under no circumstances reduce pipe size Indicated without written consent of COTR.
5. Size branches to individual fixtures as scheduled.
6. Consult the following before roughing in piping:
    a. Manufacturer's data.
    b. Large-scale architectural, and mechanical drawings of rooms containing equipment and plumbing fixtures.
7. Stub piping through wall directly behind item being served (e.g., equipment, plumbing fixtures, vending machines).
    a. Cap and protect until such time as installation is performed.

b. Exception: Upon approval of COTR, piping mains and/or branches may be run in lab benches, in built-in counters, and in cabinet work.

8. Plug or cap piping immediately after installation.
9. Provide chromed escutcheons on finished-area sides of pipe penetrations.
   a. Secure escutcheons so they make contact with floor, wall, or ceiling.
10. Provide equipment in accordance with manufacturer's instructions.
11. Provide piping supports, sleeves, and seals as Indicated in Section 15140.

3.02 DOMESTIC WATER PIPING SYSTEMS

A. General:
   1. Provide plumbing without cross- or inter-connections between potable and non-potable lines.
   2. Provide unvalved system drains on trapped portions of systems: See Section 15120.
   3. Provide thermometers and pressure gauges where indicated on drawings: See Section 15120.

B. Service entrance installation through exterior wall: See Section 15140 (water-stop pipe sleeves).

C. Backflow protection devices.
   1. Provide at following locations:
      a. At fixtures and equipment as Indicated and required by code.
      b. Where specified in Section 15440: Plumbing Fixtures.
      c. Where specified in Section 15485: High Purity Water Systems.
   2. Pipe drain from reduced pressure principle backflow preventers to floor drain or mop sink.

D. Balance hot water and tempered water circulation systems.

E. Provide manual isolation valves at following locations.
   1. To isolate groups of fixtures and equipment on branch runouts from piping mains.
   2. On each branch serving a rest room.
   3. On inlet and outlet of each equipment.
   4. On each branch to hose bibb or wall hydrant.
   5. At main feed points to domestic water pipe risers.
   6. As Indicated and as required to adequately service parts of systems and equipment.

F. Wire isolation valves on emergency fixtures open and tag "Do Not Close".

G. Provide water-hammer arresters on hot and cold water lines in accordance with PDI Standard WH-201 and ASSE-1010 sizing and placement data.

H. Testing of domestic water system:
   1. Upon completion of system or a section of system, test piping hydrostatically to pressure not less than 50 percent in excess of pipe's working pressure, but in no case less than 1040 kPa.
      a. System shall hold pressure for 24 hours.
   2. Repair leaks or replace defective pipe disclosed by tests.
   3. Repeat tests until piping indicates tight.
   4. Do not put system into service until tests are approved by Government Construction Inspector, and sterilized.

I. Sterilization of domestic water system:
   1. Sterilize system as indicated or in accordance with AWWA-C651 or C652.
   2. Thoroughly flush potable water systems.
   3. After flushing, introduce chlorine or chlorine compound into system with dosage sufficient to give an initial residual chlorine content of 50 PPM.
   4. Collect samples from various taps and fixtures throughout buildings during introduction of chlorine to assure uniform distribution.
   5. Open and close valves several times.
   6. After a 24 hour contact period, flush traces of heavily chlorinated water from systems.
   7. After flushing is complete, indicate effectiveness of disinfection by submitting laboratory reports of bacteriological tests on samples taken from system.
   8. If unsatisfactory results are obtained, repeat disinfection process until satisfactory.
   9. Do not put system into service until tests are approved by Government Construction Inspector.

3.03 DRAINAGE/VENT PIPING SYSTEMS

A. General:
   1. Changes of direction and junctions: Make with wye fittings and eighth bends.
      a. Use sanitary tee fittings in vertical pipe only.
         (1) Sanitary crosses not allowed.
   2. Provide P-trap for each direct waste-pipe connection to equipment.
   3. Trap fixtures as required by code.
   4. Provide air gaps at indirect drains.

B. Slopes:
    1. Provide horizontal soil, waste, drain, and storm lines with following slopes:
        a. DN65 and smaller pipes:
            (1) 20 mm/m.
        b. DN75 and larger pipes:
            (1) 10 mm/m.
        c. Slopes indicated on drawings override those indicated here.

C. Vents:
    1. Run vent stacks parallel to soil and waste stacks to receive branch vents from fixtures.
        a. Each vent stack shall originate from a soil or waste stack at its base.
    2. To permit proper flashing, offset through-the-roof piping away from walls on roof before passing through roof.
    3. Carry vent stacks DN100 and larger full size through roof.
    4. Provide vent lines so they will drain and not trap water.
    5. Where possible combine soil, waste or vent stacks before passing through roof to minimize roof openings.
    6. Where minimum vent-through-roof size is larger than vent size, provide increaser minimum of 305 mm below roof line.
        a. Minimum vent-through-roof size:
            (1) DN100.
    7. Extend vent stacks at least 300 mm above roofing.

D. Provide cleanouts on drainage piping as indicated below and on drawings:
    1. Locations:
        a. At dead ends.
        b. At changes of direction greater than 45 degrees.
        c. At junction of building drain and building sewer.
        d. 920 to 1220 mm above finished floor in vertical piping that connects to horizontal soil, waste, or storm piping immediately below in ceiling space or under grade.
        e. As test tee to receive test plugs in each riser at least every other floor.
        f. At maximum 15 m intervals in horizontal DN100 and smaller drains.
        g. At maximum 30 m intervals in horizontal, DN125 and larger drains.
    2. Sizes:
        a. DN100 diameter and smaller piping: Match pipe size.
        b. DN125 diameter and larger piping: Not less than

DN100.

3. Where cleanouts occur in concealed spaces, provide with extensions to wall or to floor above.
   a. Make extensions using long sweep ells or wye and eighth bends.
4. Where cleanouts are indicated in ceiling spaces above critical areas, extend cleanouts through floor above.
5. Provide carpet-marker bolts after carpet installation.

E. Provide piping and drains to allow for flashings provided under Roofing System section.
   1. Coordinate with Roofing Contractor.

F. Floor drains:
   1. At locations with waterproofing: Set top of flashing collar 12 mm below level of waterproofing.
   2. At locations without waterproofing: Place drain integrally with poured concrete.
   3. Set top of flat strainer/grate flush with finished floor.
   4. Set top of extended rim strainer a minimum of 25 mm above finished floor.
   5. Set over P-traps.

G. Testing of drainage piping systems:
   1. Do not insulate, conceal, or install furring around pipe until it has been tested to satisfaction of COTR.
      a. If inspection or test indicates defects, replace such defective work or material and repeat inspection and tests.
   2. Test piping at completion of installation of each stack or section of piping.
      a. Fill system with water to highest point and check joints and fittings for leaks.
      b. Eliminate leaks before proceeding with work or concealing piping.
      c. Minimum test height: 3050 mm.
      d. Make repairs to piping with new material.
      e. Peening and chiseling of holes or screwed joints is not allowed.

3.04 FIXTURES/EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

A. Unless otherwise noted, Division 15 only provides rough-in and final connection including but not limited to water supply stops, p-traps, and trap nipples.

B. Rough-in shall be provided based on COTR approved rough-in drawings furnished by the fixture/equipment manufacturer.

C. Water supply stops, p-traps, and trap nipples shall be of

same type and quality as specified for similar fixtures provided by Division 15.

END OF SECTION

SECTION 15411

LABORATORY PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of systems:
   1. Systems:
      a. Laboratory cold, hot, and circulating water piping systems.
      b. Laboratory drainage and vent piping systems.
      c. Pressure drainage piping.
      d. Exposed piping in finished areas.
   2. Products:
      a. Cleanouts.
      b. Drains:
         (1) Floor drains.
      c. Flashings.
      d. Neutralization tanks.
      e. Traps.
      f. Valves:
         (1) Automatic trap primer valves.
         (2) Balancing valves, constant flow control.
         (3) Check valves.
         (4) Manual valves, water.
         (5) Manual valves, waste-water.
      g. Water-hammer arresters.

B. Definitions:
   1. Brazing: High-temperature soldering.
   2. Pressure drainage piping: Branch piping from discharge of sump pump to connection with gravity drainage piping.

1.02 QUALITY ASSURANCE

A. Code: Washington Suburban Sanitary Commission Plumbing Regulations - June, 1999 Edition.

B. Pipe and fittings standards: See Section 15060.

C. Valve standards: See Section 15100 (for valves labeled "V-__").

D. Standards for sterilization: AWWA-C651 and C652.

E. Water-hammer arresters standard: ASSE-1010.

F. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS

A. Shop drawings:
   1. Piping layout drawings at 1:50 scale.

B. Product data: Model numbers are not specified; include sufficient information to verify compliance with Specifications.
   1. Drains.
   2. Neutralization tanks.
   3. Valves.
   4. Water hammer arresters.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Pressure test reports.
   2. Disinfection test report.
   3. Operating and maintenance data.
   4. Manufacturer's recommended spare parts list.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
   1. Pipe and fittings - drainage and vent:
      a. Base:
         (1) R & G Sloan GSR Fuseal.
      b. Optional:
         (1) Orion Fittings, Inc.
         (2) Enfield Industrial Corp.
   2. Cleanouts and Drains:
      a. Base:
         (1) R & G Sloan GSR Fuseal.
      b. Optional:
         (1) Town & Country Plastics, Inc.
         (2) Orion Fittings, Inc.
         (3) Enfield Industrial Corp.
   3. Neutralization tanks:
      a. Base:
         (1) Town & Country Plastics, Inc.
      b. Optional:
         (1) Nalgene Industrial Products, Nalge Co.
         (2) Enfield Industries.
         (3) KOCH Engineering Co., Inc., Knight Division.
         (4) Orion Fittings, Inc.

(5) United Utensils Company, Inc.

4. Valves (Automatic trap primer):
   a. Base:
      (1) Precision Plumbing Products.
   b. Optional:
      (1) J R Smith.
      (2) Wade.
5. Valves (Constant flow control balancing valves):
   a. Base:
      (1) Autoflow.
   b. Optional:
      (1) Griswold.
      (2) Presco.
6. Water-hammer arresters:
   a. Base:
      (1) Wade.
   b. Optional:
      (1) Precision Plumbing Products.
      (2) J R Smith.
      (3) Jonespec.
      (4) Josam.
      (5) Zurn.
      (6) Sioux Chief Manufacturing Co.
7. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPE AND FITTINGS

A. Laboratory water piping:
   1. DN50 and smaller:
      a. Above grade:
         (1) Copper, type L, with solder joints, and wrought copper or cast brass fittings.
         (2) T-drilled branch taps with brazed joints are acceptable where the tapped pipe is at least DN25 diameter and where branch is at least 2 pipe sizes smaller.
      b. Below grade:
         (1) Copper, type K soft, with brazed joints and wrought copper or cast brass fittings.
         (2) Where below-grade run of piping is shorter than 15 m, below-grade joints are not acceptable.
   2. DN65 and larger:
      a. Copper, type L, with soldered joints and wrought copper or cast brass fittings.
      b. Copper, type L, with roll-groove joints and wrought copper or cast brass fittings.
      c. In copper, T-drilled branch taps with brazed joints are acceptable where the tapped pipe is at least DN25 diameter and where branch is at least 2

pipe sizes smaller.

B. Laboratory drainage and vent piping.
   1. Above grade:
      a. Corrosion resistant, fire retardant, schedule 40 polypropylene DWV pipe and fittings with mechanical joints. Acceptable for use only in exposed or fully accessible locations.
      b. Corrosion resistant, fire retardant, schedule 40 polypropylene DWV pipe and fittings with socket fusion joints.
   2. Below grade:
      a. Corrosion resistant, schedule 80 polypropylene DWV pipe and fittings with socket fusion joints.

C. Pressure drainage piping:
   1. Corrosion resistant, schedule 80 polypropylene pressure pipe and fittings with socket fusion joints.

2.03 CLEANOUTS

A. Cleanouts, general:
   1. Provide flashing collars and clamps for CO bodies being installed in floors with finishes installed over waterproofing.
      a. Coordinate with Division Nine and Room-Finish Contractors.
   2. Dimensions are nominal.
   3. Body material (unless indicated otherwise): Same material as piping.
   4. Cleanout plugs (unless indicated otherwise): Same material as piping.
   5. Cleanouts on lines completely accessible from within pipe chases do not require covers.
   6. Cleanouts in exposed piping in equipment rooms do not require special covers.

B. Interior, floor-mounted cleanouts:
   1. Ferrule, tapped for cleanout plug with spigot or inside-caulk outlet.
   2. Two-piece, threaded, adjustable housing with nickel bronze frame and cover as specified below by floor finish.
      a. Resilient tile and sheet finish: Round flange top with scoriated cover.
      b. Ceramic tile finish: Square flange top with scoriated cover.
      c. Poured finish: Round, wide-flange top with scoriated cover.
      d. Terrazzo finish: Round top with recessed-for-terrazzo cover.

e. Concrete finish (unfinished areas): Heavy, round frame with satin-bronze, scoriated tractor top.

C. Cleanouts in vertical piping:
1. Tapped cleanout tee with threaded plug with solid nut.

D. Cleanouts in fusion joint combination wye and eighth bends or wyes.
1. Tapped spigot with threaded plug with solid nut.

E. Cleanouts in mechanical joint combination wye and eighth bends or wyes.
1. Blind plug.

F. Covers over cleanouts in concealed vertical piping:
1. Square, nickel-bronze frame with secured, smooth, stainless-steel access cover.
2. 150 x 150 mm for pipe sizes DN100 and less.
3. 230 x 230 mm for pipe sizes DN125 and larger.

2.04 FLOOR DRAINS

A. General:
1. Provide flashing clamps with seepage openings for drain bodies with flashing collars being installed in floors with finishes installed over waterproofing.
a. Coordinate with Division Nine and Room-Finish Contractors.
2. Provide underdeck clamps for drain bodies except those installed in slabs on grade.
3. Dimensions are normal.
4. Provide trap-primer taps where trap primer valves are required: See paragraph on trap primer valves.
5. Material (unless indicated otherwise): Same material as pipe.
6. LFD-1:
a. 280 mm diameter flashing collar.
b. Adjustable top.
c. 180 mm diameter, removable, grate.

2.05 FLASHINGS

A. On floors above grade, allow for flashings provided by others at penetrations in floors with finishes installed over waterproofing.
1. Coordinate with Room-Finish Contractors.

2.06 NEUTRALIZATION TANKS

A. NT-1:
1. Conventional virgin high density polyethylene, ASTM

D1248, one piece seamless construction with uniform 5 to 10 mm wall thickness, and welded external flanges.
2. Capacity: As indicated on drawings.
3. Fittings: Molded polyethylene, heat fused or welded to tank.
4. Provide bolted cover.
5. Provide limestone (marble) chips or lumps with calcium carbonate content in excess of ninety percent and ranging in diameter from 25 mm to 75 mm.
   a. Provide in 20 kg or larger sealed bags.
   b. Provide enough for initial fill and one additional fill. Deliver bags for additional fill to storage area designated by COTR.
   c. The quantity of limestone fill shall be based on the tank capacity.

2.07 TRAPS

A. Traps, general:
1. Same material, coating, and finish as piping system into which they are installed.
2. Place trap cleanouts in accessible locations.

2.08 VALVES

A. Automatic trap primer valves.
1. General:
   a. Rebuildable.
   b. Integral vacuum breaker on drain branch.
   c. Connections: Soldered or threaded.
   d. Provide trap primers as indicated on drawings.
2. Automatic trap primer valve:
   a. Serves one to eight drains.
   b. Integral backflow preventer.
   c. Designed to be installed in supply line with continuation to drain.
      (1) Activated by 20 kPa drop or more in main.
   d. Automatically adjusts to line pressures between 240 and 520 kPa.
3. Trap primer distribution reservoir.
   a. Copper reservoir with brass fittings and clear plastic inspection cover.
      (1) Feeds up to four traps through separate lines.
      (2) Provide mounting brackets.

B. Balancing valves, constant flow control:
1. Factory calibrated, direct acting, automatic pressure compensating.
2. Control flow rates within 5 percent of flow rating over operating pressure differential range.

a. Unless noted otherwise, set flow rating according to pipe sizes indicated on drawings:
(1) DN15 pipe: 0.060 L/s.
(2) DN20 pipe: 0.250 L/s.
(3) DN25 pipe: 0.600 L/s.
(4) DN32 pipe: 0.950 L/s.

3. Pressure differential range:
a. 14-220 kPa.

4. Threaded-brass or copper-sweat body with stainless-steel internal parts.

5. Provide a metal identification tag with chain for each installed valve.
a. Identify zone or location, valve model number, flow rate, direction of flow, and differential pressure range.

6. Provide with integral unions to allow field exchange of internal components without removing valve body from pipeline.

7. Provide manual valve upstream and downstream of each valve.

C. Check valves:
1. DN50 and smaller: V-24 or V-25.
2. DN65 and larger: V-28 or V-29.

D. Manual valves, water:
1. DN50 and less: V-13 or V-14.
2. DN65 to DN100:
a. V-33 or V-35 or V-62.
b. 10 position locking, manual handle.
3. DN150 and larger:
a. V-34 or V-35 or V-62.
b. Totally enclosed gear operator and wheel handle.
c. At equipment and at service entrance:
(1) Use lug type valves, V-33.
(2) Use groove-end type valves, V-62.
4. Balancing cocks:
a. Constant flow control balancing valves.

E. Manual valves, waste-water:
1. Pressure drainage piping:
a. Shut off: V-3.
b. Check: V-30.

2.09 WATER-HAMMER ARRESTERS

A. Water-hammer arresters: Engineered, and certified in accordance with American Society of Sanitary Engineering Standard ASSE-1010.

PART 3 - EXECUTION

3.01 GENERAL

A. General:
1. Provide piping as indicated and to provide fixtures and items of equipment with proper drainage, vent, and water connections as required by code.
2. Hold piping as close to structure as possible to maintain maximum head room.
3. Run piping concealed wherever possible.
4. Under no circumstances reduce pipe size indicated without written consent of COTR.
5. Size branches to individual fixtures as scheduled.
6. Consult the following before roughing in piping:
a. Manufacturer's data.
b. Large-scale architectural, and mechanical drawings of rooms containing equipment and fixtures.
7. Stub piping through wall directly behind item being served (e.g., equipment, fixtures).
a. Cap and protect until such time as installation is performed.
b. Exception: Upon approval of COTR, piping mains and/or branches may be run in lab benches, in built-in counters, and in cabinet work.
8. Plug or cap piping immediately after installation.
9. Provide chromed escutcheons on finished-area sides of pipe penetrations.
a. Secure escutcheons so they make contact with floor, wall, or ceiling.
10. Provide equipment in accordance with manufacturer's instructions.
11. Provide piping supports, sleeves, and seals as indicated in Section 15140.

3.02 LABORATORY WATER PIPING SYSTEMS

A. General:
1. Provide without cross- or inter-connections between potable and non-potable lines.
2. Provide unvalved system drains on trapped portions of systems: See Section 15120.
3. Provide thermometers and pressure gauges where indicated on drawings: See Section 15120.

B. Balance hot water circulation system.

C. Provide manual isolation valves at following locations.
1. To isolate groups of fixtures and equipment on branch runouts from piping mains.
2. On inlet and outlet of each equipment.

3. On each branch to hose bibb.
4. At main feed points to water pipe risers.
5. As indicated and as required to adequately service parts of systems and equipment.

D. Provide water-hammer arresters on hot and cold water lines in accordance with PDI Standard WH-201 and ASSE-1010 sizing and placement data.

E. Testing of water system:
1. Upon completion of system or a section of system, test piping hydrostatically to pressure not less than 50 percent in excess of pipe's working pressure, but in no case less than 1040 kPa.
a. System shall hold pressure for 24 hours.
2. Repair leaks or replace defective pipe disclosed by tests.
3. Repeat tests until piping indicates tight.
4. Do not put system into service until tests are approved by Government Construction Inspector, and sterilized.

F. Sterilization of water system:
1. Sterilize system as indicated or in accordance with AWWA-C651 or C652.
2. Thoroughly flush water systems.
3. After flushing, introduce chlorine or chlorine compound into system with dosage sufficient to give an initial residual chlorine content of 50 PPM.
4. Collect samples from various taps and fixtures throughout buildings during introduction of chlorine to assure uniform distribution.
5. Open and close valves several times.
6. After a 24 hour contact period, flush traces of heavily chlorinated water from systems.
7. After flushing is complete, indicate effectiveness of disinfection by submitting laboratory reports of bacteriological tests on samples taken from system.
8. If unsatisfactory results are obtained, repeat disinfection process until satisfactory.
9. Do not put system into service until tests are approved by Government Construction Inspector.

3.03 LABORATORY DRAINAGE/VENT PIPING SYSTEMS

A. General:
1. Changes of direction and junctions: Make with wye fittings and eighth bends.
a. Use sanitary tee fittings in vertical pipe only.
(1) Sanitary crosses not allowed.
2. Provide P-trap for each direct waste-pipe connection

to equipment.
3. Trap fixtures as required by governing code.
4. Provide air gaps at indirect drains.
5. Provide piping system in accordance with manufacturer's recommendations.
6. Provide accessories as indicated or required for complete connections.

B. Slopes:
1. Provide horizontal drainage piping with following slopes:
a. DN65 and smaller pipes:
(1) 20 mm/m.
b. DN75 and larger pipes:
(1) 10 mm/m.
c. Slopes indicated on drawings override those indicated here.

C. Vents:
1. To permit proper flashing, offset through-the-roof piping away from walls on roof before passing through roof.
2. Carry vent stacks DN100 and larger full size through roof.
3. Provide vent lines so they will drain and not trap water.
4. Where possible combine drainage and vent stacks before passing through roof to minimize roof openings.
5. Where minimum vent-through-roof size is larger than vent size, provide increaser minimum of 305 mm below roof line.
a. Minimum vent-through-roof size:
(1) DN100.
6. Extend vent stacks at least 300 mm above roofing.

D. Provide cleanouts on drainage piping as indicated below and on drawings:
1. Locations:
a. At dead ends.
b. At changes of direction greater than 45 degrees.
c. At junction of building drain and building sewer.
d. 920 to 1220 mm above finished floor in vertical piping that connects to horizontal piping immediately below in ceiling space or under grade.
e. As test tee to receive test plugs in each riser at least every other floor.
f. At maximum 15 m intervals in horizontal DN100 and smaller drains.
g. At maximum 30 m intervals in horizontal, DN150 and larger drains.
2. Sizes:

a. DN100 diameter and smaller piping: Match pipe size.
b. DN150 diameter and larger piping: Not less than DN100.

3. Where cleanouts occur in concealed spaces, provide with extensions to wall or to floor above.
   a. Make extensions using long sweep ells or wye and eighth bends.
4. Where cleanouts are indicated in ceiling spaces above critical areas, extend cleanouts through floor above.
5. Provide carpet-marker bolts after carpet installation.

E. Provide vent-through-roof to allow for flashings provided under Roofing System section.
   1. Coordinate with roofing work specified in Division 7.

F. Floor drains:
   1. At locations with waterproofing: Set top of flashing collar 12 mm below level of waterproofing.
   2. At locations without waterproofing: Place drain integrally with poured concrete.
   3. Set top of flat strainer/grate flush with finished floor.
   4. Set over P-traps.

G. Testing of drainage piping systems:
   1. Do not insulate, conceal, or install furring around pipe until it has been tested to satisfaction of COTR.
      a. If inspection or test indicates defects, replace such defective work or material and repeat inspection and tests.
   2. Test piping at completion of installation of each stack or section of piping.
      a. Fill system with water to highest point and check joints and fittings for leaks.
      b. Eliminate leaks before proceeding with work or concealing piping.
      c. Minimum test height: 3050 mm.
      d. Make repairs to piping with new material.
      e. Peening and chiseling of holes or screwed joints is not allowed.

H. Neutralization tank:
   1. Install limestone fill in accordance with tank manufacturer's written procedures.

3.04 FIXTURES/EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

A. Unless otherwise noted, Division 15 only provides rough-in and final connection including but not limited to water supply stops, p-traps, and trap nipples.

B. Rough-in shall be provided based on COTR approved rough-in drawings furnished by the fixture/equipment manufacturer.

C. Water supply stops, p-traps, and trap nipples shall be of same type and quality as specified for similar fixtures provided by Division 15.

END OF SECTION

SECTION 15440

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Definitions:
1. Aerator: Device that mixes room air with faucet's water stream.
2. Ledge-mounted faucet: Faucet with body mounted on top of faucet ledge and covered by faucet housing or single escutcheon.
3. Bottom-mounted faucet: Faucet with body mounted beneath faucet ledge; each penetration is covered by single escutcheon.

1.02 QUALITY ASSURANCE

A. Valve standards: See Section 15100 (for valves labeled "V-__").

B. Accessibility:
1. Manufacturing standards:
a. Americans with Disabilities Act (Public Law 101-336).
b. ANSI-A117.1, current edition.
2. Installing standards:
a. Americans with Disabilities Act (Public Law 101-336).
b. ANSI-A117.1, current edition.
c. Local authorities.
d. State authorities.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Assemble submittals by mark number. Model numbers are not specified; include sufficient information to verify compliance with Specifications.
1. All trim.
2. Emergency fixtures.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
1. Operating and maintenance data.

2. Guarantees.
3. Manufacturer's recommended spare parts list.

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. Acceptable manufacturers:
1. Fixtures (Emergency):
a. Base:
(1) Speakman.
b. Optional.
(1) Bradley.
(2) Encon.
(3) Western.
(4) Haws.
(5) Guardian Equipment Company.
2. Trim:
a. Base:
(1) American Standard.
b. Optional:
(1) Brasscraft.
(2) Chicago Faucet.
(3) Crane.
(4) Dearborn.
(5) Eljer.
(6) Elkay.
(7) Just.
(8) Kohler.
(9) McGuire.
(10) T&S Brass.
3. Other manufacturers desiring approval comply with Section 01640.

B. Construct or equip fixtures with air gap or anti-siphon devices to prevent siphoning non-potable water into potable water supply system.

C. Piping exposed in finished areas (including fittings and trim): See Section 15410.

D. Dimensions:
1. Dimensions are nominal.
2. Multiple dimensions:
a. First dimension: Side-to-side.
b. Second dimension: Front-to-back.
c. Third dimension: Top-to-bottom.

E. Manufacture accessible fixture assemblies to meet requirements of accessibility manufacturing standards.

F. Lavatory trim, general (following general conditions apply unless detailed otherwise in specific descriptions):
   1. P-traps: Semi-cast.
   2. Tailpieces: 1.1 x 32 or 38 mm OD copper tube.
   3. Drains: Cast brass.
   4. Stops: Loose-key.
   5. Supply pipes: Rigid riser and nipple.
      a. Soft copper tube and corrugated type not allowed.
   6. Finish of exposed parts: Satin or chrome.

2.02 EMERGENCY FIXTURES

A. Emergency showers:
   1. General (following general conditions apply unless detailed otherwise in specific descriptions):
      a. Valve: Rough chrome-plated brass, DN25, stay-open, and activated by on/off pull chains with stainless steel rings. For vertical or horizontal installation as required.
      b. DN25 copper cold-water supply (galvanized steel not permitted).
      c. Alarm horn activated by environmentally safe gas canister. Provide chain connection to shower valve activator.
      d. Provide one deluge-shower test kit for job.
         (1) Ring to encircle shower head.
         (2) Water-proof, flexible funnel attached to ring.
         (3) Holding-rod handle.
      e. Complies with ANSI Z358.1-1998.
   2. ES-1, Emergency shower:
      a. Deluge shower head and valve for exposed installation from overhead.
      b. Stainless-steel shower head, 200 mm diameter.

B. Emergency eye washes:
   1. General (following general conditions apply unless detailed otherwise in specific descriptions):
      a. DN15 copper cold-water supply (galvanized steel not permitted).
      b. Aerated spray.
      c. Supply-line strainer with removable element.
      d. Dust covers: Fall off when water flows.
      e. Complies with ANSI Z358.1-1998.
   2. EW-1, Emergency eye wash:
      a. Recessed, wall-mounted in Type 304 stainless steel cabinet.
      b. DN15 stay open ball valve activated when arms are pulled down.

c. Adjustable volume control.
d. Twin aerated spray heads.
e. Flow controls accessible.

3. EW-3:
a. Provided under Division 11.
b. Provide rough-in and final connection.
c. Provide V-13 stop.

C. Service modules:
1. SM-4, Emergency combination shower/eye wash:
a. Provided under Division 10.
b. Provide rough-in and final connection.

D. EC-1, combination emergency shower/eye wash:
1. General (following general conditions apply unless detailed otherwise is specific descriptions):
a. DN32 cold water supply connection.
b. Alarm horn activated by environmentally safe gas canister. Provide chain connection to shower valve activator.
c. DN32 galvanized steel pipe stanchion with floor flange, painted safety green.
d. Emergency signage mounted on stanchion.
e. Complies with ANSI Z358.1-1998.
2. Emergency shower:
a. Chrome-plated brass DN25 stay-open ball valve, activated by on/off pull chains with stainless steel rings.
b. Stainless steel shower head, 200 mm diameter.
3. Emergency eye wash:
a. Chrome-plated brass DN15 stay-open ball valve, activated by stainless steel push handle.
b. Supply line strainer with removable element.
c. Volume controls in each spray head.
d. Multiple outlet spray heads producing a full face wash pattern.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide fixtures in first class manner with proper connections to water, drainage and vent systems.

B. Provide fixtures at manufacturer's height unless noted otherwise.

C. Provide fixtures in accordance with manufacturers' instructions.

D. See that proper grounds are set to form a secure base and an absolutely rigid setting for each fixture.

E. Provide guards and boxing as may be required to protect fixtures against damage from operations of other trades.

F. Where pipes penetrate walls, floors, or ceilings, conceal penetrations with chrome escutcheons or stainless-steel plates.

G. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal with silicone-type sealant: See Section 07900.

I. On flush valves with pipe supports, mount pipe support to wall two-thirds of flush-valve height above fixture spud.

3.02 ADJUST AND CLEAN

A. Valves with adjustable temperature-limit stop: Adjust stop to deliver maximum 43 degC.

B. Remove dirt from fixtures, fittings and traps.

C. Secure escutcheons against wall.

END OF SECTION

SECTION 15483

NATURAL GAS PIPING SYSTEM

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. Codes:
   1. Washington Suburban Sanitary Commission Gasfitting Regulations - June, 1999 Edition.
   2. Washington Gas Company Requirements.

B. Piping and fitting standards: See Section 15060.

C. Valve standards: See Section 15100 (for valves labeled "V-__").

D. All tests shall be witnessed and signed off by COTR.

1.02 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data: Not required for COTR review.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Test reports.

PART 2 - PRODUCTS

2.01 NATURAL GAS PIPING

A. Gas piping above ground:
   1. Black steel.
   2. DN50 and smaller in inaccessible locations: Welded joints, with socket welding fittings.
   3. DN50 and smaller in accessible locations: Black malleable threaded fittings.
   4. DN65 and larger: Welded joints, with butt welding fittings.

2.02 VALVES

A. Ball valves (DN50 and smaller): V-16.

B. Plug valves:
   1. DN50 and smaller: V-60.
   2. DN65 and larger: V-41.

C. Butterfly valves (DN50 and smaller): V-57.

PART 3 - EXECUTION

3.01 NATURAL GAS PIPING INSTALLATION

A. Provide in accordance with codes.

3.02 TESTING

A. Before piping is covered, test system in presence of COTR.

B. Perform a 690 kPa air test for 6 HRS without pressure drop.

END OF SECTION

SECTION 15485

HIGH PURITY WATER PIPING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of systems:
   1. Furnish all labor, materials, tools, equipment and services to provide complete and operable high purity water systems as indicated and in accord with the provisions of the Contract Documents.
   2. Systems:
      a. CAP reagent grade water.
   3. Products:
      a. Piping and fittings.
      b. Valves.

1.02 QUALITY ASSURANCE

A. Water quality standards:
   1. CAP II: College of American Pathologists Standards.

B. Water analysis:
   1. Perform a water analysis of the domestic water supply and base final selection of equipment on the analysis.

C. Pipe and fitting standards: Section 15060.

D. Pump standards:
   1. Hydraulic Institute Standards.
   2. Hydraulic Institute Engineering Data Handbook.

E. Contractor qualifications: Contractor shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.

F. Installer qualifications: Each piping installer shall be factory trained and certified by the pipe manufacturer in the installation and joining of the indicated pipe materials.

G. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS

A. Shop drawings:
   1. Piping and equipment layout in 1:50 scale.

B. Product data:
1. Pipe and fittings.
2. Thermostatic mixing valves.
3. Filtration devices.
4. Reverse osmosis equipment.
5. Deionization equipment.
6. Storage vessels.
7. Pumps.
a. Include pump curves with point of operation indicated.
b. Vibration tests, certified by manufacturer.
8. Ultraviolet sterilizers.
9. Valves.
10. Water quality instrumentation.

C. Samples: Not required for COTR review.

D. Project information:
1. Contractor qualifications.
2. Installer qualifications.

E. Contract closeout information:
1. Test reports:
a. Pressure tests.
b. Sterilization tests.
c. On-site pump vibration retest report, certified by manufacturer.
2. Operating and maintenance data.
3. Local service office and response time for service.
4. Manufacturer's recommended spare parts list.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Pipe and fittings:
a. Base:
(1) George Fischer, Inc.
b. Optional:
(1) Orion Industries, Inc.
(2) Enfield Industrial Corp.
(3) Chemtrol.
(4) Sani-Tech.
2. Thermostatic mixing valves:
a. Base:
(1) U.S. Filter/Ionpure.
b. Optional:
(1) Bruner Corporation.
(2) Hydro Service and Supplies.

(3) Vaponics.
(4) Millipore.
(5) Culligan.
(6) Zenon Environmental Systems, Inc.
(7) Therm-o-Tech.

3. Filtration devices:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Bruner Corporation.
      (2) Hydro Service and Supplies.
      (3) Vaponics.
      (4) Millipore.
      (5) Culligan.
      (6) Zenon Environmental Systems, Inc.
      (7) EcoWater.
4. Reverse osmosis equipment:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Bruner Corporation.
      (2) Hydro Service and Supplies.
      (3) Vaponics.
      (4) Millipore.
      (5) Culligan.
      (6) Zenon Environmental Systems, Inc.
      (7) HydroMax.
5. Deionization equipment:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Bruner Corporation.
      (2) Hydro Service and Supplies.
      (3) Vaponics.
      (4) Millipore.
      (5) Culligan.
      (6) Zenon Environmental Systems, Inc.
      (7) HydroMax.
6. Storage vessels:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Hydro Service and Supplies.
      (2) Vaponics.
      (3) Nalgene.
      (4) Zenon Environmental Systems, Inc.
7. Distribution pumps:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Tonkaflo.

(2) Goulds.
(3) Sta-rite.
(4) Aurora Pump Company.
(5) Grundfos.

8. Ultraviolet sterilizers:
   a. Base:
      (1) U.S. Filter/Ionpure.
   b. Optional:
      (1) Aqua Fine.
      (2) Vaponics.
      (3) Hydro Service and Supplies.
      (4) Zenon Environmental Systems, Inc.
9. Valves:
   a. Manufacturer of piping.
10. Water quality instrumentation:
   a. Base:
      (1) U.S.Filter/Ionpure.
   b. Optional:
      (1) Bruner Corporation.
      (2) Hydro Service and Supplies.
      (3) Vaponics.
      (4) Millipore.
      (5) Culligan.
      (6) Zenon Environmental Systems, Inc.
      (7) GF Signet.
11. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPE AND FITTINGS

A. CAP II system water pipe, fittings and joints:
   1. Pipe and fittings:
      a. Non-pigmented natural polypropylene containing no antioxidants, slip agents or reprocessed material and conforming to the requirements of ASTM D4101.
      b. Pipe shall be Schedule 80 and conform to the dimensional requirements of ASTM D2447, ASTM D1785, or SDR.
      c. Fittings shall be Schedule 80 socket or butt type and conform to the dimensional requirements of ASTM D2447, ASTM D1785, or SDR.
   2. Joints:
      a. Heat fused socket or butt type utilizing an electrically heated, thermostatically controlled fusion bonding tool and conforming to the requirements of ASTM D2657.
      b. Heat fused socket or butt type utilizing electrical fusion coils energized by a low voltage supply conforming to the requirements of ASTM F1290.
      c. Threaded joints at connections to equipment shall

be made with teflon tape applied to the male fitting. Pipe dope is not permitted.

d. Chemical fusing shall not be permitted.

2.03 THERMOSTATIC MIXING VALVE ASSEMBLY

A. The thermostatic mixing valve assembly shall consist of a thermostatic controller with union check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows element mounted out of water, volume control shut-off valve, dial thermometer, wall brackets and fasteners. Capacity shall be as scheduled. All components shall be chrome plated brass.

2.04 FILTRATION DEVICES

A. Multimedia filtration:

1. The unit shall be a fully automatic, multi-layered, granular media filter consisting of a minimum of 3 distinct filter layers in addition to a supporting layer. The filter layers shall be stratified with the coarsest layer at the top and the finest layer at the bottom. Particle retention shall be 10 micron and larger.
2. Tank shall be constructed in conformance with the latest edition of Section VIII for ASME code pressure vessels and shall be so stamped and certified. Tank shall be electric welded from industrial grade carbon steel and rated for a minimum 690 kPa working pressure, and shall be hydrostatically tested at 50 percent in excess of the rated working pressure. Access openings shall be provided in the tank.
3. Support shall be provided for the unit. The support shall consist of a full bottom tank skirt or structural legs and leveling shims.
4. Tanks shall have the interior lined with a permanently heat bonded, inert, monolithic 0.76 mm thick nonleachable virgin polyethylene liner. The lining shall meet the requirements of the United States Food and Drug Administration. The lining shall be 100% spark tested for lining integrity. Furnish spark test certification. The exterior shall be degreased, pre-cleaned and phosphatized prior to application of a 0.18 mm thick epoxy mastic enamel.
5. The internal distribution system shall consist of an upper and lower component. The distribution system shall be a fine-slotted self cleaning plastic manifold, or , a fine-slotted self cleaning stainless steel manifold, or, multi fine slotted self cleaning plastic manifolds mounted on a hub radial. The lower distribution system shall be embedded in a single

layer subfill of washed and graded quartz underbedding a minimum of 50 mm deep.

6. Vessel shall be fitted with a unitized 5-cycle multi-functional main control valve to accomplish the operational steps of backwash, slow rinse, and fast rinse. Valve shall include fixed and self-adjusting flow regulators to control flow rates during regeneration cycles at pressures between 200 and 860 kPa. The valve shall be designed in such a way that service can be performed without disconnecting the inlet and outlet plumbing connections. Valve shall be constructed of corrosion-free inert thermoset reinforced phenolic polymer, that complies with FDA regulations. Valve shall be completely hydraulic in operation with no electric motors, and shall have built-in eductors. All valve seals will be static O-rings; no sliding seals will be used.
7. The main control valve shall be operated by a solid state time clock control capable of backwashing the filter at a pre-set time. The control shall operate on 24 volts and step-down transformer shall be supplied with it. the control shall include a manual override to permit manual initiation of backwashing. The control shall have provision for individual adjustment of backwash and rinse times. An isolated contact shall be provided to interlock the filter operation with other equipment.
8. Internal and external piping shall be Schedule 80, Class 12454-B PVC.
9. Provide pressure gauges and sampling cocks on the inlet and outlet of each tank.
10. Automatic valves shall be hydraulically operated valves of 30% glass reinforced thermoplastic construction, Buna N diaphragms, and EPDM seals. Manual valves shall be true union ball valves of PVC construction, EPDM O-rings, and teflon seats.

B. Water filtration devices:
   1. General:
      a. The cartridge filter system shall be designed to remove particles of the specified size range from water. The design flow rate shall not exceed 0.2 L/s per 255 mm equivalent filter cartridge length.
   2. Nominal filters:
      a. The filter housing shall be 316L stainless steel construction. The housing shall consist of two parts, filter bowl and head. The bowl shall have a satin finish. Design of housing shall permit cartridge removal without disconnection of piping. The head design shall incorporate two vent plugs. Fixed guides within the filter housing shall allow

easy loading, unloading and proper alignment and seating of the filter cartridge. The filter housing shall be designed to accommodate nominally rated filter cartridges with a knife-edge seal. An O-ring shall be provided to seal the two part housing. Filter housing shall be provided with a universal mounting bracket. The filter housing shall be designed for operation at 690 kPa and 25 øC. The following accessory items shall be provided with the filter housing:
(1) Universal mounting bracket.
(2) Isolation and flush valves, DN20 PP ball valves.

b. Cartridges with nominal pore size ratings of 3 to 5 microns shall be wound polypropylene or melt-blown polypropylene fibers (except where noted) producing a filter medium with a graded pore structure which decreases in size from the outside surface to the center core. The filter cartridges shall be non-fiber releasing. The polypropylene media shall meet FDA requirements for use in food contact applications. Configuration shall be Code O.

3. Absolute filters:

a. The filter housing shall be made of low-carbon 316L stainless steel. Surface finish shall be electropolished 180-grit. Housing shall consist of two parts, filter bowl and head. Fixed guides within the filter housing shall allow easy loading, unloading, proper alignment, and seating of the filter cartridge(s). Design of housing shall permit cartridge removal without disconnection of piping. Bowl shall include sanitary drain valve, and sanitary vent. An O-ring shall be provided to seal the two part housing. The housing shall be designed for operation at a minimum of 690 kPa. The housing shall be designed for use of Code O cartridges.

b. Cartridges with absolute ratings of 0.2 microns shall be constructed of a validated thermo-plastic polypropylene cartridge with a pleated hydrophilic PVDF filter membrane over a non-woven polypropylene support layer. Configuration shall be Code O.

2.05 CARBON ABSORPTION FILTRATION

A. The unit shall be a fully automatic, activated carbon granular media filter. The media shall be made from selected grades of bituminous coal combined with suitable binders, and shall have an iodine number of at least 850

and a minimum abrasion number of 75. Particle retention shall be 40 micron and larger.

B. Tank shall be constructed in conformance with the latest edition of Section VIII for ASME code pressure vessels and shall be so stamped and certified. Tank shall be electric welded from industrial grade carbon steel and rated for a minimum 690 kPa working pressure, and shall be hydrostatically tested at 50 percent in excess of the rated working pressure. Access openings shall be provided in the tank. Tank shall be constructed with a flat false bottom.

C. Support shall be provided for the unit. The support shall consist of a full bottom tank skirt or structural legs and leveling shims.

D. Tanks shall have the interior lined with a permanently heat bonded, inert, monolithic 0.76 mm thick nonleachable virgin polyethylene liner. The lining shall meet the requirements of the United States Food and Drug Administration. The lining shall be 100% spark tested for lining integrity. Furnish spark test certification. The exterior shall be degreased, pre-cleaned and phosphatized prior to application of a 0.18 mm thick epoxy mastic enamel.

E. The internal distribution system shall consist of an upper and lower component. The distribution system shall be a fine-slotted self cleaning plastic manifold, or , a fine-slotted self cleaning stainless steel manifold, or, multi fine slotted self cleaning plastic manifolds mounted on a hub radial. The lower distribution system shall be provided with mesh wrap and installed on the false flat bottom. Subfill is not permitted.

F. Vessel shall be fitted with a unitized 5-cycle multi-functional main control valve to accomplish the operational steps of backwash, slow rinse, and fast rinse. Valve shall include fixed and self-adjusting flow regulators to control flow rates during regeneration cycles at pressures between 200 and 860 kPa. The valve shall be designed in such a way that service can be performed without disconnecting the inlet and outlet plumbing connections. Valve shall be constructed of corrosion-free inert thermoset reinforced phenolic polymer, that complies with FDA regulations. Valve shall be completely hydraulic in operation with no electric motors, and shall have built-in eductors. All valve seals will be static O-rings; no sliding seals will be used.

G. Internal and external piping shall be Schedule 80, Class 12454-B PVC.

H. Provide pressure gauges and sampling cocks on the inlet and outlet of each tank.

I. Automatic valves shall be hydraulically operated valves of 30% glass reinforced thermoplastic construction, Buna N diaphragms, and EPDM seals. Manual valves shall be true union ball valves of PVC construction, EPDM O-rings, and teflon seats.

2.06 REVERSE OSMOSIS UNITS

A. General:
1. The unit shall be capable, upon initial startup, of reducing the dissolved mineral content of the water by at least 96 percent based on membrane industry design standards, as described more fully below.

B. Wall-mounted R.O. Units with capacity up to 120 lph:
1. Prefilter:
a. The equipment shall include replaceable element type prefilter housings mounted on the frame. Each filter housing shall be of polypropylene construction. Each filter cartridge shall be a nominal type as described in 2.04, B.,2., and rated at 3 microns nominal.
2. Pump:
a. A pump and motor assembly shall be provided to boost the feed water to unit operating pressure. This pressure shall be sufficient to maintain the specified product flow during the standard life of the modules, including partial fouling.
3. Modules:
a. The unit shall use reverse osmosis elements in a spiral-wound modular configuration. The elements shall be the polyamide thin film composite membrane type and shall be capable, upon initial startup, of producing water at the scheduled nominal flow. Performance is based on membrane standard conditions of feed water at 25 øC.
4. Controls:
a. The unit shall include a solid state microprocessor controller. Control functions shall include "Operate/Standby", "Reset", and "Emergency Stop". Indicator lamps shall be activated by:

- Power on
- Pump on

- Product tank full
- Unit in flush
- Low pressure
- High water temperature
- Low % rejection

b. Alarms shall activate on:

- High temperature
- Low % rejection
- Low pressure at pump inlet

5. Assembly:
   a. All components shall be assembled on a rigid metal frame suitable for mounting on a wall.
   b. Provide with conductivity meter.

2.07 STORAGE VESSEL

A. Storage vessels shall have capacity as scheduled.

B. Materials of construction shall be designed to prevent recontamination of the stored water. Interior linings shall be as scheduled.

C. Vessels for storage of CAP II water shall be designed to seal the stored water from the atmosphere except through 0.2 micron absolute hydrophobic vent filters. Vent filters shall be designed to prevent positive or negative pressures in the storage vessel in excess of about 1490 Pa of water column at the peak fill and draw flow rates. Vessels for storage of ASTM E-1 water shall be provided with a complete nitrogen blanketing system.

D. Storage vessels shall be designed to allow for complete drainage and to facilitate periodic cleaning and disinfection.

E. Materials:
   1. Polyethylene:
      a. Vertical polyethylene storage tanks shall be vertical design with flat top, cone bottom, and molded from premium grade medium density polyethylene. The melt index of the resin shall be modified to give good moldability, stress crack resistance, and low temperature impact strength. The resin shall be FDA approved for food handling applications.

F. Provide a gasketed lid on polyethylene tanks.

G. Provide a minimum of seven tank fittings for inlet, outlet, vent filters, level controls and overflow.

2.08 DISTRIBUTION PUMPS

A. Distribution pump shall be stainless steel, multi-stage centrifugal type with capacity as scheduled.

B. The pump suction/discharge chamber, impellers, pump shaft, diffuser chambers, outer discharge sleeve, and impeller seal ring retainers shall be constructed of 316 stainless steel. The motor stool shall be constructed of cast iron isolated from the pumped fluid by a 316 stainless steel insert. The pump shaft coupling shall be constructed of cast iron. The impellers shall be secured directly to the pump shaft by means of a splined shaft arrangement. Intermediate and lower shaft bearings shall be tungsten carbide and ceramic. Pumps shall be equipped with a high temperature mechanical seal assembly with tungsten carbide seal faces mounted in stainless steel seam components.

C. The pump motor shall be sized to insure the pump is non-overloading when operating on the specified pump curve. The motor shall be as scheduled. Motor design shall be of the open drip-proof type, with a NEMA C face design operating at a nominal 3450 RPM with a minimum safety factor of 1.15. Lower motor bearings shall be adequately sized to insure long motor life.

D. Provide vibration isolators on the suction and discharge of the pump. Vibration isolators shall be PTFE bellows type with stainless steel flanges.

2.09 ULTRAVIOLET STERILIZERS

A. The ultraviolet sterilizers shall be capable of destroying greater than 99 percent of the microorganisms in water with 254 nanometer ultraviolet radiation at the rated flow.

B. The sterilizer shall consist of an electroplated and passivated 316L stainless steel chamber with a clear fused quartz jacket, ultraviolet lamp(s), and electrical ballast with power cordset. Unit shall be rated for 860 kPa working pressure. Each high intensity ultraviolet lamp shall provide greater than 30,000 microwatt seconds per square centimeter of 254 NM ultraviolet radiation after 8000 hours operation based on a coefficient of absorption of 0.06.

C. Unit shall be U.L. listed. 120 volts, 60 Hz.

D. Provide automatic quartz sleeve cleaner, intensity monitor with UV sensor and lamp status alarm. Piping connections shall include 316L stainless steel light trap.

E. Where indicated, provide 185 NM lamps instead of 254 NM lamps.

2.10 VALVES

A. Shut-off valves: Diaphragm type, same material as piping system.

B. Check valves: True union ball type for either vertical or horizontal mounting, same material as piping system.

2.11 WATER QUALITY INSTRUMENTATION

A. General:
1. Provide, where indicated, monitor/controllers to analyze water quality. They shall be suitable for panel, wall, or pipe mounting as required. Units shall have a minimum 3 digit LCD autoranging display. Enclosure shall be NEMA 4X. Power requirements 115 volt, 60 Hz. Units shall have automatic temperature compensation referenced to 25 degC. The unit shall be capable of alarm activation through a SPDT relay.

B. Resistivity controller:

□&dDMode□&d@	□&dDRange□&d@
Megohm-cm	0-20
Degrees Celsius	0-100

C. Conductivity controller:

□&dDMode□&d@	□&dDRange□&d@
Microsiemens/cm	1-999
Degrees Celsius	0-100

D. Rejection controller:

□&dDMode□&d@	□&dDRange□&d@
Percent	0-99
Microsiemens/cm	1-999

PART 3 - EXECUTION

3.01 GENERAL

A. Install all items of equipment in strict accordance with the manufacturer's instructions including, if required, the erection of an on-site clean environment for the purpose of pipe fabrication.

B. Install piping to provide every fixture and item of equipment requiring high purity water with suitable supply connection.

3.02 PIPING INSTALLATION

A. Install piping and fittings in accordance with manufacturer's written procedures.

B. Inspect every joint in the polypropylene piping to verify integrity and internal characteristics in accordance with the pipe manufacturer's written procedures.

C. Joints determined to be defective in integrity or internal characteristics shall be redone at Contractor's expense.

D. Install piping so that entire system can be recirculated back to to equipment that produces high purity water.
   1. Maximum non-recirculated dead-end length: 3 pipe diameters.

3.03 FIXTURES/EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

A. Unless otherwise noted, Division 15 only provides rough-in and final connection.

B. Rough-in shall be provided based on COTR approved rough-in drawings furnished by the fixture/equipment manufacturer.

3.04 PUMP VIBRATION TESTS

A. Each pump 0.37 kW and above shall be dynamically balanced in the factory and run tested with pump and motor fully assembled. Maximum pump vibration shall not exceed 2 mm per second. After installation, factory trained technicians shall re-test and verify on the field that the pumps meet the specified vibration criteria.

3.05 SYSTEM START-UP

A. Employ the services of a factory authorized service representative to supervise, inspect, and provide operator training for initial start-up and system operation.

3.06 DISTRIBUTION PIPING LEAK TEST

A. The distribution piping from the discharge of the mixed bed demineralizer (CAP II system) shall be leak tested with high purity water at 860 kPa for a period of 4 hours. The water for the test shall either be the product of the system equipment, or brought in from an outside source. The water quality used for testing shall be equal to final system quality. If the water is the product of the system equipment, the equipment shall have already been sterilized. The water used for the test shall not be recirculated through the equipment, but shall be discharged to drain following completion of the test.

B. Repair or replace any portion of the piping found defective. If repair or replacement is required, the entire system shall be retested. This procedure shall be performed until compliance with the test criteria can be demonstrated.

3.07 STERILIZATION OF EQUIPMENT AND PIPING

A. Equipment:
   1. All items of equipment shall be sterilized in accordance with the published requirements of the equipment manufacturer. Provide a copy of the equipment manufacturer's sterilization procedure to the COTR's Representative.
   2. Field adjustments required to ensure proper functioning of the equipment shall be performed prior to the commencement of the sterilization procedure.

B. Piping System:
   1. Sterilization of the piping system shall be performed using hydrogen peroxide as the sterilization agent. The hydrogen peroxide solution strength and duration of procedure shall be in accordance with the requirements of the piping manufacturer. System equipment shall be sterilized prior to sterilization of the piping system. Provide a copy of the piping manufacturer's sterilization procedure to the COTR's Representative.
   2. Sterilization of the piping system shall be performed following successful completion of the piping leak test. Deionized water for the sterilization of the piping may be the product of the sterilized system equipment, or at the Contractor's option, the deionized water may be brought in from an outside source. If the deionized water is brought in from an outside source, it shall have the same qualities as the final product produced by the system equipment.
   3. Components of the system equipment subject to degradation from the hydrogen peroxide solution shall

be isolated from the piping prior to introduction of the hydrogen peroxide into the piping system. Additionally, prior to performing the sterilization procedure:
    a. Disconnect ultra-violet sterilizer(s).
    b. Remove sub-micron filter cartridges from their housings and install 5 micron filter cartridges.
    c. Verify all sink valves are closed.
4. At the completion of the sterilization procedure, the hydrogen peroxide solution shall be flushed to drain until no residual hydrogen peroxide is found in the effluent.
5. Following the completion of the sterilization procedure including flushing of solution to drain:
    a. Reconnect ultra-violet sterilizer(s).
    b. Remove the 5 micron filter cartridges and install the sub-micron filter cartridges.
    c. Verify all sink valves are closed.
    d. Verify that all components of the equipment which were isolated during the sterilization procedure have been placed back in service.

C. After sterilization is complete, provide evidence of effectiveness of sterilization by filing with COTR, laboratory reports of tests on samples taken from system.
1. Number and locations of taking samples as specified by COTR.

D. If satisfactory results are not obtained, repeat above sterilization process until satisfactory results are obtained.

E. Do not put system into service until satisfactory tests are reviewed by COTR.

3.08 TESTING

A. Do not insulate or conceal pipe until it has been tested to satisfaction of COTR.

B. Upon completion of a section of system, test hydrostatically to pressure not less than 50 percent in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case less than 1040 kPa.
1. System shall hold pressure for 24 hours.

C. If test indicates defects, replace such defective work or material and repeat tests.
   1. Make repair to piping with new material.
   2. No caulking of holes will be acceptable.

END OF SECTION

SECTION 15486

LABORATORY GAS AND VACUUM SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of work: Laboratory gas and vacuum systems include:
   1. Laboratory vacuum system.
   2. Laboratory compressed air system.
   3. Instrument compressed air system.
   4. Nonflammable gas systems.
      a. Nitrogen. (See Section 15489 for High Purity Nitrogen).
   5. Piping materials.
   6. Valves and valve assemblies.
   7. Outlets.
   8. Compressed air plant.
   9. Vacuum plant.

1.02 QUALITY ASSURANCE

A. Material standards:
   1. Pipe and fittings: Section 15060.
   2. Valve standards: Section 15100 (for valves labeled with a "V" prefix).
   3. Piping supports: Section 15140.
   4. Silver brazing filler alloys: ANSI/AWS-A5.8, Specification for Brazing Filler Metal.

B. Standards for design, installation and testing of systems:
   1. American National Standards Institute (ANSI).
      a. A5.8 Specification for Brazing Filler Metal.
      b. A13.1 Identification of Piping Systems.
      c. B16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
      d. B120.1 Pipe Threads, General Purpose.
   2. American Society of Mechanical Engineers (ASME).
      a. Boiler and Pressure Vessel Code.
      b. B31.1 Power Piping.
      c. B31.9 Building Services Piping.
      d. B88 Seamless Copper Water Tube.
      e. B819 Seamless Copper Tube for Medical Gas Systems.
   3. American Welding Society (AWS).
      a. B2.2 Standard for Brazing Procedure and Performance Qualification.
   4. Compressed Gas Association (CGA).
      a. G-4.1 Cleaning Equipment for Oxygen Service.
      b. G-7.1 Commodity Specification for Air.

c. G-10.1 Commodity Specification for Nitrogen.

5. Copper Development Association (CDA).
   a. Copper Tube Handbook.
6. Instrument Society of America (ISA).
   a. S7.3 Quality Standard for Instrument Air.

C. Installer qualifications: Contractor shall be licensed, and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.

D. Qualification of brazing procedures and brazer performance:
   1. Qualification of the brazing procedures and brazer performance shall be in accordance with either Section IX "Welding and Brazing Qualifications" of the ASME Boiler and pressure Vessel Code or AWS B2.2 including the modification stated herein.
      a. Procedures and brazers shall be qualified by tension tests.
      b. The Brazing Procedure Specification shall include cleaning, joint clearance, overlap, internal purge gas, purge gas flow rate, and filler metal.
      c. The Brazing Procedure Qualification Record and the Record of Brazer Performance Qualification shall document the filler metal used, cleaning, joint clearance, overlap, internal purge gas and flow rate used during brazing of the test coupon, and that no internal oxidation was exhibited on the completed test coupon.
      d. Qualification of the brazing procedures is permitted by a technically competent group or agency under the following conditions:
         (1) The Brazing Procedure Specification and the Procedure Qualification Record shall meet the requirements of this Specification and either ASME Section IX or AWS B2.2.
         (2) Obtain a copy of both the Brazing Procedure Specification and the supporting qualification records and shall sign and date these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.
         (3) Qualify at least one brazer in each Brazing Procedure Specification used.
      e. The performance qualification of the brazer shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding 12 months, or there is a specific reason to question the ability of the brazer.
   2. On-site testing of brazers shall be permitted subject

to the approval of the authority having jurisdiction. Records shall be maintained of the brazing procedure specification used and individual brazer testing.

E. Testing agency qualifications: Independent of facility, Contractor, or Contractor suppliers.
1. Specializing in testing the indicated systems.
2. Furnish evidence of 5 years minimum experience in such testing.

F. Definitions:
1. Oil-free dry nitrogen for purging/testing - minimum of Grade D per CGA G-10.1.
2. Oil-free compressed air for laboratory air system - minimum of Grade F per CGA G-7.1.
3. Oil-free compressed air for instrument air system - minimum qualities per ISA-S7.3.

G. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS

A. Shop drawings: Not required for COTR review.

B. Product data:
1. Valves.
2. Compressed air plant.
a. Factory test reports.
3. Vacuum plant.
a. Factory test reports.
4. Filters.
5. Piping materials.

C. Samples: Not required for COTR review.

D. Project information:
1. Installer qualifications.
2. Testing agency qualifications.

E. Contract closeout information:
1. Certification of:
a. Pressure test results.
b. Cross-connection tests.
c. Purge and analysis tests.
2. Operating and maintenance data.
3. COTR instruction report.
4. Manufacturer's recommended spare parts list.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver equipment and parts factory cleaned and processed

to site in original factory sealed package ready for installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
   1. Compressed air plant:
      a. Base: Ingersoll-Rand.
      b. Optional:
         (1) Atlas-Copco.
         (2) Rotaryaire.
         (3) Kobelco.
   2. Vacuum plant:
      a. Base: Bush, Inc.
      b. Optional:
         (1) Squire-Cogswell Company.
         (2) Quincy.
         (3) Ohmeda.
         (4) Chemetron Medical Division, Allied Healthcare Products, Inc.
   3. Valves:
      a. Base: Conbraco-Apollo.
      b. Optional:
         (1) Chemetron Medical Division, Allied Healthcare Products, Inc.
         (2) Ohmeda.
         (3) Oxequip.
         (4) Puritan-Bennett.
   4. Filters:
      a. Base: Arrow Pneumatic, Inc.
      b. Optional:
         (1) Hankison.
         (2) Wilkerson Corporation.
   5. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPING MATERIALS

A. Compressed air piping at service entrance (from 300 mm inside building to 1500 mm outside): Same as indicated for outside utilities.

B. Pressurized piping systems (except high purity nitrogen) up to 860 kPa: Hard-drawn seamless copper tubing (ASTM-B819), Type K or L, cleaned for oxygen service by the manufacturer in accordance with CGA Pamphlet G-4.1, with high temperature solder joints and wrought copper fittings (ANSI B16.22). Cast fittings shall not be used.

1. Bear one of the following markings:
   a. OXY.
   b. MED.
   c. OXY/MED.
2. Minimum size: DN15.
3. Type L tubing is not acceptable for installation below grade.

C. Vacuum piping: Hard-drawn seamless copper tubing (ASTM-B819), Type K or L, with high temperature solder joints and wrought copper fittings (ANSI B16.22). Cast fittings shall not be used.
   1. Labeled or otherwise identified prior to installation in order to preclude inadvertent inclusion into the pressurized systems.
   2. Minimum size: DN20.

D. Vacuum pump exhaust line(s): Hard-drawn seamless copper tubing (ASTM-B88), Type K or L, with high temperature solder joints and wrought copper fittings (ANSI B16.22). Cast fittings shall not be used.

E. Pipe hangers: Copper plated and as specified in Section 15140.

2.03 VALVES

A. Valves pressurized piping systems up to 860 kPa: Full port, quarter-turn, ball type, three piece construction.
   1. Designed working pressure: 2758 kPa WOG.
   2. Blow-out proof stem.
   3. Cleaned for oxygen service by manufacturer in accordance with CGA Pamphlet G-4.1.
   4. Size to DN65: Chrome plated bronze ball, Teflon or Buna-N seats, O-Ring stem seals.
   5. Size DN75 and larger: Chrome plated bronze ball, Teflon seats, O-Ring stem seals.
   6. Clean, cap and deliver to site in sealed package bearing manufacturer's identifying tag or stamp.
   7. Provide with Type K or L copper tube extensions for making connection to pipeline.

B. Valves vacuum piping systems: Full port, quarter turn, ball type, three piece construction.
   1. Design working pressure: 735 mm mercury vacuum.
   2. Blow out proof stem.
   3. Size to DN65: Chrome plated bronze ball, Teflon or Buna-N seats, O-ring stem seals.
   4. Size DN75 and larger: Chrome plated bronze ball, Teflon seats, O-ring stem seals.
   5. Provide with Type K or L copper tube extensions for

making connection to pipeline.

C. Labels: Identify each valve handle with color coded label for intended service in accordance with ANSI A13.1.

2.04 OUTLETS

A. Laboratory outlets: Provided under Division 11. Provide rough-in and final connection only.

2.05 COMPRESSED AIR PLANT

A. Compressed air plant: ASME receiver desiccant air dryers, and dew point monitor.
   1. Capacity: As scheduled.
   2. System discharge pressure: 690 kPa.

B. Air receiver: Vertical type.
   1. Size: As scheduled.
   2. Automatic drain trap.
   3. Safety pressure relief valve.
   4. Pressure gauge.
   5. Sight glass.
   6. Section VIII, ASME "Boiler and Pressure Vessel Code" construction.

C. Compressed air desiccant drying system:
   1. Operation conditions:
      a. Inlet flow rate: 800 SCFM.
      b. Inlet air pressure: 690 kPa (100 PSIG).
      c. Inlet air temperature: 18 to 38 degC.
      d. Inlet moisture content: Saturated.
      e. Volume of dry air required: 680 SCFM.
      f. Required dry air dew point: -40 degC at line pressure.
      g. Prefilter and final filter with metallic components of stainless steel, having replaceable cartridges with an absolute removal rating of particulates and micro organisms of 1 micron.
   2. Provide twin tower desiccant beds for alternate operation. Provide field adjustable, solid state timer to control purge cycles.
   3. Unit shall be completely assembled, piped and wired at the factory, and shall be complete with:
      a. Tower outlet pressure gauges.
      b. System outlet pressure gauge.
      c. Desiccant fill and drain ports.
      d. Inlet control valves, outlet check valves, shutoff valves, standard pressure relief valves.
      e. Purge exhaust mufflers.
      f. Control panel with on-off switch, power on light,

purge flow indicator, etc.

D. Dewpoint monitor: Consists of a sensor housing, cable assembly, mainframe with controls and digital display, and mounting hardware.
   1. Continuously display system dewpoint in degree Centigrade.
      a. Accuracy: Plus or minus 2 degrees at 345 kPa and 25 degC ambient.
   2. Provide selector switch to display alarm setpoint and measured temperature value.
   3. Provide with below range light.
   4. Provide a cancelable audible alarm.
   5. Sensor operating pressure: 690 kPa, minimum.
   6. Power: 115V/1Ph/60Hz.
   7. Provide mounting bracket for monitor for wall or pipe mounting.
   8. Provide cable assembly with twist-lock pin connectors for secure connection to sensor and monitor.

2.06 INSTRUMENT AIR FILTER/REGULATOR ASSEMBLY (IAFRA)

A. IAFRA shall consist of integral filter/regulator, coalescing filter and desiccant air dryer all in one complete assembly.

B. Assembly shall be Arrow Pneumatics, Inc., Model VC7510 or approved equal.

C. Assembly shall be provided for each branch to casework or equipment indicated as requiring instrument air (IA) service.

D. Assembly shall be located in the service galley as indicated on the typical lab service piping arrangement diagrams.

2.07 VACUUM PLANT, OIL RECIRCULATING

A. Vacuum plant: Completely packaged, continuous duty system prewired and prepiped to single point connections.
   1. Type of unit: Duplex.
   2. Capacity: As scheduled.
   3. Operation:
      a. Start first pump at 530 mm Hg vacuum; stop at 635 mm Hg vacuum.
      b. Start second pump at 480 mm Hg vacuum; stop at 580 mm Hg vacuum.

B. Vacuum pumps: Rotary vane, oil sealed, air cooled type.
   1. Oil filtered, integral recirculating oil supply.

2. Oil and mist removal.
3. Synthetic oil baffle removing 99.9 percent oil and smoke.
4. Mount each pump and motor on common baseplate with coupling and guard.
5. Check and anti-suck valve mounted at pump inlet.
6. Non-metallic and non-asbestos vanes.
7. Capable of continuous operation over working pressure range of 0 to over 735 mm Hg vacuum.
8. Motors: See Section 15010.

C. Vacuum pump accessories: Provide for each pump:
1. Discharge separator/silencer.
2. Provide isolation valves and check valves between pumps and receivers.
3. Inlet check valve and filter.
4. Flexible inlet and discharge connection hoses.
5. Vibration isolators: Combination spring-neoprene in shear with 25 mm deflection, minimum.
6. Vacuum exhaust in accord with compressed gas requirements.
7. Provide drain leg adjacent to each pump discharge, minimum 250 mm with drain valve.

D. Vacuum tank: ASME code construction.
1. Size: As scheduled.
2. Provide vacuum gauge.

E. Control panel: UL listed.
1. NEMA 1 enclosure.
2. Type of unit: Duplex.
3. Magnetic starters with overload protection for every phase and low voltage release protection.
4. H-O-A selector switches.
5. Control circuit transformers with fused secondary.
6. Vacuum switches:
7. Magnetic alternator.
8. Non-fused disconnect switches.
9. Lead-lag sequencing kit to provide even wear operation of pumps.
10. Controlled time run (CTR):
a. Provide on units with 15 kW motors and larger.
11. Thermal malfunction protection devices.
12. Vacuum gauge on cabinet cover.

PART 3 - EXECUTION

3.01 INSTALLATION OF PRESSURIZED SYSTEMS

A. General: See Sections 15010 and 15060.

B. Piping, valves, fittings and other components shall have been thoroughly cleaned of oil, grease and other readily oxidizable materials as if for oxygen service. These materials shall be plugged, capped, or otherwise sealed until final assembly. Particular care shall be taken in the storage and handling of the materials to maintain their clean condition. Immediately prior to final assembly, the material shall be visually examined internally for contamination. Material that has become contaminated and is determined to be no longer suitable for oxygen service shall not be installed.
   1. Off-site cleaning:
      a. Piping, valves, fittings, and other components shall be specially cleaned for oxygen service in a facility equipped to clean, rinse and purge the material in accordance with the requirements of CGA Pamphlet G-4.1.
   2. On-site cleaning:
      a. On-site cleaning of the interior surfaces of tubes, valves, fittings, and other components shall be limited to recleaning surfaces in the immediate vicinity of the joints that have become contaminated prior to brazing.
      b. Surfaces shall be cleaned by washing in a clean, hot water/alkaline solution, such as sodium carbonate or trisodium phosphate (1 LB to 3 GAS of potable water). Interior surfaces shall be thoroughly scrubbed and rinsed with clean, hot, potable water.

C. The piping or tubing shall be cut square using a sharp cutter to avoid deformation of the pipe or tube. The burred ends shall be reamed to full bore of pipe or tube and the chips removed. The cutting device and reamer shall be free from grease, oil or other lubricant not suitable for oxygen service.

D. Brazed joints shall be brazed using capillary fittings which comply with ANSI B16.22. Make brazed joints with brazing filler alloys that bond with the base metals being brazed and which comply with ANSI/AWS-A5.8.
   1. Copper-to-copper joints shall be made using copper-phosphorous or copper-phosphorous-silver brazing filler alloy (BCuP series) without flux.
   2. When joining dissimilar metals such as copper and brass, use an appropriate flux with either a copper-phosphorous, copper-phosphorous-silver (BCuP series), or a silver (BAg series) brazing filler alloy.
      a. The flux shall be applied sparingly and in a

manner to avoid leaving any excess inside of completed joints.

3. The surface to be brazed shall be cleaned using a clean stainless steel wire brush or equivalent. The use of steel wool is prohibited. The cleaning shall not result in grooving of the surfaces to be joined. After cleaning, the surfaces shall be wiped using a clean, lint-free white cloth. During this cleaning, care shall be taken to avoid contamination of the "cleaned for oxygen" internal surfaces of the tube and components. The joints shall be recleaned if contaminated prior to brazing. Joints shall be brazed within 1 hour of being cleaned.
4. Where dissimilar metals, such as copper and bronze or brass, are being brazed, flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. The flux shall be applied and worked over the surfaces to be brazed using a stiff stainless steel bristle brush to ensure adequate coverage and wetting of the surfaces with flux. Short sections of copper tube shall be brazed to the noncopper component, where possible, and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system. Flux-coated brazing rods shall be permitted in lieu of the application of flux to the surfaces to be joined on tube DN20 size and smaller.
5. The tube end shall be inserted fully into the socket of the fitting. Where flux is permitted, the joint shall be heated slowly until the flux has liquefied. Once this has occurred, or where flux is not used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint. Techniques for heating the joint, applying the brazing filler metal, and making joints shall be as stated in the appropriate sections in the CDA Copper Tube Handbook.
6. During the brazing procedure, joints shall be continuously purged with oil free dry nitrogen to prevent the formation of copper oxide on the inside surface of the joint. The flow of purge gas shall be maintained until the joint is cool to the touch.
7. During and after installation, openings in the piping system shall be kept capped or plugged to avoid unnecessary loss of purge gas while brazing and to prevent debris or other contaminants from entering the system, except that during brazing, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is being introduced. During brazing, the purge gas flow rate shall be maintained at a level that will not produce a positive

pressure in the piping system. After brazing, the discharge opening shall be plugged or capped to prevent contamination of the inside of the tube.

8. After brazing is complete, the outside of all joints shall be cleaned by washing with water and a stainless steel wire brush to remove any residue to permit clear visual inspection of the joint. Where flux has been permitted, hot water shall be used.
9. Each brazed joint shall be visually examined after cleaning of the outside of the joint. Evidence of the following conditions shall be considered unacceptable.
   a. Flux or flux residue.
   b. Excessive oxidation of the joint.
   c. Presence of unmelted filler metal.
   d. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube.
   e. Cracks in the tube or components.
   f. Cracks in the braze filler metal.
   g. Failure of the joint to hold the test pressure.
   h. Brazed joints that are found to be defective under conditions a,c,d,f, or g shall be permitted to be repaired, except that no joint shall be repaired more than twice. Brazed joints that are found to be defective under conditions b and e shall be replaced.

E. Threaded joints.
   1. Threads on pipe and fittings shall be tapered pipe threads complying with ANSI B1.20.1.
   2. Threaded joints in piping systems shall be tinned or made up with polytetrafluoroethylene tape or other thread sealant suitable for oxygen service. Sealants shall be applied to the male threads only.

F. Install pipe lines where they will not be subject to mechanical injury.

G. Run branch piping full size to each item of equipment, or outlet, including vertical drops; provide reducer at connection point to item of equipment or outlet.

H. Follow manufacturer's recommendations regarding removal or disassembly of valves during brazing to prevent damage to seats and seals.

I. After installation of piping, but before installation of outlet valves, alarms and gauges; blow lines clear with oil free, dry nitrogen.

J. Label or paint piping to indicate its gas content.

1. For labeling use metal tags, stenciling, stamping or adhesive markers in a manner that is not readily removable.
2. Labeling to appear on piping at intervals of not more than 6.5 m and at least once in each room and each story traversed by piping system.
3. Where supplementary color identification of piping is used, paint in accordance with gases and colors indicated in CGA Pamphlet C-9.

3.02 INSTALLATION OF VACUUM SYSTEMS

A. The joints in the copper tubing except those as valves or at equipment requiring pipe thread connections, shall be made with brazing material having a melting point of not less than 540 øC.

B. Particular care shall be exercised in applying the flux to avoid leaving any excess inside the completed joints.

C. The outside of the tube and fittings shall be cleaned by washing with hot water after assembly.

D. Following installation of the piping, but prior to attachment of the vacuum line to the vacuum pump(s) and receiver(s) and prior to installation of the vacuum alarm switch, station inlets, and gauges, the line shall be blown clear by means of oil free, dry nitrogen.

E. Threaded joints shall be installed by tinning the male thread with soft solder, litharger and glycerin, polytetrafluoroethylene tape, or a suitable luting compound.

3.03 INSTALLATION OF COMPRESSED AIR AND VACUUM PLANTS

A. Install in accord with manufacturer's instructions and recommendations.

B. Provide control wiring between control panel and individual vacuum pumps.

C. Provide factory service representative to supervise installation and start-up, and to set pressure and vacuum switches.

3.04 TESTING OF THE PRESSURE/VACUUM SYSTEMS

A. The testing included herein shall be performed by the installer and certified in writing to the COTR. These tests shall be successfully completed prior to performing

the tests required by the section entitled "Certification of Systems".

B. Do not jacket or conceal piping until thoroughly tested and certified.

C. Initial pressure test:
   1. After installation of terminal devices (with test caps if supplied in place) and prior to attachment of system components such as alarm switches, and gauges, subject each section of piping system to test pressure of 1.5 times the normal system working pressure but not less than 1030 kPa with oil-free dry nitrogen. Maintain this test pressure until each joint has been examined for leaks using soapy water or other leak detection method which is safe for use with oxygen.
      a. DO NOT TEST hydrostatically.
   2. Repair leaks and retest in accord with above procedure.
   3. When initial pressure testing has been successfully completed, blow the piping clear with oil-free dry nitrogen. This shall be done prior to the installation of all system devices and components required for the final pressure test.

D. Final pressure test:
   1. After completion of all initial pressure testing for the individual piping systems, perform a final 24 hour standing pressure test for each system at 20 percent above normal operating line pressure. This test shall be performed with all system devices and components attached.
      a. Use oil-free dry nitrogen as the test gas.
   2. After piping system is filled with test gas, the supply valve and every outlet closed, and the source of test gas disconnected, the system shall remain leak-free for 24 hours.
      a. The only allowable pressure changes during the 24 hour test period shall be those caused by variations in ambient temperature around piping system.
      b. Record ambient temperature and system pressure at beginning and end of 24 hour test.
   3. Repair leaks and retest in accordance with above procedure.
   4. After 24 hour test is successfully completed, maintain a minimum of 414 kPa on systems.

E. Furnish gauges, tools, pumps, gases and other equipment and materials required for testing.

F. Exercise care to keep testing equipment and materials free of oil.

3.05 PURGING OF PIPING SYSTEMS

A. After every system has been tested, disconnect source of test gas and connect proper gas source to each respective system.

B. Following pressurization, open outlets in a progressive order, starting nearest source and completing process of purge flushing at outlet farthest from source.
   1. Allow purge gas to impinge upon a white cloth material at a minimum flow rate of 100 liters per minute until no evidence of discoloration is evident and test gas used during previous tests has been removed from piping systems.

3.06 CERTIFICATION OF SYSTEMS

A. Retain an independent testing agency to perform the tests and examinations indicated herein and provide written certification of same.

B. After installation of complete system, certify the following mechanical functions:
   1. Operation of air system control sensors such as dewpoint, air temperature, and all other air-quality monitoring sensors and controls shall be checked for proper operation and function before system is put into service.
   2. Quality of compressed air as delivered by compressor air supply shall be verified upon installation and after 24 hours of operation at a sample point downstream of pressure regulators and upstream of piping system.

C. Certify that no cross connections exist between systems using the following procedures:
   1. Reduce systems to atmospheric pressure.
   2. Disconnect sources of test gas from the systems except the one system to be checked.
   3. Pressurize this system with oil-free dry nitrogen, or gas for which this system is intended, to a pressure of 345 kPa.
   4. With appropriate adapters matching outlet labels, check each individual station outlet of systems installed to determine that test gas is being dispensed from only outlets of this system.
   5. Where a vacuum piping system is installed, cross-connection testing shall include that system

with other gas piping systems.
6. Disconnect source of test gas and reduce system tested to atmospheric pressure.
7. Then proceed to test each additional piping system in accordance with above procedures.

D. Certify that piping systems have been purged.

E. Certify that piping systems are delivering the specified gas by examining each outlet flow with appropriate analyzer and document concentrations found.

F. Certify that system components perform to manufacturer's design specifications and pipelines are free of debris, including water.

G. Certify that air is dry as specified.
1. Determine dew point of samples taken at source and at most distant outlet of each lateral branch.
2. Record temperatures and pressures affecting dryness.

H. Certify that vacuum system performs as specified.

I. Retest after installing Contractor has corrected deficiencies found.

J. Testing agency to furnish test equipment and supplies including gases used in testing.

3.07 EQUIPMENT/SERVICE FITTINGS PROVIDED UNDER OTHER DIVISIONS

A. Unless otherwise noted, Division 15 only provides rough-in and final connection.

B. Rough-in shall be provided based on COTR approved rough-in drawings furnished by the equipment or casework manufacturer.

END OF SECTION

SECTION 15487

LIQUID NITROGEN PIPING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of work includes the furnishing of labor and material to provide a complete and operable liquid nitrogen piping system.

1.02 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer shall be regularly engaged in the supply and servicing of liquid nitrogen piping systems, including providing engineering services and produce evidence of at least five years of such activity.

B. Installer qualifications: Contractor shall be licensed, and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.

C. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS

A. Shop drawings:
   1. Liquid nitrogen piping layout at 1:50 scale.

B. Product data:
   1. Pipe and fittings.
   2. Phase separator.
   3. Vacuum pump.
   4. Valves.
   5. Gauges.
   6. Liquid level control console.

C. Samples: Not required for COTR review.

D. Project information:
   1. Installer qualifications.

E. Contract closeout information:
   1. Test reports.
   2. Operating and maintenance data.
   3. Local service office and response time for service.
   4. Manufacturer's recommended spare parts list.

PART 2 - PRODUCTS

2.01 GENERAL

A. All components used in the liquid nitrogen distribution system shall be products of a single manufacturer and shall be marketed collectively as a system. All materials used in the system shall be compatible with the low temperature service requirements.

B. Field fabrication of major components, or acquisition and use of components from multiple manufacturers is not acceptable.

C. Acceptable Manufacturers:
   1. Base:
      a. Vacuum Barrier Corporation (dynamic vacuum system).
      b. Minnesota Valley Engineering (static vacuum system).
   2. Other manufacturers desiring approval comply with Section 01640.

2.02 SYSTEM UTILIZING DYNAMIC VACUUM

A. Pipe and fittings:
   1. Double Wall Pipe: Two concentric, corrugated copper tubes, separated by a Teflon spacer. The spacer shall be in the form of a ribbon, twisted on its own axis, and wrapped in a helical configuration in the annular space between the two tubes. The exterior surface of the outer tube shall be coated with plastic. The annular space shall be continuously evacuated by a vacuum pump capable of maintaining a dynamic vacuum of 0.01 microns absolute or better.
   2. Triple Wall Pipe: Three concentric, copper tubes. The outer two tubes shall be corrugated and shall be separated by a Teflon spacer. The inner most tube shall not be corrugated. The spacer shall be in the form of a ribbon, twisted on its own axis, and wrapped in a helical configuration in the annular space between the outer two tubes. The exterior surface of the outer tube shall be coated with plastic. The annular space between the outer two tubes shall be continuously evacuated by a vacuum pump capable of maintaining a dynamic vacuum of 0.01 microns absolute or better.
   3. Fittings:
      a. The available fittings shall include but not be limited to bayonet connections, elbows, crosses,

tees, and end terminations. All fittings shall be of dimensions commensurate with the piping to which attached and shall possess the same vacuum insulating qualities.

b. End terminations shall be suitable for the designated individual application, and shall include an end with proper thermal isolation. Where appropriate, the end terminations shall have a pump-out port for the maintenance of vacuum.

c. Bayonet connections shall contain connections on each vacuum port to which a metal jumper hose can be attached to permit the dynamic vacuum to be continuous around the fitting.

B. Phase separator:

1. The phase separator shall be a vacuum insulated Dewar type vessel fabricated of stainless steel and shall include an inlet bayonet connection, an automatic valve, an inlet relief valve, a reservoir relief valve, a vacuum zone valve, and a vent terminating in a male bayonet connection.

C. Vacuum pump:

1. The vacuum pump shall be an air-cooled oil diffusion pump, two-stage mechanical fore pump, and cooling fan mounted on a compact base. The pump shall have a continuous vacuum capacity of 0.01 microns absolute or better.

D. Valves:

1. All valves shall be suitable for use with the other system components.
2. Liquid nitrogen shut-off: Authentic stainless steel, 1000 kPa maximum operating pressure, non-rising stem, vacuum jacketed, bayonet connections, manual operation.
3. Liquid nitrogen shut-off: Authentic stainless steel, 1000 kPa maximum operating pressure, non-rising stem, vacuum jacketed, bayonet connections, pneumatic operation, solenoid actuated, 115 Volt, 60 Hz.
4. Vacuum shut-off: Brass, 1/4 turn, Teflon seals, Viton o-ring stem seal, integral annullus relief valve, two plugged DN6 female NPT taps, VF-25 flanged end connections.
5. High vacuum solenoid: Brass, continuous duty normally closed solenoid actuator, Viton o-ring seals, 115 Volt, 60 Hz.
6. Back pressure regulating: Authentic stainless steel and brass globe valve assembly, Teflon seats, vacuum jacketed, bayonet connections (liquid nitrogen), VF-25 flanged connections (vacuum).

E. Vacuum gauge:
1. Cabinet mounted, adjustable set point, 0 to 100 millitorr range, 2 m power cable, 3 m gauge tube cable. Used in conjunction with a gauge sensing tube.

F. Electronic liquid level control console:
1. Use in conjunction with the phase separator to regulate the liquid nitrogen level, and to monitor system vacuum.
2. The liquid nitrogen portion shall contain the following features:
a. "FILLING" Light. Light shall latch ON as the as the liquid level falls through the LOW level setting, and shall latch OFF as the liquid level rises through HIGH level setting.
b. Five liquid level lights as follows: - EMPTY - MIN. LEVEL - LOW LEVEL - HIGH LEVEL - OVERFLOW.
c. OFF/ON switch controlling only this portion of the console.
3. The vacuum portion shall contain the following:
a. Vacuum gauge with adjustable set point.
b. System alarm light set to annunciate when the system vacuum rises above the set point.
4. The Console shall incorporate a control circuit to the phase separator fill valve. In the event that the OVERFLOW setting is reached, the control circuit shall disconnect the fill valve until such time as the liquid level drops below the overflow level.

G. Automatic Dewar Filling Station:
1. The automatic Dewar filling station shall provide fully automatic fail-safe operation. The filling station shall incorporate solid state electronics, safety relief values, and dual solenoid valves. A security key switch shall be included to limit access to authorized users and to permit operation in a "Manual" mode. 115 volt, single phase, 60 Hz.

2.03 SYSTEM UTILIZING STATIC VACUUM

A. Pipe and fittings:
1. Inner carrier:
a. The design and manufacturing of the vacuum insulated pipe shall be in accordance with ANSI B31.3 - Chemical Plant and Petroleum Refining Piping and latest applicable addenda for 1035 kPa.
b. Material shall be "INVAR 36" or 304 stainless steel, ASTM A312 pipe, welded or seamless.
c. Flow rate and size shall be as indicated on drawings.

d. Pipe ends shall be bayonet joints for joining spools and as specified on drawings at use point(s).

2. Vacuum jacket:
   a. The vacuum jacket shall be designed in accordance with the ASME Code for Unfired Pressure Vessel, Section VIII for an internal vacuum and external atmospheric pressure with the assembly at ambient temperature.
   b. Material shall be 304 stainless steel, ASTM A312 welded pipe.
   c. Expansion joints (NOTE: Only required when stainless steel inner carrier is used). Shall be installed in the jacket pipe of each spool as required to compensate for the differential rates of expansion and contraction between the inner carrier and jacket pipe.
      (1) Material: Type 304 stainless steel with Type 304 stainless steel ends for butt welding.
      (2) Design: Normal movement with minimum design as follows:

External pressure:	140 kPa with internal vacuum
Internal pressure:	240 kPa
Cycle life:	5000 cycles

3. Spacers:
   a. The inner carrier shall be supported within the jacket by a support system designed to absorb thermal loads on the inner pipe when partially or completely filled with product, to minimize heat leakage, withstand loadings (a, b, and c below) during shipping and loading, and (d) during and after installation:
      (1) Three "g" load applied vertically downward.
      (2) Three "g" load applied vertically upward.
      (3) Two "g" load applied horizontally, longitudinally, or laterally combined with one "g" load vertically downward.
      (4) Meet uniform building code for Zone 3 seismic requirement when inner line is filled with Trichlorethylene.
4. Laminar radiation shielding:
   a. The inner line shall be "super insulated" with a minimum of fifteen alternate layers of aluminum foil and Dexter glass fiber paper.
5. Chemical gettering system:
   a. Each spool shall have molecular sieve and a hydrogen converter installed in the vacuum annullus for the purpose of removing the majority

of vacuum contaminants released by outgassing. The quantity of sorption pumping materials required for each spool section shall be determined by the manufacturer.

6. Evacuation port:
   a. Each spool shall be equipped with a combination evacuation/relief valve port complete with a Hastings DV-6R vacuum transducer for monitoring the vacuum level without breaking into the vacuum annullus.
      (1) Location shall be in an approved location or approximately centered on each spool with consideration to personnel safety, accessibility, and non-interference with other equipment.
7. Manufacturing:
   a. Shall be accomplished through the use of certified welders. Welder's certification to be submitted upon request.
8. Evacuation:
   a. Heat shall be applied during pumping to accelerate outgassing. Minimum temperature shall be 93 øC. Spools to be sealed at less than 10 microns.
   b. Means shall be employed on the vacuum pumping system to prevent oil from backstreaming into the spool vacuum space.

B. Phase separator:
   1. The phase separator shall be a vacuum insulated Dewar type vessel fabricated of stainless steel and shall include an inlet bayonet connection, an automatic valve, an inlet relief valve, a reservoir relief valve, a vacuum zone valve, and a vent terminating in a male bayonet connection.

C. Valves:
   1. All valves shall be suitable for use with the other system components and shall be products of the system manufacturer.

D. Automatic Dewar Filling Station:
   1. The automatic Dewar filling station shall provide fully automatic fail-safe operation. A security key switch shall be included to limit access to authorized users and to permit operation in a "Manual" mode.

PART 3 - EXECUTION

3.01 FABRICATION

A. The complete installation shall be in accordance with the Contract Documents, and the requirements of the system manufacturer.

B. The quantity of connections shall be minimized by making the sections of piping as long as practical while maintaining functionality.

C. To the greatest extent possible, corners shall be achieved by bending the pipe. The arc of the bend shall not be less than the minimum bend radii specified by the piping manufacturer.

D. The pressure of the liquid nitrogen supply shall not exceed 210 kPa.

3.02 PIPING

A. Install vacuum insulated piping in accordance with manufacturer's written procedures.

B. Dynamic vacuum system:
   1. Provide double wall pipe and fittings from source to phase separator.
   2. Provide triple wall pipe and fittings from phase separator to point of use.

3.03 PHASE SEPARATOR

A. Supply of liquid nitrogen to the phase separator shall be controlled by a pneumatically operated valve which is governed by a solenoid valve. The solenoid valve shall respond to electrical signals from a sensor probe in the phase separator to maintain the liquid level at essentially atmospheric pressure.

B. The gaseous vapor, at the top of the separator, shall be vented to the atmosphere at approximately 1 atmosphere.

C. Liquid nitrogen shall be dispensed by gravity from the bottom of the separator through the inner tube of the triple wall pipe to the end termination at the point of use. The pressure in this portion of the system shall be approximately equal to the hydrostatic head from the phase separator to the point of use.

D. An end trap and bypass shall be installed ahead of each end termination to permit liquid and gas to return to the phase separator through the annular space between the inner two tubes of the triple wall pipe.

3.04 VALVES

A. High vacuum solenoid valves must be installed in the upright position. The system side of the vacuum connection shall have an annullus relief valve installed.

B. Vacuum ball valves shall be installed with the annullus relief valve on the system side of the valve.

3.05 SUPPORTS

A. Supports shall be provided in quantity and type required by the piping system manufacturer.

3.06 TESTING

A. The complete system shall be cold tested for vacuum integrity at the factory using liquid nitrogen prior to shipment to the site.

B. The installed system shall be helium leak tested with a mass spectrometer to a sensitivity of 1 x 10 □&a-50V-9□&a+50V standard cubic centimeters of helium per second at each joint.

C. Vacuum retention test (static system only):
   1. Each spool shall be tested over a two day period with the spool isolated from the pump at ambient temperature. The pressure in the annual space shall be measured every 24 HRS and recorded. Spools will be acceptable if:
      a. There is a pressure rise of eight microns or less. A pressure greater than eight microns will require one additional day of vacuum retention. The line shall be considered acceptable if the third day's reading indicated the vacuum is stable.
      b. The maximum stabilized pressure before shipping is 35 microns. (Consult factory for seven day or greater retention).

END OF SECTION

SECTION 15488

LIQUID NITROGEN STORAGE TANK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of work includes the furnishing of labor and material to provide a complete and operable liquid nitrogen storage tank.

1.02 QUALITY ASSURANCE

A. Manufacturer qualifications: Tank manufacturer shall be regularly engaged in the manufacturing of liquid nitrogen storage tanks and produce evidence of at least 5 years of such activity.

B. Installer qualifications: Contractor shall be licensed, and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity.

C. All tests shall be witnessed and signed off by COTR.

1.03 SUBMITTALS (See Division 1)

A. Shop drawings:
   1. Tank indicating all piping connections and accessories.

B. Product data:
   1. Tank.
   2. Accessories.
   3. Factory test and inspection certification.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Operating and maintenance data.
   2. Manufacturer's recommended spare parts list.

1.04 DELIVERY AND STORAGE

A. Equipment and materials shall be properly stored, adequately protected and carefully handled to prevent damage before and during installation. Damaged or defective items shall be replaced at no cost.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable manufacturers:
    1. Liquid nitrogen storage tank:
        a. Base:
            (1) Minnesota Valley Engineering.
        b. Optional:
            (1) Air Products, Inc.
    2. Other manufacturers desiring approval comply with Section 01640.

2.02 NITROGEN TANKS

A. Supply two (2) nitrogen tanks configured with the following features and characteristics:
    1. Tank No.1:
        a. Nominal capacity: 22 710 liters.
        b. Pressure ratings:
            (1) Design pressure: 510 kPa.
            (2) Relief valve setting: 510 kPa.
            (3) Pressure buildup regulator setting: 100 kPa (max. limit 1200 kPa).
            (4) Back pressure regulator: 170 kPa.
        c. Inner vessel shall be made of stainless steel.
        d. Outer vacuum shell shall be made of carbon steel.
        e. Insulation values must be submitted for acceptance. Composite insulate the tank to limit evaporation to .14 percent LOX per day for bulk storage.
        f. Automatic pressure building system.
        g. Dual inner tank relief valve and rupture disc with diverter valve.
        h. Fill line check valve and drain valve.
        i. Fill fitting, capped for local installation.
        j. Vacuum annullus rupture disc or lift plate.
        k. Liquid level gauge with adjustable low level switches/indicators and dry contacts to alarm panel(s).
        l. Appropriate line relief valves.
        m. The liquid withdraw shall be vacuum jacketed with a vacuum jacketed valve. The withdraw connection shall be compatible for use with the project vacuum jacketed pipe system.
    2. Tank No.2:
        a. Nominal capacity: 5675 liters.
        b. Pressure ratings:
            (1) Design pressure: 860 kPa.

(2) Relief valve setting: 860 kPa.
(3) Pressure buildup regulator setting: 100 kPa (max. limit 1200 kPa).
(4) Back pressure regulator: 170 kPa.

c. Inner vessel shall be made of 9 percent nickel.
d. Outer vacuum shell shall be made of carbon steel.
e. Insulation values must be submitted for acceptance. Composite insulate the tank to limit evaporation to .14 percent LOX per day for bulk storage.
f. Automatic pressure building system.
g. Dual inner tank relief valve and rupture disc with diverter valve.
h. Fill line check valve and drain valve.
i. Fill fitting, capped for local installation.
j. Vacuum annullus rupture disc or lift plate.
k. Liquid level gauge with adjustable low level switches/indicators and dry contacts to alarm panel(s).
l. Appropriate line relief valves.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install tank on concrete foundation (provided under another division of the specification).
1. Supervise and inspect the LN□&a+50V2□&a-50V tank system during installation, and inform the COTR of any work which must be completed or modified prior to filling. Field pressure test the equipment as per manufacturer's recommendation and applicable codes/regulations.
2. Following installation, all field erected piping and tank connect points should be tested at the maximum operation pressure to check for leaks.
3. Crane, related equipment and rigging personnel shall be supplied by the purchaser of the equipment.

3.02 WARRANTY

A. Provide minimum three (3) years warranty on the vacuum on the tank and minimum of ninety (90) days on the accessories.

END OF SECTION

SECTION 15489

HIGH PURITY NITROGEN PROCESS GAS PIPING SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of work:
   1. Provide all labor, materials, tools, equipment and services to provide complete and operable high purity nitrogen system as indicated and in accordance with the provisions of the Contract Documents.
   2. Provide tubing, fittings and valves.
   3. All tubing, fittings and valves shall be DN15 unless noted otherwise.

1.02 QUALITY ASSURANCE

A. Standards for the design, installation, and testing of systems:
   1. American National Standard Institute (ANSI).
      a. A13.1 Identification of Piping Systems.
      b. B120.1 Pipe Threads, General Purpose.
   2. American Society of Mechanical Engineers (ASME).
      a. Boiler and Pressure Vessel Code.
      b. B31.1 Power Piping.
      c. B31.9 Building Services Piping.

B. Installer qualifications: Contractor shall be licensed, and shall provide evidence of the successful completion of at least five high purity process gas distribution projects of equal or greater size and complexity.
   1. Welders:
      a. All welding shall be performed in accordance with ASTM B31.1.
      b. All welders performing work under this specification shall be fully qualified in accordance with the requirements of Section IX of the ASME Boiler and Pressure Vessel Code and shall provide a copy of the Certificate of Qualification to the COTR prior to any welding being performed.
      c. Each welder shall identify their work.

C. No deviations shall be made in the indicated materials, cleaning processes, installation procedures, or testing and certification requirements without written approval by the COTR.

D. The COTR reserves the right to reject all or any part of the system not conforming with the requirements of this

Specification.
1. Rejection of materials determined to be unsuitable shall be grounds for replacement of the materials at no additional cost to the Government.
2. Rejection do to improper installation procedures shall be grounds for replacement of the effected portions of the system at no additional cost to the Government.
3. Rejection of testing/certification procedures shall be grounds for the Government to hire the services of an independent testing/certification agency to perform the required testing/certification. Expenses resulting from this action shall become the responsibility of this Contractor.

E. Inspection and testing agency qualifications:
1. Retained by Contractor, but independent of facility, project contractors, and suppliers.
2. Specializing in testing the indicated systems.
3. Furnish evidence of 5 years minimum experience in such testing and successful completion of a minimum of 5 high purity process gas projects of equal or greater size.

F. All tests shall be witnessed and signed off by the COTR.

1.03 SUBMITTALS

A. Shop drawings:
1. Piping layout drawing at 1:50 scale.

B. Product data:
1. Pipe and fittings.
2. Valves.

C. Samples: Not required for Architect review.

D. Project information:
1. Installer qualifications.
2. Individual welder certification.
3. Testing/certification agency qualifications.

E. Contract closeout information:
1. All certified test records.
2. Operating and maintenance data.
3. Instruction report.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment and parts to the site factory cleaned and processed in original factory sealed package ready for installation.

B. Provide appropriate storage and handling procedures to assure integrity of factory cleanliness of products.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
   1. Tubing and fittings - Stainless Steel:
      a. Base:
         (1) Alfa Laval/Cardinal Systems Tech 50.
      b. Optional:
         (1) Swagelok/Cajon.
         (2) Micro Group, Inc.
   2. Valves, Stainless Steel:
      a. Base:
         (1) Nupro Co.
      b. Optional:
         (1) ITT Grinnel.

B. When materials arrive on the job site, the material shall be inspected to be sure that no damage to the end caps and bags occurred during shipment. Once the material arrives on the job site, it is to be stored in such a manner that it does not become contaminated or damaged.

2.02 CLEANING MATERIALS

A. Chemicals:
   1. 1-1-1 Trichloromethane, "Semi-Conductor Grade": Minimum assay 86 percent; maximum residue after evaporation 10 PPM.
   2. Acetone, "Semi-Conductor Grade": Minimum assay 99.5 percent; maximum residue after evaporation 5 PPM.

B. Lint free cleaning material: Kimberly-Clark "Kimwipes" approximately 300 x 425 mm, stock no. 34355 or approved equal.

C. Protective rubber gloves (resistant to Trichloromethane).

D. Stainless steel pans.

E. Stainless steel fitting brush.

F. Plastic caps (external fit-up).

G. Polyethylene bags.

H. Purge gases:

1. Argon from a cryogenic source filtered with a 0.2 micron membrane filter.
2. Nitrogen from a cryogenic source filtered with a 0.2 micron membrane filter.

I. Semi-clean room, an area with suitable ventilation to protect workmen from trichloromethane fumes.

J. Filters: 0.2 micron rated; non-fiber releasing, membrane filter.

2.03 TUBING

A. Provide seamless Type 316L stainless steel tubing complying with ASTM-A-269. Interior surface shall be bright annealed, clean and free of oxides, corrosion and demarkation.

B. All stainless steel tubing shall be cleaned off site by manufacturer, with a non-etchant cleaning solution, nitrogen purged, and capped to Federal Standard 209B, Class 10 prior to shipment to construction site.

C. Alfa Laval/Cardinal Systems Tech 50.

2.04 FITTINGS

A. The stainless steel tubing fittings shall be type 316L stainless steel wrought or forged (casting is not allowed), made for butt welding, cleaned and free of stains, dirt, oxides and contaminants which can be classified deterious. Each fitting shall be individually purged and bagged.

B. Alfa Laval/Cardinal Systems Tech 50.

2.05 FILLER METALS

A. Stainless steel: Joints in stainless steel lines shall be welded with bare rod Type 316.

2.06 VALVES

A. General:
1. Provide valves cleaned for high purity use and shipped in individual protective wrapping.
2. Identify each valve with engraved, numbered, metal or plastic tag chained to handle.
3. Provide valves full tube size unless indicated otherwise.

B. Stainless steel valves: NUPRO LD Series 316 stainless steel diaphragm valve with welded ends, tube extensions, PC2 purge connections.

PART 3 - EXECUTION

3.01 WELDING AND FABRICATION

A. General:
1. Cut tube with ends square and true to size.
a. Use tubing cutter with sharp cutting wheels.
b. Do not use hack saws or similar type cutting tools.
c. Remove all burrs at end of tube when cut is made.
d. It is the welder's responsibility to remove all dirt or particles from interior surface when cut is made. Absolutely none is allowed in system.
2. Visually inspect pipe, valves and fittings at time of installation.
3. Clean section of tubing to be cut from length with an abrasive cloth sufficient for joint area on each side of intended cut off point before cut is made.
4. Support tubing and fitting as necessary to keep axis straight and in line and maintain equal clearance around tubing and fitting to permit uniform capillary action to have proper effect on alloy position.
5. If system becomes contaminated due to fabrication techniques, system is to be replaced.

B. Stainless steel lines:
1. Weld using gas-tungsten-arc welding process, with 100 percent argon shielding.
2. Use constant-current power supply equipped with high frequency starting and foot control.
3. During fabrication, continuously purge lines with argon gas from a cryogenic source and allow to escape into atmosphere through a restrictor. Maximum impurity requirements of purge gas shall not exceed the following limits:
a. H2O - 1 PPM.
b. O2 - 2 PPM.
c. THC - Less than 1 PPM.
d. Purge gas shall be filtered with a 0.2 micrometer membrane filter.
e. For each purge restrictor used, use minimum flow of 80 to 120 mL/s of purge gas, but use sufficient purge gas to prevent oxidation and carry off vapors.
4. Replace welded joints which show evidence or cracks, cold welds, open porosity, tungsten inclusion or other defects or fit-up workmanship.

3.02 CLEANING PROCEDURE

A. General cleaning procedure:
   1. All tube, valves, fittings, and miscellaneous appurtenances must be cleaned using the following procedure. In addition, the COTR may eliminate or abbreviate this procedure if components are sent cleaned and bagged and inspections for cleanliness indicate little or no additional cleaning is required.
   2. Procedure:
      a. Solvent clean with 1-1-1 Trichloromethane. Submerge all wetted surfaces for 15 minutes, blow dry with nitrogen.
      b. Solvent clean with acetone. Rinse all wetted surfaces and blow dry with nitrogen.
      c. Solvent clean with isopropyl alcohol. Rinse all wetted surfaces.
      d. Blow dry with nitrogen and insure dryness.
      e. Bag the components with the wetted surfaces in a nitrogen atmosphere.
   3. Cleanliness verification:
      a. Valves:
         (1) Inspect valves to be sure bags are not punctured.
         (2) Set aside valves with broken bags, caps off or which look suspicious.
         (3) Visually inspect valves prior to installation.
         (4) If slight contamination is found, reclean.
         (5) If heavy contamination, reject and send back to vendor.
      b. Fittings:
         (1) Inspect each fitting. If fittings are found to be contaminated:
            (a) Reclean, if minor.
            (b) Reject, if major, and contact manufacturer.
      c. Pipe and tube:
         (1) Inspect each piece of tube for mechanical damage.
         (2) Through each piece of tube, shoot a tight-fitting wad of lint free cleaning material soaked in 1-1-1 trichloromethane using nitrogen pressure.
         (3) Inspect the wad for discoloration or particles. There shall be no evidence of discoloration or particles.
         (4) If there is only a slight evidence of discoloration or particles on the wad, additional wads soaked in 1-1-1 Trichloromethane may be shot through the tube

to clean the tube. However, if the tube is not clean by the fifth wad, the tube must be rejected.

(5) After the tube is accepted, blow dry with nitrogen.

(6) Shoot a wad soaked in isopropanol through the tube to remove the trichloromethane residue.

(7) Blow the tube dry with nitrogen and bag the ends.

(8) Tube accepted for use shall be used within 48 hours of acceptance. After 48 hours the tube must be re-inspected.

3.03 PIPE LABELING

A. Place labeling on pipes:
   1. Every 3 meters on straight pipe runs.
   2. Before and after valves and joints.
   3. Before and after passing through walls and partitions.

B. Attach self-adhesive markers after completion of pipe cleaning and spray over markers with protective coating of clean epoxy.
   1. Label all pipe hung at ceiling or in other accessible space.
   2. Wrap one full turn of reinforced tape over both ends of markers and flow arrows to prevent peeling.

C. Provide custom labels for piping systems for which no manufactured labels are available; submit sample for approval to COTR.

D. Designated legends and background colors for system pipe markers.

Pipe System	Legend	Color
Nitrogen (High Purity)	Nitrogen - HP	Green

3.04 FINAL PRESSURE TESTING

A. General:
   1. The COTR has the option to cut out several welded joints of each system to visually inspect the cleanliness and workmanship of the joint. If the joint section is found unacceptable, then the replacement cost will be borne by the Contractor. If the joints are acceptable, then the cost will be borne by the Government.
   2. Prior to testing operation, open valves and blow out pipelines to remove foreign matter which may have

accumulated.
a. Purge lines by progressively opening and closing valves.
3. Perform testing in presence of the COTR.
4. Use only high purity nitrogen as previously specified for purging and pressure testing.
5. Do not pound or hammer on any joints or equipment.
6. Observe safety procedures constantly.
7. Use gauges cleaned for oxygen service.

B. Testing procedure:
1. Check systems to assure compliance with latest drawings.
a. Check pressure and temperature rating of valves to assure compliance with the manufacturer's designated standard. Verify that valves are consistent with intended usage.
2. Check safety valves for pressure settings.
a. Make adjustments and corrections to assure conformance with drawings prior to proceeding with testing activity.
b. Do no exceed pressure ratings of installed equipment.
3. Install test gauges and connect test gas source to convenient process connections.
4. Pressure test system at 1035 kPa. Isolate source and hold for 24 hours without a drop in pressure unless the drop can be accounted for by a temperature change.
5. Test joints with bubble leak detecting solution when pressure reading indicates leakage; repair leaks and retest per Step 4 above.
6. After completion of testing, remove gauges and gas source and return the system to the condition shown on drawings. Insure the system is pressurized to at least 140 kPa.

3.05 FINAL PURITY AND LEAK TESTING

A. The Contractor shall hire the services of a certified independent testing agency to perform the following:
1. Purity test:
a. The nitrogen system shall be tested by purging with nitrogen of quality as specified in the attached table.
b. Provide intermediate purity testing during construction if necessary to obtain final purity requirements.
c. Final (100 percent Construction Completion) purity testing shall meet or exceed the requirements in the attached table.

PURITY REQUIREMENTS AT 100 PERCENT
CONSTRUCTION COMPLETION

SYSTEM: NITROGEN
Purging Gas: Nitrogen

(Purity of Nitrogen) Max. Impurity Levels	* Difference
02 - 2 PPM	Less than 1 PPM
H2O - 1 PPM	Less than 1 PPM
THC - 1 PPM	Less than 1 PPM total
CO/CO2 - 3 PPM	Less than 1 PPM
**	no PPM 1 (u)

* Difference in the purity of the purging gas entering the system to the gas exiting the system.

** Purge gases shall be filtered with 0.2 micro meter membrane filters.

END OF SECTION

SECTION 15510

HYDRONIC PIPING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of systems:
   1. Systems:
      a. Chilled water piping (CWS, SCWS, PCWS).
      b. Coil header piping.
      c. Condensate and cooling coil drain piping.
      d. Condenser water and tower cleaning assembly piping (CTS, TCAS).
      e. Heating and heat recovery (HWS, CHRWS) water piping.
      f. Glycol water piping (LTGWS, GWS).
      g. Make-up water piping.
      h. Water treatment system piping.
      i. Laboratory slab conditioning water piping (LSWS).
      j. Steam generator feed water and blowdown piping.
   2. Products:
      a. Air vents.
      b. Expansion tanks.
      c. Flow switch wells.
      d. Strainers.
      e. Air separator/eliminator.
      f. Pressure and temperature test station/combination.
      g. Valves.
      h. Water flow measurement devices.
      i. Water treatment system.
      j. Glycol water make-up system.
      k. Process cooling water filters.
      l. Water meters.

B. Work installed but not furnished:
   1. Automatic valves: Furnished in Section 17000.
      a. Provide fittings and reducers required for installation of automatic valves.
   2. Temperature sensing wells: Furnished in Section 17000.
   3. Electric immersion heaters: Furnished in Section 17000.

1.02 QUALITY ASSURANCE

A. Piping: ASTM labeled for rating specified.

B. Piping standards: Section 15060.

C. Manual valve standards: Section 15100 (for valves with "V" prefix).

1.03 SUBMITTALS

A. Shop drawings:
1. Piping layouts at 1:50 scale.

B. Product data:
1. Air vents.
2. Expansion tanks.
3. Strainers.
4. Valves, constant flow control.
5. Valves, manual.
6. Valves, pressure reducing.
7. Valves, safety (pressure relief).
8. Valves, triple duty.
9. Water flow measurement devices.
10. Water treatment system.
11. Glycol make-up system.
12. Water filters.
13. Water meters.

C. Samples: Not required for COTR review.

D. Project information:
1. Qualifications of chemical cleaning agency.

E. Contract closeout information:
1. Operating and maintenance data.
2. Guarantee.
3. Field test reports.
4. Cleaning final certifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers:
1. Air vents, automatic:
a. Base:
(1) ITT Bell & Gossett.
b. Optional:
(1) Armstrong.
(2) Fisher.
(3) Hoffman.
(4) Illinois.
(5) Johnston Corp.
(6) Spirax Sarco Inc.
(7) Taco.

(8) Thrush Amtrol, Inc.
(9) Trane.

2. Air vents, manual:
   a. Base:
      (1) Crane.
   b. Optional:
      (1) Jenkins.
      (2) Johnston Corp.
      (3) OIC.
      (4) Powell.
      (5) Stockham.
      (6) Walworth.
3. Expansion tanks:
   a. Base:
      (1) Taco.
   b. Optional:
      (1) Thrush Amtrol, Inc.
      (2) Armstrong Pumps.
      (3) ITT Bell & Gossett.
      (4) Wheatly.
4. Pressure/temperature test stations, combination (P/T plug).
   a. Base:
      (1) Peterson Equipment Company (Pete's plug).
   b. Optional:
      (1) Sisco.
      (2) Super Seal.
      (3) Fairfax Co.
5. Strainers, air separator/eliminators:
   a. Base:
      (1) ITT Bell & Gossett.
   b. Optional:
      (1) Thrush Amtrol, Inc.
      (2) Armstrong.
      (3) Taco, Inc.
      (4) Wheatly.
6. Strainers, in-line wye strainer and valve combination:
   a. Base:
      (1) Autoflow, Inc.
   b. Optional:
      (1) Griswold Controls.
      (2) Presco.
7. Strainers, single-basket and tee:
   a. Base:
      (1) ITT Hoffman.
   b. Optional:
      (1) Armstrong.
      (2) Gustin-Bacon.
      (3) O C Keckley.
      (4) Metraflex.
      (5) Mueller Steam Specialty.

(6) Spence.
(7) Spirax Sarco, Inc.
(8) Tate Temco, Inc.
(9) Tate-Elliot.
(10) Victaulic.

8. Strainers, suction diffuser:
   a. Base:
      (1) ITT Bell & Gossett.
   b. Optional:
      (1) Gustin-Bacon.
      (2) Mueller.
      (3) Taco.
      (4) Victaulic.
      (5) Armstrong.
      (6) Wheatly.
9. Valves, pressure reducing (water):
   a. Base:
      (1) ITT Bell & Gossett.
   b. Optional:
      (1) Watts.
      (2) Armstrong Pumps.
      (3) Conbraco.
      (4) Taco.
      (5) Thrush Amtrol, Inc.
10. Valves, safety (water and glycol):
   a. Base:
      (1) ITT Bell & Gossett.
   b. Optional:
      (1) Farris.
      (2) Armstrong Pumps.
      (3) Taco.
      (4) Teledyne Farris Engineering.
      (5) Thrush Amtrol, Inc.
11. Valves, triple duty:
   a. Base:
      (1) ITT Bell & Gossett.
   b. Optional:
      (1) Gustin-Bacon.
      (2) Victaulic.
      (3) Wheatly.
12. Water flow measurement devices:
   a. Base:
      (1) Aeroquip.
   b. Optional:
      (1) Data Industrial.
      (2) Dynasonics.
      (3) Gerand Engineering Co.
      (4) Victaulic.
13. Valves, constant flow:
   a. Base:
      (1) Autoflow.

b. Optional:
(1) Griswold Controls.
(2) Presco.

14. Water-treatment-system cleaning chemicals:
a. Base:
(1) Oakite Products, Inc.
b. Optional:
(1) Diversey Water Technologies.
(2) Mitco.

15. Water-treatment-system chemical feeders:
a. Base:
(1) Neptune.
b. Optional:
(1) Mitco.
(2) Calgon.
(3) Diversey Water Technologies.
(4) Nalco.

16. Glycol water make-up system:
a. Base:
(1) Morr Control.
b. Optional:
(1) Mitco.
(2) Calgon.
(3) Diversey Water Technologies.
(4) Nalco.

17. Glycol water:
a. Base:
(1) Dow Chemical Company.
b. Optional:
(1) Olin Corporation.
(2) Ashland Chemical Co.

18. Process cooling water filters:
a. Base:
(1) Filterite.
b. Optional:
(1) Claude Laval/Lakos Separators.
(2) Osmonics.

19. Water meters:
a. Base:
(1) Hersey.
b. Optional:
(1) Badger.
(2) Rockwell.

20. Other manufacturers desiring approval comply with Section 01640.

2.02 PIPE AND FITTINGS

A. Chilled water piping, above grade:
1. Copper, type L, with soldered joints, and wrought copper or cast brass fitting; or T-drilled with brazed

joints. (CWS, SCWS, PCWS, LTGWS).
a. Mechanical groove-end coupling and fittings may be used for sizes DN75 and larger.

2. Black steel. (CWS, SCWS, LTGWS).
a. DN50 and smaller: Threaded joints, with cast iron or malleable iron threaded fittings.
(1) Limit the use of threaded fittings in glycol systems to equipment and valve connections.
b. DN65 and larger: Welded joints.
c. Grooved type couplings and fittings may be used for chilled water piping.
d. Do not use black steel for process cooling water system (PCWS).

B. Coil header piping:
1. Fabricate of black steel pipe with weld-o-lets for tees.
2. Copper, type L, with soldered joints, and wrought copper or cast brass fittings.
3. T-drilled Type L copper with brazed joints.

C. Condensate and cooling-coil-drain piping:
1. Copper, type M or L, and soldered joints with 50-50 solder.
2. Galvanized steel with cast iron drainage type fittings.

D. Condenser water piping: Same as chilled water piping.

E. Tower cleaning assembly piping: Same as chilled water piping.

F. Heating and glycol-water piping:
1. Black steel, with welded joints.
a. For DN65 and larger: Use forged butt welding fittings.
b. For DN50 and less: Use socket welding fittings, 13.8 or 20.7 MPa class.
c. Threaded pipes and nipples may be used at equipment connections.
d. Weld-o-let or thread-o-let type of fittings may be used in lieu or tees for branch connections, provided main is one size larger than takeoff.
(1) Couplings or half couplings are not acceptable except for non-flow connections such as thermometers or gauges.
e. Limit use of threaded fittings in glycol systems to equipment and valve connections.
2. T-drilled Type L copper with brazed joints.
3. Grooved type couplings and fittings may be used. In copper piping, grooved connections may be used in

pipes DN75 and over.

G. Make-up water and glycol piping:
1. Same as system served.
2. Connect to backflow preventer provided under Section 15410.

H. Water treatment system piping:
1. Same as system served.

I. Laboratory slab conditioning water piping (LSWS):
1. Piping in slab: Cross-linked polyethylene (PEX) tubing as indicated.
2. Flexible connection between slab piping and the supply and return headers: Rubber hose as indicated.
3. System piping other than indicated above: Same as chilled water piping.

J. Steam generator feedwater and steam generator blowdown piping:
1. Black steel as specified for heating and glycol-water piping.

2.03 AIR VENTS

A. Air vents, automatic:
1. 1040 kPa rated, minimum.
2. Maximum working pressure: 680 kPa.
3. Maximum temperature: 100 degC.
4. Cast bronze, chrome plated, body with renewable valve and seat.
5. Synthetic rubber disc.

B. Air vents, manual:
1. Vent valves: DN8 860 kPa globe angle valve with XH nipple connecting to pipe.

2.04 EXPANSION TANKS

A. Tanks, expansion (air-elimination system):
1. Pre-pressurized diaphragm type with charging valve.
2. Size: As scheduled.
3. Rated pressure: 860 kPa.
4. Rated operating temperature: 115 degC, minimum.
5. Precharge pressure: Same as scheduled minimum operating pressure.
6. Bladder: Heavy duty butyl, removable for inspection.
7. ASME constructed and stamped.

2.05 FLOW SWITCH WELLS

A. Flow switch wells:
   1. Install DN25 thread-o-let for flow switch installation.
   2. Provide DN25 nipple and cap.

2.06 STRAINERS

A. Strainers, in-line wye strainer and valve combination:
   1. One piece configuration consisting of O-ring union, P/T plug, blow down and ball valve with handle.
   2. Strainer valves DN32 and smaller: 20 mesh stainless steel stainer.
   3. Strainer valves DN40 and larger: Limit passage of particles 1000 microns and larger.
   4. Bronze body construction with threaded connections.
      a. Internal parts: Brass and stainless steel.
   5. Provide valves with unions to allow field exchange of internal components without removing valve body from pipeline.
   6. Provide metal ID taps permanently marked to indicate direction of flow, strainer mesh and model number.

B. Strainers, single-basket type.
   1. Screwed or flanged.
   2. Body: Cast iron, flanged ends, bolted access cover.
   3. Coating: Rust inhibiting.
   4. Working pressure, non shock: 1040 kPa.
   5. Screens: Bronze, monel or stainless steel.
      a. DN50 and less: 1.20 mm perforations.
      b. DN65 and larger: 3.20 mm perforations.

C. Strainers, suction diffusers:
   1. Angle cast iron body type with inlet vanes and combination diffuser-strainer-orifice cylinder.
   2. Provide with disposable 16 mesh strainer for system start-up.
   3. Orifice cylinder with 5 mm diameter openings.
      a. Designed to withstand pressure differential equal to pump shutoff head (maximum 1200 kPa).
      b. Free area equal to 5 times cross-section area of pump suction opening.
   4. Vane length: Not less than 2-1/2 times pump suction opening.
   5. Provide with adjustable support foot to carry weight of suction piping.

D. Strainer, tee-pattern type.
   1. Grooved ends.
   2. Body: One-piece ductile iron casting conforming to ASTM-A536 or malleable iron conforming to ASTM-A47.
   3. Coating: Rust inhibiting.

4. Working pressure rating: 2070 kPa.
5. Basket screen: 304 stainless steel 1.12 mm wire in a woven No.6 mesh wire screen with 3.20 mm opening.
6. Vertical down flow or horizontal flow.
7. Cleaning access through blank end cap.

E. Strainers, wye:
1. See Section 15120, Piping Specialties.

2.07 AIR SEPARATOR/ELIMINATOR

A. Combination air separator and air elimination valve in a single unit.
1. ASME Boiler and Pressure Vessel Code compliant.
2. Centrifugal vortex air separator.
3. Self-sealing air elimination valve which closes to prevent entry of air during negative pressure conditions.
4. For bypass type application.
5. Maximum operating temperature: 115 degC.
6. Operating pressure: 13.8 to 1030 kPa.
7. Flow range: 0 to 0.5 L/s.

2.08 PRESSURE AND TEMPERATURE TEST STATIONS, COMBINATION

A. Pressure/temperature test station, combination:
1. Station to receive either a DN6 OD temperature or pressure probe.
2. Fitting: Solid brass, DN8 NPT, with 2 valve cores of neoprene (maximum 95 degC at 3450 kPa) or Nordel (maximum 135 degC at 3450 kPa).
3. Provide long length (XL) at locations with pipe insulation.
4. Provide with color coded and marked cap with gasket, rated at 6900 kPa at 60 degC.

B. Pressure and temperature test kit:
1. Range: 0-700 kPa.
2. 3 mm OD probe and 125 mm stem pocket testing thermometers.
a. Provide two for chilled water: -4 to 52 degC.
b. Provide two 10-260 degC for hot water.
3. No.500 gauge adapter with 3 mm OD probe.
4. Protective carrying case.
5. Turn over to COTR.

2.09 VALVES

A. Manual valves:
1. Angle valves:
a. DN50 and smaller: V-17.

b. DN65 and larger: V-18.

2. Balancing valves:
   a. DN50 and smaller: Bell & Gossett Circuit Setter Plus Model CB with molded insulation.
   b. DN65 and DN75: V-40.
   c. DN100 and larger: V-34.
3. Ball valves (DN50 and smaller):
   a. V-13 or V-14.
4. Butterfly valves:
   a. DN65 and larger: V-34 or V-35.
5. Steam generator blowdown valves: Plug, globe, angle and check.
   a. Rated for 1730 kPa and 205 degC.
6. Steam generator feedwater valves: Plug, globe, angle and check.
   a. Rated for 1730 kPa and 205 degC.
7. Check valves, pump discharge, cycling application (for cooling coil condensate pumps: P-107, P-206, P-207, P-208, P-309, P-407, P-408, P-506, P-507):
   a. DN50 and smaller: V-26.
   b. DN65 and larger: V-30.
8. Check valves, pump discharge, unless otherwise specified:
   a. DN50 and smaller: V-25 or V-26.
   b. DN65 and larger: V-28, V-29, or V-30.
9. Check valves, other:
   a. DN50 and smaller: V-25.
   b. DN65 and larger: V-28 or V-29.
10. Gate valves:
    a. DN50 and smaller: V-1 or V-2.
    b. DN65 and larger: V-3.
11. Globe valves:
    a. DN50 and smaller: V-6 or V-7.
    b. DN65 and larger: V-8.
12. Plug valves:
    a. DN50 and smaller: V-36.
    b. DN65 and larger: V-37.
13. Sampling cocks:
    a. V-58.
14. Shut off valves at AHU coils (DN100 and smaller):
    a. V-34.

B. Pressure reducing valves:
1. Water type, diaphragm operated with low inlet pressure check valve and built-in strainer.
2. Construction:
   a. Body: Brass.
   b. Diaphragm: EPT.
   c. Check valve: Rubber.
   d. Seat: Brass.
   e. Stem: Brass with Buna N insert.

f. Strainer: Brass.
3. Maximum working pressure: 690 kPa.
4. Adjustable pressure range: 175-415 kPa.

C. Safety valves, water:
1. ASME-approved, tight-shutoff, self-closing.
2. DN65 and less: Screwed.
3. DN75 and larger: Flanged.
4. Ten percent over pressure.
5. Test lever.
6. Capacity: Same kW as equipment served. See schedules.
7. Relief setting: 860 kPa unless indicated otherwise.

D. Triple-duty valves:
1. Non-slam check valve with spring-loaded disc.
2. Calibrated adjustment feature to regulate pump discharge flow and shut-off.
3. Cast iron body.
4. 1210 kPa working pressure, 150 degC operating temperature.
5. Valves capable of being repacked under full line pressure.

E. Constant flow control valves:
1. Factory calibrated, direct acting, automatic pressure compensating.
2. Control flow rates within 5 percent of flow rating over operating pressure differential range.
a. Set flow rating as indicated.
3. Pressure differential range:
a. 15-220 kPa.
4. Threaded-brass body with (2) DN8 pressure taps with caps, and stainless-steel internal parts.
5. Provide a metal identification tag with chain for each installed valve.
a. Identify valve model number, rated L/s, direction of flow, and differential pressure range.
6. Provide with integral unions and integral ball valve. Y configuration to allow field exchange of internal components without removing valve body from pipeline.

2.10 FLOW MEASUREMENT DEVICES

A. Differential pressure and direct flow meters:
1. Wall mounted type meter with 150 mm round dial, 270 degree indication.
2. Range: 0-12.5 or 0-25 kPa as required by measuring device.
3. Readings to be between 25 and 75 percent of full scale.

4. Provide purge valves and hoses, minimum of 6 m.
5. Meter assembly rated at 1700 kPa and 120 degC.
6. Arrange tubing for multi-station measurement. Four measuring devices maximum. Label each connection. Letter size 10 mm minimum.
7. Provide L/s direct reading single station meter where indicated on drawings.

B. Venturi flow measuring device:
1. Accuracy: Plus/minus 1 percent at design flow.
2. Maximum pressure drop: 2.4 kPa.
3. Provide safety shut-off valves, sensing taps, nipples and quick connection couplings.
4. Identify with metal tag on chain indicating:
a. Size.
b. Equipment served.
c. L/s.
d. Meter reading for flow rate specified.
5. Sizes DN15 through DN50 brass, screwed.
6. Sizes DN65 and over steel, flanged or butt welded.
7. Install with a minimum of 5 pipe diameters straight pipe upstream and 2 pipe diameters downstream and per manufacturer's recommendation.
8. Permanent pressure loss shall be not more than 25 percent of design flow rate differential pressure.

2.11 WATER TREATMENT SYSTEM

A. Water treatment system cleaning chemicals:
1. Alkaline:
a. Oakite 62, 162, 24, 77.
2. Acid:
a. Oakite 32.

B. Water treatment system operating chemicals:
1. Provide type of treatment and chemical dosages in accordance with water analysis as recommended by manufacturer of treatment chemicals.
2. Provide water treatment chemical for the process cooling water system that has the following characteristics:
a. Weak organic acid and amine.
b. Biodegradable.
c. Contains no mineral acids (hydrochloric, suffuric).
d. Contains no nitrates, molybdates, or heavy metals.
e. Inhibitor of calcium carbonate precipitation and certain mineral scales (iron oxide, calcium, magnesium).
f. H.E.R.C. Products Inc., Compound 400 Inhibitor Concentrate, or approved equal.

C. Water treatment system chemical feeders:
   1. Pot type feeders constructed for operating pressure of 1380 kPa maximum.
   2. Capacity of feeders: 18 L minimum.
   3. Provide legs for floor mount and full bottom drain.
   4. Wide mouth cap with "O" ring seal will close easily by hand. Cap shall not be operable under pressure.

2.12 GLYCOL-WATER MAKE-UP SYSTEM

A. Glycol-water make-up storage tank:
   1. Self-supporting polyethylene, minimum 4 mm thickness, with removable cover or black steel with 4 mm polyethylene insert.
   2. Capacity shall be 200 L, with approximate diameter of 600 mm and height of 900 mm.
   3. Reinforced threaded pipe connections shall be provided for all connections.
   4. Provide identification for tank indicating name of the contents.

B. Glycol-water make-up pump:
   1. Bronze fitted, self-priming, high head type suitable for pumping a 25 percent to 50 percent glycol-water solution in intermittent service.
   2. Provided with a mechanical shaft seal.
   3. Flange connected to a NEMA Type C motor.
   4. Capacity: 0.1 L/s at 690 kPa.
   5. The Contractor may substitute a "gear-within-a-gear" positive displacement type pump with built-in relief valve set for 350 kPa.
   6. Built-in or external relief valve set for design head of the pump, as indicated on drawings.

C. Glycol-water pressure control:
   1. Stainless steel diaphragm, positive snap-acting SPST switch mechanism, rated 10 amps, 120 volts AC.
   2. General purpose (NEMA 1) enclosure.
   3. Rated for pressure to 1000 kPa.
   4. Provide first low pressure switch to make circuit on low water pressure. It shall cycle make-up pump to maintain pressure in glycol-water circuit.
   5. Provide second low pressure switch to make circuit on lower water pressure. It shall send signal for low pressure alarm.

D. Back pressure regulating valve:
   1. Spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim.
   2. Capacity to relieve 100 percent of pump flow with an

allowable rise in the regulated pressure of 70 kPa above the setpoint.
3. Setpoint shall be 100 kPa above system PRV setting.

E. Low glycol water level control:
1. Steel or cast iron float housing, stainless steel float.
2. Positive snap-acting SPST switch mechanism, rated 10 amps, 120 volts AC, in General Purpose (NEMA 1) enclosure.
3. Rated for pressure to 1000 kPa.
4. Make alarm circuit on low water level.

F. Morr Control GF-1.

2.13 GLYCOL-WATER

A. Industrially inhibited propylene glycol, phosphate-based:
1. Fluid must pass ASTM-D1384.
2. Provide free annual analysis by fluid manufacturer.
3. Corrosion inhibitors formulated for HVAC systems to keep pipes free of corrosion without fouling.
4. Dow Chemical Company: Dowfrost.

2.14 PROCESS COOLING WATER FILTERS

A. Filter cartridge: 100 percent polypropylene FDA compliant, high flow melt-spun.
1. 5 micron rating.
2. 65 mm OD, 40 mm ID.
3. Size cartridges for maximum flow rate of 0.32 L/s per 250 mm length.
4. Maximum initial pressure loss is 4 kPa at recommended maximum flow rate.

B. Filter housing:
1. Accept the required number of cartridges in 500 mm, and 1000 mm lengths.
2. ASME Code, carbon steel construction.
3. 1000 kPa maximum operating pressure.
4. Size for the number of cartridges required to meet filtration requirements at the maximum initial cartridge pressure loss.
5. Size and capacity scheduled.

2.15 WATER METER

A. Provide sealed register, displacement type, magentic drive water meter with impulse contactor for remote reading by Building Management System.
1. Water meter shall be bronze body with threaded ends.

2. Impulse contactor shall read flow in liters.
3. Water meter shall be line size as indicated on the drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. Provide in accordance with Section 15060 and Section 15010.

B. Connect equipment.

3.02 PIPE AND FITTINGS

A. Threaded joints in glycol-water piping:
1. Remove pipe cutting oil from threads by scrubbing in Portland cement.
2. Coat dry threads with "Permatex" pipe compound prior to assembly.

B. Do not insulate or conceal piping until testing is completed.

3.03 AIR VENTS

A. Air vents, automatic:
1. Provide shut off valve ahead of vent.
2. Provide copper relief line from valve to drain or drip pan.
3. Provide at locations indicated on equipment and piping schematic drawings.

B. Air vents, manual:
1. Vents shall prevent air binding in systems.
2. Pipe discharge of vent to a location where air and water may be collected in a bucket.
3. Locations:
a. Provide at trapped high points of closed piping systems.
b. Provide at coil headers in air handling units, unit heaters, fan coil units, air terminal units, and where indicated.

3.04 FLOW SWITCH WELLS

A. Provide flow switch wells at following locations:
1. Condenser water supply line to each chiller.
2. Chilled water return line to each chiller.

3.05 PRESSURE AND TEMPERATURE TEST STATIONS, COMBINATION

A. Provide at locations indicated on equipment details and piping schematic drawings.

3.06 STRAINERS

A. Provide full line size strainers ahead of control valves (motor operated), regulating valves, pumps, and as indicated.

B. Provide strainer types as indicated:
   1. Condenser water: Single-basket, or wye type.
   2. Chilled water: Single-basket, tee, or wye type.
   3. Heating and glycol water: Single-basket, tee, or wye type.
   4. Laboratory slab conditioning water: Single-basket, tee, or wye type.

C. Connections to suit piping.

D. Provide blow-down valves:
   1. Strainers DN150 and larger: DN40 blow-down valve.
      a. Pipe blow down to drain.
   2. Strainers DN50 to DN125: DN25 blow-down valve with DN20 hose end connection.
   3. Strainers DN40 and smaller: DN15 blow-down valve with DN20 hose end connection.

3.07 VALVES

A. Heating and cooling pipe risers:
   1. Provide isolation valves at main feed points to risers.
   2. Provide isolation valves at branch take-offs from risers.

B. Provide safety valves on heat exchangers' piping between exchanger and isolation valves.

C. Provide drain piping at safety valves and valves with test levers.
   1. Extend piping to within 150 mm above nearest floor drain.

D. Provide system drains: See Section 15120.

E. Provide 3-valve manifold for each differential pressure sensor.
   1. Coordinate locations and quantities of sensors with Controls Contractor.

3.08 WATER FLOW MEASUREMENT DEVICES

A. Provide as indicated.

B. Install flow meters at eye level.

3.09 WATER TREATMENT SYSTEM

A. Mount chemical feeder across pumps of water systems as indicated.

3.10 TESTING

A. Test heating and cooling piping upon completion of a section or of entire system.
   1. Test hydrostatically to pressure not less than 50 percent in excess of maximum pressure to which pipe will ordinarily be subjected, but in no case less than 1040 kPa. Perform test for one hour without pressure drop.
   2. Repair or replace leaks or defective pipe disclosed by tests.
   3. Repeat tests until piping indicates tight.
   4. Provide a testing schedule and description of test method to COTR two weeks before beginning testing. Give 24 hours advance notice of any change from testing schedule.

B. Testing of polyethylene tubing shall be as specified in Section 15060.

3.11 CLEANING OF HYDRONIC PIPING SYSTEMS

A. Engage and pay for the services of a recognized chemical cleaning agency. Submit qualification of agency to COTR through the submittal process.
   1. Furnish all chemicals, perform sampling and testing.
   2. Supervise chemical cleaning operations.
   3. Agency's representative shall be present on site at all times during flushing and chemical cleaning process.

B. Provide a cleaning schedule and description of cleaning method to COTR two weeks before beginning testing. Give 24 hours advance notice of any change from testing schedule.

C. Isolate and do not operate system pumps until system has been cleaned.

D. At system completion, make temporary connection to domestic water system, and flush system until clear water is visible from drain connection. Do not install water filter cartridges until PCWS system is clean.
   1. Drain system after flushing.

E. At project completion, clean systems:
   1. Thoroughly flush system with a recommended hot solution (70-82 degC) of alkaline cleaning chemical to remove oil and grease that may be present.
      a. Thorough flushing includes eliminating air from system.
      b. Drain systems, and rinse completely with clean water.
   2. Add water and acid solution, and circulate through systems as recommended by manufacturer to remove rust and scale.
      a. Circulate solution through systems at maximum pump flow rate for at least 24 hours.
      b. Provide temporary pumping equipment, portable storage tanks, and accessories to perform chemical cleaning. Do not use system pumps to circulate cleaning solution.
      c. Drain systems, and rinse completely with clean water.
         (1) Rinse system at a minimum velocity of 3 m/s.
         (2) Allow system to drain at no more than 0.3 L/s while allowing the system to continuously circulate.
         (3) Continue drainage until water is clean without evidence of residual chemicals.
   3. Check drain water for pH level. Continue draining and circulating until pH of system matches the pH of make up water.

F. After all cleaning is complete, and just before start-up, clean strainers.

G. Glycol water systems: Follow glycol manufacturer's recommendations.

H. Remove all non-potable effluent and chemicals from site or treat effluent in manner in which it may be disposed through the sanitary system. Treatment of effluent shall be approved by COTR prior to disposal to sanitary system.

I. Provide final certification, including pH test results, to COTR indicating sign off of each system or subsystem by COTR representatives. Certification shall be signed by the mechanical contractor and the chemical cleaning agency.

3.12 START-UP

A. After cleaning is complete, and water pH is acceptable to manufacturer of water treatment chemicals, add manufacturer-recommended amount of chemicals to systems.

B. For glycol-water systems, add sufficient glycol to provide the required percent by volume of glycol to water mixture.

C. Percent of glycol:
   1. Low temperature glycol, LTGWS: 25 percent.
   2. High temperature glycol, GWS: 40 percent.

D. Provide monthly testing for the first six months after start-up to verify that the correct chemical concentrations are present in each system.

END OF SECTION

SECTION 15880

AIR DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Description of system:
1. Medium and low pressure ductwork, fittings and accessories.
2. Laboratory exhaust ductwork.
3. Dampers.
4. Fire and smoke dampers.
5. Fireproof duct covering.
6. Diffusers, registers and grilles.
7. Silencers.
8. Air blenders.
9. Louver blank-off panels.
10. Ventilators.

B. Work installed but not furnished:
1. Automatic dampers: Section 17000.
2. Air flow measuring devices: Section 17000.
3. Duct smoke detectors: Section 16720.
4. Electric reheat coils: Section 17000.
5. Air shower fan unit: Section 11630.
6. Instrument test ports: Sections 15991 and 15992.

C. Definitions:
1. Low pressure ductwork: 12.7 m/s velocity or less and static pressure 500 Pa or less.
2. Medium pressure ductwork: Over 12.7 m/s velocity or static pressure over 500 Pa.
3. Concealed insulated surfaces: Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, and above suspended ceilings.
4. Exposed insulated surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels, distribution levels and rooms without suspended ceilings.

D. Drawings Indicate tentative arrangement of diffusers and lights.
1. COTR reserves right to rearrange, lights and diffusers prior to actual installation to suit needs.
2. Final location of ceiling mounted diffusers, registers and grilles: Architectural Reflected Ceiling Plans, except use locations on mechanical drawings for laboratory galleys and for walk-on ceiling

penetrations above shielded rooms within laboratories.

1.02 QUALITY ASSURANCE

A. Design and installation standards:
   1. ASHRAE Guide and Data Book - Equipment, current chapter on duct construction.
   2. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.
   3. ADC Test Code FD 72-R1, Flexible Air Duct Test Code.
   4. AMCA Standard 210, Test Code for Air Moving Devices.
   5. ASHRAE Standard 70-72, Method of Testing for Rating the air flow performance of outlets and inlets.
   6. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 1995 edition.
   7. SMACNA HVAC Duct Construction Standard - Metal And Flexible, Second Edition, 1995.
   8. International Mechanical Code.

B. Fire and smoke rating test standards: ASTM-E84, NFPA-255 and UL 723.

C. Duct sizes indicated are internal sizes.
   1. Where double wall ducts or plenums are used, increase size to maintain interior dimensions.

1.03 SUBMITTALS

A. Shop drawings:
   1. Ductwork layout at 1:50 scale.

B. Product data.

C. Samples: Not required for COTR review.

D. Project information: Not required for COTR review.

E. Contract closeout information:
   1. Operating and maintenance data.
   2. Test reports.

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. Acceptable manufacturers:
   1. Ductwork, medium pressure:
      a. Base:
         (1) United McGill Corp.
      b. Optional:

(1) Semco.
(2) Sheet Metal Products Co.
(3) Monroe Metal Manufacturing Co.
(4) Spiral-Air.
(5) Spiral Pipe of Texas, Inc.
(6) Wesco.

2. Proprietary duct connection systems:
   a. Base:
      (1) Ductmate Industries, Inc.
   b. Optional:
      (1) Nexus.
      (2) WDCI (Ward Duct Connector Inc.).
3. Duct sealer:
   a. Base:
      (1) Durkee-Atwood.
      (2) Hardcast.
      (3) United McGill Corp.
      (4) Precision Adhesives HVAC, Inc.
   b. Optional:
      (1) Foster Products Division, H B Fuller Co.
4. Duct sealing tape:
   a. Base:
      (1) Durkee-Atwood.
      (2) Hardcast.
      (3) United McGill Corp.
5. Turning vanes:
   a. Base:
      (1) Aero-Dyne.
      (2) Airsan.
      (3) Tuttle and Bailey.
      (4) Titus.
      (5) Vent Products Co.
6. Flexible duct connectors:
   a. Base:
      (1) Duro-Dyne.
      (2) Elgin.
      (3) Ventfabrics.
7. Flexible ducts, preinsulated:
   a. Base:
      (1) Hart & Cooley.
   b. Optional:
      (1) Acme Engineering and Manufacturing Corp.
      (2) CertainTeed Corp.
      (3) Clevepak Corp., Clevaflex Division.
      (4) General Flex Corp.
      (5) Goodman Manufacturing Corp.
      (6) Flexible Technologies, Automation Industries, Inc.
      (7) H K Porter Co., Inc., Thermoid Division.
      (8) Thermaflex.
8. Flexible ducts, uninsulated:

a. Base:
(1) United McGill Corp.
(2) ATCO Rubber Products, Inc.
(3) Or approved equal.

9. Access doors:
a. Base:
(1) Air Balance, Inc.
(2) American Warming & Ventilating Co.
(3) Nailor-Hart.
(4) Prefco Products, Inc.
(5) Ruskin Manufacturing Co.
(6) United McGill Corp.
(7) Zurn.

10. Pre-fabricated metal stacks:
a. Base:
(1) Metalbestos.
(2) Metal-Fab.
(3) Or approved equal.

11. Fireproof duct covering:
a. Base:
(1) Pabco, Division of Fibreboard Corp.
(2) Thermal Ceramics.
(3) Or approved equal.

12. Manual dampers:
a. Base:
(1) American Warming & Ventilating Co.
b. Optional:
(1) Air Balance, Inc.
(2) Carnes.
(3) Krueger.
(4) Penn Ventilator Co.
(5) Prefco Products, Inc.
(6) Ruskin Manufacturing Co.
(7) Safe-Air Inc.
(8) Vent Products Co.

13. Backdraft dampers:
a. Base:
(1) American Warming & Ventilating Co.
b. Optional:
(1) Air Balance, Inc.
(2) Carnes.
(3) Cesco Products.
(4) Penn Ventilator Co.
(5) Prefco Products, Inc.
(6) Ruskin Manufacturing Co.
(7) Safe-Air Inc.

14. Fire and smoke dampers:
a. Base:
(1) Ruskin Manufacturing Co.
b. Optional:
(1) Air Balance, Inc.

(2) American Warming & Ventilating Co.
(3) CESCO Products.
(4) Nailor-Hart.
(5) National Controlled Air.
(6) Phillips-Aire.
(7) Prefco Products, Inc.
(8) Safe-Air Inc.
(9) Vent Products Co., Inc.

15. Diffusers, registers and grilles:
    a. Base:
        (1) Carnes.
        (2) Tuttle and Bailey.
    b. Optional:
        (1) Anemostat.
        (2) Krueger.
        (3) Titus.
16. Silencers:
    a. Base:
        (1) Industrial Acoustics, Co.
    b. Optional:
        (1) AeroSonics, Inc.
        (2) Baldwin-Ehret-Hill.
        (3) Engineered Products.
        (4) Vibroacoustics.
        (5) Gale Noise Control.
        (6) Rink Corp.
        (7) Semco.
        (8) Titus.
        (9) Tran-Sonics.
        (10) United McGill Corp.
17. Air blenders:
    a. Base:
        (1) Blender Products, Inc.
    b. Optional:
        (1) Kees, Inc.
        (2) Miller Picking, Inc.
18. Ventilators:
    a. Base:
        (1) Loren Cook Co.
    b. Optional:
        (1) Carnes.
        (2) Aerovent, Inc.
        (3) Acme Engineering and Manufacturing Corp.
        (4) Cesco-Advance Air.
        (5) Jenn Industries, Inc.
        (6) Penn Ventilator Co.
        (7) Greenheck Fan Corp.
19. Other manufacturers desiring approval comply with Section 01640.

B. Sheet metal:

1. Galvanized steel (G90): ASTM-A525, F.S.QQ-I-716.
2. Black steel: ASTM-A109, F.S.QQ-S-636.
3. 2S alloy aluminum: ASTM-B209, F.S.QQ-A-561.
4. 3S alloy aluminum: ASTM-B209, F.S.QQ-A-359.
5. Stainless steel: ASTM-A167, F.S.QQ-S-766.
6. Copper: ASTM-B152, F.S.QQ-S-576.
7. Lead: F.S.QQ-L-201 (grade A).

C. Duct sealer: NFPA rating of "Non-Combustible".
1. Flame spread rating: 25 or lower, in dry condition.
2. Smoke developed rating: 50 or lower, in dry condition.
3. Resistant to water and water vapors.
4. Pressure rupture rating: 4 kPa, minimum.
5. Sealer and mastic used with rigid fibrous glass ducts shall be listed and labeled in accordance with UL 181A.
6. Sealer and mastic used with flexible air ducts and duct connectors shall be listed and labeled in accordance with UL 181B.
7. Durkee-Atwood, Permatite Class I; Hardcast 601; or United McGill, Uni-Grip Duct Sealer.

D. Solder: ASTM-B23, grade 50B or F.S.QQQ-S-571, Composition Sn50.

E. Duct sealing tape: NFPA rating of "Non-Combustible".
1. Flame spread rating: 25 or lower, in dry condition.
2. Smoke developed rating: 50 or lower, in dry condition.
3. Adhesive: Specifically compounded for maximum adhesion to galvanized and stainless steel.
4. Tape used with flexible air ducts and air connectors shall be listed and labeled in accordance with UL 181A.
5. Tape used with rigid fibrous glass ducts shall be listed and labeled in accordance with UL 181B.
6. Durkee-Atwood "Insta-Seal" Class I; Hardcast FTA-20 and RTA-50; Tremco 440; or United McGill, Uni-Cast tape.

F. RTV foam: UL listed room temperature vulcanized silicone rubber foam.

2.02 DUCTWORK

A. Ductwork - general: Constructed of galvanized steel sheet unless otherwise indicated/specified.
1. Maintain full areas and suitable shapes at every point.
2. Shapes may be changed to fit unusual space conditions.

3. Provide necessary transitions and offsets to complete systems.

B. Ductwork, low pressure, sheet metal:
   1. Low pressure ductwork includes but is not limited to:
      a. Ductwork on outlet side of air terminal units.
      b. Parts of supply, return, exhaust, make-up, outside and relief air ductwork as indicated.
   2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
      a. Rectangular duct: Table 1-6 M, 750 Pa static pressure, positive or negative.
      b. Round duct: Table 3-2 AM & 3-2 BM, 500 Pa static pressure, positive or negative.
   3. Transverse joints, rectangular:
      a. Ducts with longest side 900 mm and longer: Use proprietary flanged duct connection systems (i.e., Ductmate 35/25 slide-on systems).
         (1) Seal transverse flanged duct connections with pressure sensitive, high density, closed cell, neoprene or polyurethane tape gasket or "Tremco 440".
      b. Non-proprietary SMACNA T-22 flanged connection and proprietary TDC/TDF flanges may be used as defined in the SMACNA HVAC Duct Construction Standards manual.
      c. Non-proprietary T-24 flanges are not acceptable.
      d. Ducts with longest side shorter than 900 mm:
         (1) Proprietary flanged duct connection systems are optional.
         (2) Refer to SMACNA HVAC Duct Construction Standards manual for proper duct construction.
         (3) TDC/TDF duct connection system is not acceptable.
   4. Longitudinal seam: Use Pittsburgh lock seam only.
   5. Seal sheet metal ducts to Seal Class A requirements.
   6. Runouts to diffusers: Shall be flexible ducts.
      a. Exception: Flexible ducts may not pass through smoke or fire rated walls, floors or ceilings.
      b. Flexible duct length: Minimum 2000 mm; maximum 4000 mm.
      c. Minimum turning radius: As recommended by manufacturer but not less than one duct diameter centerline radius.
   7. Flexible connectors for branch ducts to registers and grilles.

C. Ductwork located outside, exposed to weather:
   1. Stainless steel sheet, Type 316.
   2. Construct using flanged duct connection systems.
   3. Seal flanged ends with pressure sensitive, high

density, closed cell, neoprene or polyurethane tape gasket or "Tremco 440".
4. Use continuous cleat seals on top joints of ducts.

D. Ductwork, medium pressure:
1. Medium pressure ductwork includes:
a. Supply ductwork from air handling unit discharge to connection with air terminal units.
b. Rectangular supply, return, and exhaust duct operating over 500 Pa static pressure as indicated.
c. Round or flat oval exhaust and return duct as indicated.
2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
a. Rectangular duct: Table 1-8 M, 1500 Pa static pressure, positive or negative. Use Table 1-9 M, 2500 Pa static pressure where high pressure classification is indicated.
b. Round duct: Table 3-2 AM & 3-2 BM, 2500 Pa static pressure.
c. Flat oval duct: Table 3-4, 2500 Pa static pressure.
3. Transverse joints, rectangular:
a. Use proprietary flanged duct connection systems (i.e., Ductmate 35/25 slide-on systems).
(1) Seal transverse flanged duct connections with pressure sensitive, high density, closed cell, neoprene or polyurethane tape gasket or "Tremco 440".
b. Non-proprietary SMACNA T-22 flanged connection and proprietary TDC/TDF flanges may be used as defined in the SMACNA HVAC Duct Construction Standards manual.
c. Non-proprietary T-24 flanges are not acceptable.
4. Seal medium pressure duct to seal Class A requirements.
5. Runouts to air terminal units: Flexible ducts.
a. Exception: Flexible ducts may not pass through smoke or fire rated walls, floors or ceilings.
b. Flexible duct length: Minimum 2000 mm; maximum 3000 mm.
c. Minimum turning radius: As recommended by manufacturer but not less than one duct diameter centerline radius.

E. Ductwork and plenums, double walled: Internally insulated.
1. Round, flat oval or rectangular installed as indicated on drawings.
a. Internal metal liner: Perforated.

b. 25 mm fiberglass insulation minimum.
c. External pressure-tight metal shell.
d. Except for exhaust systems, provide woven fiberglass cloth face between insulation and perforated metal liner to prevent insulation entering air stream.

2. External and internal metal liner: Galvanized steel meeting ASTM-A527/A527M unless otherwise specified or indicated.
3. Continuous weld seams of pressure shell.
4. Insulation thermal conductivity (k): Maximum of 0.039 W/m.K at 24 degC mean temperature.
5. Connections: Slip or flanged couplings.
6. Noise attenuation: 1.5 dB/m with airflow.
7. United Sheet Metal, Acousti-K27.
8. Stainless steel (316L) outer shell for ducts and plenum installed outside, exposed to weather.

F. Duct hangers and supports: In accordance with following:
1. Medium and low pressure ductwork (sheet metal): SMACNA HVAC Duct Construction Standard, Chapter 4.

G. Duct fittings and joints on low pressure systems:
1. Radius elbows without vanes: Radius ratio (R/W) of 1.5 and greater.
2. Radius elbows with vanes: Radius ratio (R/W) less than 1.5; use where space limitations occur.
a. R/W = 0.75 to 1.0: Provide 3 vanes in elbow.
b. R/W = 1.0 to 1.25: Provide 2 vanes in elbow.
c. R/W = 1.25 to 1.5: Provide 1 vane in elbow.
d. Provide vane spacing per Figure 2-5, SMACNA HVAC Duct Construction Standards.
3. Where square elbows are indicated or required, provide with turning vanes.
4. Connections to diffusers, grilles and registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
5. Branch connections:
a. Round: Factory built short cone or bellmouth type.
b. Rectangular: 45 degree entry type or radius elbow.
6. Provide necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or indicated on drawings.
7. Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.

H. Duct fittings and joints on medium pressure systems:

1. Elbows 80-200 mm diameter: Die stamped, for minimum air friction loss, with continuous corrosion resistance welds.
2. Elbows over 200 mm diameter: Welded segment type, not less than 5 pieces for 90 degree elbows, and not less than 3 pieces for 45 degree elbows, using corrosion resistant welds.
3. Tees: "Low loss, short cone type", unless specifically detailed otherwise for space limitations.
4. "Y's" 45 degree type; 60 degree type may be used if space conditions dictate.
5. Install "Y's" as indicated.
6. Where tees are indicated, "Y's" may be substituted if space is available.
7. "Y's": Straight sided type (no cone).
8. "Y" takeoffs from horizontal ceiling mounted ducts to serve boxes: May be straight sided, shop fabricated type by accurately cutting and welding "Y's" into spiral ducts without use of fittings.

I. Turning vanes: For square elbows.
1. Velocities up to 12.7 m/s: Single vane, runner Type 2, with 20 mm trailing edge, 50 mm vane radius and 40 mm vane spacing, minimum 0.7 mm.
   a. For widths over 900 mm install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
2. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45 degrees angle to give optimum turning.

J. Flexible duct connectors - supply air, return air, make-up air, relief air, and non-laboratory exhaust systems, interior application:
1. Material: Neoprene double coated closely woven glass fabric (745 g/m2 weight) flexible connectors with factory attached galvanized sheet metal edges. (DuroDyne "Neoprene" Standard Grade).
2. Fasten connector to sheet metal duct work and to fan collar extension in manner which meets duct pressure class requirements.
3. Locate in inlet and outlet of fans, as close to fan as possible.
4. Provide at ducts crossing building expansion joints, for ducts penetrating walk-on ceilings and as indicated.
5. Connections shall not be under tension.
6. Provide minimum separation distance of 50 mm across the connection.

K. Flexible duct connectors - laboratory exhaust systems,

interior applications; all exhaust systems, exterior applications:

1. Material: Hypalon coated woven fiberglass fabric (800 g/m2 weight) flexible connector with factory attached stainless steel edges. (DuroDyne "Durolon").
2. Fasten connector to sheet metal duct work and to fan collar extension in manner which meets duct pressure class requirements.
3. Locate in inlet and outlet of fans, as close to fan as possible.
4. Provide for laboratory exhaust system ducts penetrating walk-on ceilings and as indicated.
5. Connections shall not be under tension.
6. Provide minimum separation distance of 50 mm across the connection.

L. Flexible ducts, preinsulated:

1. Low pressure construction:
   a. Spiral wire or band, reinforced mylar liner.
   b. Nominal 25 mm x 12 kg/m3 fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
2. Medium pressure construction:
   a. Heavy gauge corrugated aluminum.
   b. Nominal 25 mm x 12 kg/m3 fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
   c. Aluminized mylar, wire reinforced and fabric type not permitted.
3. Rated working pressure:
   a. Low pressure duct: Positive 750 Pa minimum; negative 370 Pa minimum, for return or exhaust air connections.
   b. Medium pressure duct: Positive 2000 Pa minimum.
4. Fire resistant, self extinguishing, UL Standard 181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. Thermal conductance(C): 1.31 W/m2.K.
6. Low pressure connections:
   a. Secure duct to collar or sleeve with 13 mm metal draw band clamp.
   b. Secure insulation jacket with 2 wraps of tape to match vapor barrier.
7. Medium pressure connections:
   a. Secure duct to collar or sleeve with duct sealer and number and type of fasteners as required in SMACNA Duct Construction Standards.
   b. Secure insulation jacket with 2 wraps of duct tape.
8. Duct sealer: E Moore Co., Tuff-Bond No.12; or Benjamin Foster No.30-02.

9. Turn radius: Not less than R/D equal to 1.0.
10. Provide flexible duct supports in accordance with Figure 3-9 and 3-10, SMACNA HVAC Duct Construction Standards.

M. Flexible ducts, uninsulated:
1. Provide for all connections to HEPA filter diffusers, for all galley CD-5 diffusers connected to transfer ducts, and where indicated.
2. Medium pressure construction:
   a. Heavy gauge corrugated aluminum.
   b. Aluminized mylar, wire reinforced and fabric type not permitted.
3. Rated working pressure:
   a. Medium pressure duct: Positive 2000 Pa minimum.
4. Fire resistant, self extinguishing, UL Standard 181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. Medium pressure connections:
   a. Secure duct to collar or sleeve with duct sealer and number and type of fasteners as required in SMACNA HVAC Duct Construction Standards.
6. Duct sealer: E Moore Co., Tuff-Bond No.12; or Benjamin Foster No.30-02.
7. Turn radius: Not less than R/D equal to 1.0.
8. Provide flexible duct supports in accordance with Figure 3-9 and 3-10, SMACNA HVAC Duct Construction Standards.

N. Access doors:
1. Provide at fire, smoke, or duct mounted dampers, smoke detectors, air flow, temperature, humidity, static pressure sensors, in-line equipment, major turning vanes (upstream side) and as indicated on drawings.
2. Medium pressure ductwork:
   a. Doors shall close with air pressure, and shall have latches and hinges.
3. Doors on insulated ducts: 50 mm extension neck to clear insulation.
4. Install doors to permit easy visual inspection of components located inside duct.
5. Hardware: Ventlok as follows:
   a. Doors up to 300 mm maximum, in any direction: One No.100.
   b. Doors up to 450 mm long: Two No.140 or No.205.
   c. Doors up to 600 mm long: Two No.260.
   d. Doors over 600 mm long: Two or more No.310.
6. Provide gasket seal on access doors.
7. Sash locks are not acceptable.
8. Provide door pulls on doors over 600 mm: Ventlok 220 or 310.

2.03 LABORATORY EXHAUST DUCTWORK

A. Laboratory exhaust ductwork:
1. Applies to all ductwork connected to the following fans:

EF-101, EF-102, EF-103, EF-104, EF-105, EF-201, EF-203, EF-204, EF-206A, EF-206B, EF-301, EF-302, EF-303, EF-304, EF-401, EF-403A, EF-403B, EF-404, EF-501, EF-502, EF-503, EF-504.

2. Construct in accordance with SMACNA HVAC Duct Construction Standards as specified under: Ductwork, medium pressure.
3. Construction material for ductwork, fittings and accessories:
   a. Stainless steel sheet, Type 304. For all ductwork connected to EF-101, EF-102, EF-103, EF-104, EF-105, EF-206A, EF-206B, and EF-403B. For all branches connected to fume hoods and all ducts located outside, exposed to weather, that are part of systems connected to the remainder of the indicated exhaust fans.
   b. Galvanized steel sheet. For all interior ductwork, except branches connected to fume hoods, connected to EF-201, EF-203, EF-204, EF-301, EF-302, EF-303, EF-304, EF-401, EF-403A, EF-404, EF-501, EF-502, EF-503, and EF-504.

4. Bolts, screws and rivets:
   a. Exposed in air stream in stainless steel ducts, Type 304.
   b. Exposed in air stream in galvanized ducts or not exposed to air stream: Zinc plated, machine hex head type with machine hex nuts.

5. Sleeves:
   a. 0.7 mm galvanized spiral duct or 1.3 mm black steel.

6. For all exhaust systems: Welding of joints shall only be used as required by SMACNA HVAC Duct Construction Standards.

B. Stacks for Instrument West and Instrument East exhaust fans:
1. Constructed of double walled duct as specified under ductwork, except as follows:
   a. 75 mm fiberglass insulation.
   b. Connections: Solid welded, including straight

sections of longitudinal seam duct and lateral fittings with end cap for base. Provide each stack on job site as a complete unit, no field welding of stack will be allowed.

2. Supported at base on support frame as indicated and braced laterally where they pass through roof overhang.
3. Provide 50 mm diameter threaded pipe nipple with cap welded to end cap for draining water from stack.
4. Outlets of stacks shall be 3050 mm above the adjacent roof parapet.

C. Stacks for Cleanroom exhaust fans.
1. Constructed of 1.6 mm 316L stainless steel sheet with fully welded longitudinal and transverse joints including connections to inline silencers, using inert gas welding procedure.
2. Supported at base or lower end as indicated and braced laterally where they pass through roof overhang.
3. Base mounted stacks shall be sealed with a stainless steel plate welded to the bottom with a 50 mm diameter threaded pipe nipple with cap welded to the plate for draining water from stack.
4. Outlets of stacks shall be 3050 mm above the adjacent roof parapet unless otherwise indicated.

D. Stacks for Metrology West and Metrology East exhaust fans.
1. Single wall positive pressure pre-fabricated pipe of 316 stainless steel, minimum 1.3 mm thick.
2. Stack comprised of straight pipe lengths, 45 degree lateral tee, drain tee cap, exit cone, full angle ring and plate support assembly.
3. Pipe joints shall be sealed by use of factory supplied V-bands and silicone sealant.
4. Plate support assembly able to support total height of stack.
5. Maximum allowed spacing between lateral guides/ supports is greater than 3700 mm.
6. Provide same standard lengths of straight pipe for all stack diameters so that all joints are aligned when constructed. Use longest straight pipe available for fewest number of equally spaced joints in each 3700 mm bay of the stack frame. Top section shall be length indicated.

2.04 FIREPROOF DUCT COVERING

A. Manufactured duct covering to provide two hour rated enclosure around exhaust ducts as indicated.

B. Provide for the following duct systems:

1. Laboratory exhaust ductwork within Instrument Lab penthouses. (Served by EF-201, EF-203, EF-204, EF-206A, EF-206B, EF-401, EF-403A, EF-403B, EF-404.

2. Portions of exhaust systems served by EF-103, EF-104, EF-105A, EF-105B as indicated.

2.05 DAMPERS

A. Dampers - general:
   1. Sizes and types: As indicated.
   2. Locate as indicated.
   3. Factory built and assembled dampers.

B. Dampers, automatic:
   1. Furnished in Section 17000, Controls and Instrumentation.
   2. Install as specified in this section.

C. Dampers, manual (rectangle and square):
   1. Opposed blade type, fitted with shank bolts, marked for direction (open/closed).
   2. Provide for double socket wrenches to fit square shank and locking hex nut.
   3. Construction: Heavy black iron frames, flat or angle iron, with blades of 1.5 mm galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.

D. Damper, manual (round):
   1. Butterfly type with circular blade mounted to shaft.
   2. Frame: Minimum 1.9 mm galvanized steel channel.
   3. Blade: Minimum 2.7 mm galvanized steel.
   4. Axle: 13 mm diameter.
   5. Bearings: Self-lubricating nylon or stainless steel sleeve.
   6. Full circumference neoprene blade seal.
   7. Locking hand quadrant.

E. Dampers, backdraft, low pressure:
   1. Counterbalanced, gravity operated.
   2. Fabricate of aluminum.
   3. Blades: Provided with common linkage rod and felt seals.

2.06 FIRE DAMPERS

A. Fire dampers - general:
   1. UL labeled, 1.5 Hour rated (unless otherwise indicated), 74 degC fusible link.
   2. 0.85 mm galvanized steel curtain-type blades.

3. Roll formed 1.0 or 0.85 mm galvanized steel frame.
4. Provide as indicated and as required by NFPA and local regulations.
5. Provide with mounting angles, sleeves, and adapter fittings as required for installation and duct connection.
6. Blades must be out of air stream.
7. In small ducts, 200 mm and less: 25 mm larger in each dimension to give total loss through damper of 25 Pa or less.

B. Static rated fire dampers:
1. Air Balance, Model 119, Ruskin Model IBD.

C. Fire dampers in high pressure ducts (passing through 2 Hour rated walls):
1. With sleeve and adapter fittings on each side of sleeve.
2. Air Balance, Model 119 or Ruskin Model IBD.

2.07 SMOKE DAMPERS

A. Smoke dampers - general:
1. UL classified as a leakage rated damper for use in smoke control systems under UL555S, latest edition, and bear a UL label attesting to same.
2. Suitable for velocity and pressure of system.
3. Jamb seals: Stainless steel flexible metal compression type.
4. Provide in ductwork adjacent to smoke partition (not in wall) with actuator in accessible location and visible for inspection.
5. Provide dampers and actuators as a single entity which meets all applicable UL555S qualifications for both dampers and actuators as a rated assembly.
6. Frame: 1.5 mm minimum.
7. Loss through wide open damper:
a. Not more than 37 Pa at 15 m/s face velocity for medium pressure.
b. Not more than 37 Pa at 10 m/s face velocity for low pressure.
8. Provide smoke dampers as indicated.

B. Smoke dampers, low pressure:
1. Parallel blade type with blades linked together for operation in unison and bearings arranged for automatic operation.
2. UL555S Leakage Rating: Class I (20 L/(s.m2) at 250 Pa).
a. Ruskin Model SD50.
3. Blades: Extruded aluminum air foil.

4. Blade width: Not more than 200mm.

C. Smoke dampers, square or rectangular, medium pressure:
1. Parallel or opposed blade type with linkage for automatic operation.
2. UL555S Leakage Rating: Class I (20 L/s/m2).
a. Ruskin Model SD60 or SD50.
3. On round or flat oval ductwork:
a. Provide dampers in an enclosure with round or oval connections on each side.

D. Smoke dampers, round or flat oval:
1. Single blade type with encompassed blade edge seal.
2. UL555S Leakage Rating: Class I (20 L/(s.m2) at 250 Pa).
a. Ruskin Model SDRS25.

E. Damper actuator (operator): Pneumatic type, factory installed.
1. Furnished under this section.

2.08 DIFFUSERS, REGISTERS AND GRILLES

A. Diffusers, ceiling:
1. Square type.
2. Size, type and manufacturer: As scheduled.
3. Finish of steel units: Factory applied, baked or electrocoated enamel; color as selected by COTR or as indicated. Color of laboratory diffusers to match color of walk-on-ceiling as approved by COTR.
4. Sponge rubber gasket for surface mounted ceiling diffusers.
5. Provide necessary screws, duct collars, transitions and air pattern deflectors.
6. Paint interior of perforated supply and return diffusers flat black.
7. Nominal 600 x 600 mm panel style diffusers:
a. Provide in areas with lay in ceilings.
8. 300 x 300 mm face diffusers with overlap style mounting for 150 mm diameter neck sizes; and 600 x 600 mm face for neck sizes 200 mm and larger:
a. Provide for hard ceilings but not in walk-on ceiling.
9. Provide easily removed inner core with a positive lock.
10. Provide opposed blade dampers where indicated.

B. Diffusers, wall:
1. High capacity diffusers, single element type, arranged as indicated.
2. Diffusers shall have capability of individual element

adjustment to provide a minimum air deflection of 30 degrees from any plane perpendicular to the face. Adjustment shall be accomplished from front or back of diffuser without tools.

3. Diffusers are to be of aluminum construction. Finish: anodized.

C. Linear diffusers:
   1. Plenum slot type for use with variable air systems in offices and other areas as indicated.
   2. Adjustable linear slot type for use in special areas (corridors, lobbies) as indicated.
      a. Extruded aluminum construction with one or more parallel slots. Each slot shall contain pattern controls, adjustable from the face of the diffuser to deflect the discharge air along a selected axis within a semi-circle of 180 degrees. The same pattern controls shall function as volume control dampers without affecting the air discharge pattern.
      b. For continuous installations, butted units shall be provided with alignment splines. Screws or other fasteners shall not be visible after installation.
      c. Finish shall consist of natural white enamel or anodized exterior surfaces, as indicated, and flat black finish on visible interior deflector member.
      d. Mounting frames, where required by installation, shall contain flanges for attaching to framing members. Frames shall also contain alignment spline sockets.

D. Air grilles and registers:
   1. Size, type and manufacturer: As scheduled.
   2. Finish of steel units: As scheduled. Color of laboratory ceiling grilles to match color of walk-on ceiling as approved by COTR. Color of wall grilles at wall mounted snorkels and wall return register to match color of wall panels as approved by COTR.
   3. Finish of aluminum units: Satin anodized.
   4. Sponge rubber gasketed for ceiling and wall units.
   5. Provide necessary screws, duct collars and transitions.
   6. Provide opposed blade dampers in registers.

2.09 SILENCERS

A. Silencers:
   1. Prefabricated, straight thru design.
   2. Airflow pressure drop and noise reduction (NR) values as indicated.

3. Size and shape as indicated.
4. Outer casing: 0.85 mm, minimum, galvanized steel.
5. Interior partitions or splitters: 0.7 mm, minimum, perforated galvanized steel.
6. Aluminum construction: At least 50 percent thicker than steel specified.
7. Provide stainless steel construction where used in stainless steel duct systems.
8. Use straight thru, relatively narrow air passages.
9. Use airtight construction.
    a. Make unit leakproof when subjected to differential air pressure of 2000 Pa between outside and inside.
    b. Weld lock joints or seams or fill with mastic.

B. Silencers, insertion loss (IL) rating:
1. In third octave band (180 to 355 Hz).
2. Tests made in such manner as to eliminate end reflections, beaming or directivity, flanking, standing waves, and rooms absorptions.
3. Test method may be either "in-duct with anechoic termination" or "reverberant rooms with tunnel between".
4. Size of units tested: Not smaller than 600 x 600 mm rectangular or 600 mm outside, with full size connections.
5. Submit corroborative report of tests made in nationally recognized, qualified, independent testing laboratory approved by AMCA for airflow determinations.

C. Silencers, airflow pressure drop rating:
1. Do not exceed pressure drop at specified airflow(s).
2. Base rating on results of tests made in manner to provide reliable data.
3. Basic setup: Standard code method as adopted by AMCA for testing fans.

D. Silencer, acoustical fill:
1. Inert, vermin and moisture proof, inorganic glass or mineral fiber.
2. Density: 14 kg/m3, minimum.
3. Pack behind partitions or splitters under not less than 5 percent compression to provide "spring" and avoid settling.
4. Cover in woven fiberglass cloth to prevent entry of particles into air stream.
5. Provide silencers with polymer sheeting to prevent entry of particles into air stream where scheduled.
6. Provide packless silencers (with no fill of any kind) where scheduled.

2.10 AIR BLENDERS

A. Air blenders:
   1. Type, size, pressure drop, and capacity shall be as scheduled.
   2. Air blenders shall be completely fixed devices with no moving parts.
   3. Air blenders shall be supplied with a panel for mounting within the duct/plenum without additional blankoff parts.
   4. All air blenders shall be geometrically similar. If blenders are not geometrically similar, then each blender must be individually tested to determine the Mixing Effectiveness and pressure loss of the device.
   5. Performance of static blenders shall be stated in terms of Mixing Effectiveness. The Mixing Effectiveness shall be stated in terms of the distance downstream of the blender and the outdoor air ratio (percent OA).
   6. Tests used to establish Mixing Effectiveness must state the Mixing Effectiveness of the test unit without a blender installed.
   7. Pressure Loss of each blender must be stated in terms of blender area ratio and approach velocity.
   8. Blenders shall be fabricated of 2 mm aluminum and panels shall be constructed of 3 mm aluminum.
   9. Capable of providing 90 percent temperature Mixing Effectiveness at two equivalent duct diameter distance downstream of blender.

2.11 LOUVER BLANK-OFF PANELS

A. Provide blank off panels behind inactive louver sections.
   1. Double wall construction with minimum 0.85 mm galvanized sheet metal.
      a. 25 mm thick rigid insulation.
   2. Paint side facing louver flat black.

2.12 ROOF VENTILATORS

A. Roof ventilators:
   1. Size and type: As indicated.
   2. Housings:
      a. Aluminum or galvanized steel.
      b. Capable of withstanding 150 kg/m2 snow load and 160 km/h wind.
   3. Hoods:
      a. Easily removable for access to throat area.
      b. Provide with birdscreens.
   4. Provide factory prefabricated, insulated roof curbs.

a. Curb height: 200 mm, above finished roof.
b. Type to suit roof construction and provide water tight enclosure.
c. Provide level installation regardless of roof slope.
d. Sponge rubber mounting pad to provide positive weatherseal, dampen mechanical noise, prevent air leaks.

5. Provide gravity backdraft dampers in roof curbs below relief air roof ventilators.

PART 3 - EXECUTION

3.01 GENERAL

A. Install and coordinate systems and components.

B. Install air flow measuring stations and electric reheat coils furnished under Section 17000 in accordance with manufacturer's installation instructions and as specified.

C. Install duct smoke detectors in accordance with manufacturer's installation instructions and as specified.

D. Install air shower fan unit furnished under Section 11630 in accordance with manufacturer's installation instructions and as indicated. Provide vibration isolation as specified in Section 15240.

E. Install instrument test ports furnished under Sections 15991 and 15992 at locations directed by the respective agencies. Cut and patch duct and insulation as required to install instrument test ports and test sensors and as required to maintain integrity of insulation vapor barrier.

3.02 INSTALLATION OF DUCTWORK, DIFFUSERS, REGISTERS, GRILLES

A. Install generally as indicated.

B. Conceal ductwork in finished spaces unless indicated otherwise.

C. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves only the specific electrical rooms, elevator machine rooms, or spaces.

D. Exercise special care to provide tight fitting, well

fabricated, well braced ductwork systems.

E. Field assemble rectangular, round or flat oval ductwork as follows:
   1. Use caulking grade joint sealer applied slip joints, or:
   2. Use slip joints, couplings, etc., sealed with "shrink fit" plastic bands, with thermal setting adhesives preapplied to plastic bands, or:
   3. Use slip joints, couplings, etc., sealed with pressure sensitive tape, or:
   4. Use Ductmate Spiralmate or Ovalmate systems.
   5. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.

F. Install flanged duct connection systems in accordance with manufacturer's construction standards.

G. Install pre-fabricated pipe for Metrology exhaust stacks in accordance with manufacturer's instructions.

H. In medium pressure ductwork, do not use 2 piece mitered 90 degree elbows with or without vanes unless approved by COTR.

I. Make duct connections from hoods, openings, fans, and other devices.

J. Provide fan discharge ductwork, minimum 800 mm straight run from fan discharge flange.
   1. 800 mm straight run may include flexible connections and transitions.
   2. Coordinate fan arrangement with duct discharge routes.

K. Where ducts pass thru fire rated and smoke rated construction, maintain rating indicated.
   1. Where fire dampers are not used, seal around duct with firestopping.
   2. See Section 07270 for materials.

L. Provide fireproof duct covering in accordance with manufacturer's instructions as required to achieve an Underwriters' Laboratories, Inc. compliant installation.

M. Provide all necessary transitions to duct mounted silencers, air blenders, coils, and other devices.

N. Provide typical, prototype installation for the following: diffusers, registers, grilles, and snorkels mounted in walk-on ceiling, duct penetrations (lab exhaust and other

duct) through walk-on ceiling. Obtain approval of COTR before proceeding with the remainder of the installations.

O. Drawings Indicate proposed arrangement of ducts, flex ducts, air terminal units and air outlets/inlets. Where flexible ducts exceed the maximum length specified, provide hard duct of the same size to keep flex duct less than maximum. Where flexible ducts fall short of the minimum length specified, adjust hard duct length or positions of devices to provide minimum length of flex duct.

3.03 INSTALLATION OF FIRE AND SMOKE DAMPERS

A. Install in accordance with manufacturer's instructions.

B. Seal smoke and fire dampers at wall or floor opening and between damper and sleeve or duct around one side of damper's downstream face.
1. See Section 07270.

C. Floor mounted dampers may be installed in a concrete floor curb.

D. Provide typical, prototype installation to include floor and wall mounted dampers for the different wall and floor constructions. Obtain approval of COTR before proceeding with the remainder of the damper installations. Submit certificate of approval to COTR prior to installation of any other fire and smoke dampers.

3.04 PERFORMANCE TESTS

A. Test each section of air ductwork with air pressure equal to its design pressure rating before external insulation is applied.
1. As required, test portions of system to permit finish work.
2. Leakage not to exceed that permitted for Leakage Class 6 as defined in SMACNA HVAC Systems Duct Design manual for Seal Class A.
3. Testing procedures shall be as described by Associated Air Balance Council testing procedure for duct leakage testing.

B. Use a pressure blower to provide supply air for test.

C. Provide a testing schedule and description of testing method to COTR two weeks before beginning of testing. Give 24 hours of advance notice of any change from testing schedule.

D. Provide final certification to COTR indicating sign off of each system or subsystem by COTR representatives. Certification shall be signed by mechanical contractor.

E. Perform air flow pattern "smoke" test on laboratory adjustable diffusers (CD-3, CD-4, CD-6, and CD-7) to establish proper position of adjustment (closest to horizontal) that will prevent short circuiting of supply air into general exhaust grilles. Use this established position to set the adjustment for all lab diffusers.

3.05 INSTALLATION OF AIR BLENDERS

A. Follow manufacturer's written installation instructions.

B. Reinforce duct if necessary to eliminate vibration.

C. Arrangement of blenders: As detailed and scheduled.

3.06 CLEANING

A. At Acceptance, clean work installed under this section.

B. Remove dirt, dust, and all foreign matter from ducts.

C. Vacuum and wipe with clean cloth all supply ducts and plenums.

3.07 EQUIPMENT DEMONSTRATION

A. At Acceptance, inspect, test, and demonstrate satisfactory operation of each piece of equipment and its accessories in the presence of COTR.

B. If inspection or test indicates defects, replace defective work or material.

C. Repeat inspections and tests until defects are eliminated.

END OF SECTION

BUILDING 216
PANEL SCHEDULES

B6-3-C/40-1
B6-3-J/51-1
B2-3-H/37-2
B4-3-D/37-1
B4-3-E/37-1
B4-3-G/37-1
B4-3-G/37-2
B4-3-D/43-1
B4-3-D/43-2
B4-3-G/43-1
B4-3-G/43-2
B4-3-H/43-2
B2-3-D/49-2
B2-3-E/49-2
B2-3-F/54-1
B2-3-F/54-2
B2-3-H/54-1
B4-3-D/49-2
B4-3-F/49-1
B4-3-F/49-2
B4-3-G/49-1
B4-3-H/49-1
B4-3-D/54-2
B4-3-E/54-2
B4-3-F/54-1
B4-3-F/54-2
B4-3-G/54-1
B4-3-H/54-1
B4-3-H/54-2

PANELBOARD NO: **B6-3-C/40-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: IE3026

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO AND THRU-FEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3018		900			20	1	A			20	1		540			RECEPT IE3C03	2
3	RECEPT IE3017		900			20	1		B		20	1		900			RECEPT IE3G01	4
5	RECEPT IE3016		900			20	1			C	20	1		540			RECEPT IE3C06	6
7	RECEPT IE3015		900			20	1	A			20	1		900			RECEPT IE3G02	8
9	RECEPT IE3014		900			20	1		B		20	1		900			RECEPT IE3C07	10
11	RECEPT IE3013		900			20	1			C	20	1		1200			SM-8 IE3C01	12
13	J-BOX IE3012		1200			20	1	A			20	1		1200			CLOCK IE3038	14
15	J-BOX IE3012		1200			20	1		B		20	1		1200			RECEPT IE3008	16
17	J-BOX IE3012		1200			20	1			C	20	1			840		P-407 & FCU-3	18
19	RECEPT IE3007		900			20	1	A			20	2		1040			RECEPT IE3009	20
21	RECEPT IE3006		900			20	1		B					1040				22
23	RECEPT IE3C01		720			20	1			C	20	1		1200			RECEPT IE3009	24
25	RECEPT IE3005		900			20	1	A			20	1		1200			RECEPT IE3012	26
27	RECEPT IE3004		900			20	1		B		20	2			1500		*DWH-5 IE3025	28
29	RECEPT IE3003		900			20	1			C					1500			30
31	RECEPT IE3002		900			20	1	A			20	1	**900**				**TRACK LIGHTS F0122**	32
33	RECEPT IE3001		720			20	1		B		20	1	**900**				**TRACK LIGHTS F0114**	34
35	RECEPT IE3001		540			20	1			C	20	1					SPARE	36
37	J-BOX IE3001		500			20	1	A			20	1	1500				LTG #IE3L06	38
39	RECEPT IE3023		540			20	1		B		20	1	900				LTG #IE3L12	40
41	RECEPT IE3025		720			20	1			C	20	1	900				LTG #IE3L18	42

*PROVIDE GFPE C/B AT 30mA

PANELBOARD NO: **B6-3-C/40-1**

SUBTOTAL CONNECTED KVA	0.0	18.1	0.0	0.0		5.1	11.9	3.8	0.0	SUBTOTAL CONNECTED KVA
						5.1	30.0	3.8	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B6-3-C/40-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: IE3026

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	SPARE					20	1	A			20	1					SPARE	44
45	SPARE					20	1		B		20	1					SPARE	46
47	SPARE					20	1			C	20	1					SPARE	48
49	SPACE					-	1	A			-	1					SPACE	50
51	SPACE					-	1		B		-	1					SPACE	52
53	SPACE					-	1			C	-	1					SPACE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60

PANELBOARD NO: B6-3-C/40-1

SUBTOTAL CONNECTED KVA	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	0.0	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-3-J/51-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: IE3076
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
BUS: 225 A
MAIN: MLO AND THRU-FEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3053		900			20	1	A			20	1		900			RECEPT IE3G03	2
3	RECEPT IE3054		900			20	1		B		20	1		540			RECEPT IE3C08	4
5	RECEPT IE3055		900			20	1			C	20	1		900			RECEPT IE3G04	6
7	RECEPT IE3056		900			20	1	A			20	1		540			RECEPT IE3C09	8
9	RECEPT IE3057		900			20	1		B		20	1		720			RECEPT IE3075	10
11	RECEPT IE3058		900			20	1			C	20	1		1200			JB CLOCK IE3039	12
13	J-BOX IE3063		1200			20	1	A			20	1		1200			RECEPT IE3061	14
15	J-BOX IE3063		1200			20	1		B		20	2		1040			RECEPT IE3061	16
17	J-BOX IE3063		1200			20	1			C				1040				18
19	RECEPT IE3063		1200			20	1	A			20	1		1200			RECEPT IE3059	20
21	RECEPT IE3C12		900			20	1		B		20	1		1200			SM-8 IE3C11	22
23	RECEPT IE3064		900			20	1			C	20	1		840			FCU-3 & P-407D	24
25	RECEPT IE3065		900			20	1	A			20	1					SPARE	26
27	RECEPT IE3C11		540			20	1		B		20	1		200			JB CLOCK AMP IE3073	28
29	RECEPT IE3066		900			20	1			C	20	2			1500		*DWH-5 IE3075	30
31	RECEPT IE3067		900			20	1	A							1500			32
33	RECEPT IE3068		900			20	1		B		20	1	**900**				**TRACK LIGHTS E0107**	34
35	**TRACK LIGHTS D0111**	**1800**				20	1			C	20	1	**900**				**TRACK LIGHTS D0101**	36
37	SPARE					20	1	A			20	1	150				LTG #IE3L33	38
39	SPARE					20	1		B		20	1	150				LTG #IE3L32	40
41	SPARE					20	1			C	20	1	600				LTG #IE3L42	42

*PROVIDE GFPE C/B AT 30mA

PANELBOARD NO: **B6-3-J/51-1**

SUBTOTAL CONNECTED KVA	1.8	16.1	0.0	0.0	2.7	11.5	3.0	0.0	SUBTOTAL CONNECTED KVA
					4.5	27.7	3.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B6-3-J/51-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: IE3076

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	SPACE					-	1	A			-	1					SPACE	44
45	SPACE					-	1		B		-	1					SPACE	46
47	SPACE					-	1			C	-	1					SPACE	48
49	SPACE					-	1	A			-	1					SPACE	50
51	SPACE					-	1		B		-	1					SPACE	52
53	SPACE					-	1			C	-	1					SPACE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60

TRACK LIGHTS D0111 **1800**

PANELBOARD NO: B6-3-J/51-1

SUBTOTAL CONNECTED KVA	1.8	0.0	0.0	0.0		0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						1.8	0.0	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-3-H/37-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1		180			RECEPT G0103	2
3	SPARE					20	1		B		20	1		180			RECEPT G0103	4
5	SPARE					20	1			C	20	1		180			RECEPT G0103	6
7	SPACE					-	1	A			-	1					SPACE	8
9	SPACE					-	1		B		-	1					SPACE	10
11	SPACE					-	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-3-H/37-2**

SUBTOTAL CONNECTED KVA	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	0.5	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-D/37-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L06		540			20	1	A			20	1		540			RECEPT IE3L06	2
3	RECEPT IE3L06		540			20	1		B		20	1		360			RECEPT IE3G01	4
5	RECEPT IE3L06		540			20	1			C	20	1		180			RECEPT IE3G01	6
7	RECEPT IE3L06		360			20	1	A			20	1					SPARE	8
9	RECEPT IE3L06		540			20	1		B		20	1				500	**LASER PANEL F0122**	10
11	RECEPT IE3L06		360			20	1			C	20	1		540			RECEPT IE3G01	12
13	RECEPT IE3L06		540			20	1	A			20	2		520			RECEPT IE3L06	14
15	RECEPT IE3L06		360			20	1		B					520				16
17	RECEPT IE3L06		540			20	1			C	20	2		520			RECEPT IE3G01	18
19	RECEPT IE3L06		540			20	1	A						520				20
21	RECEPT IE3G01		180			20	1		B		20	2		520			RECEPT IE3G01	22
23	SPARE					20	1			C				520				24
25	SPACE					-	1	A			20	2		520			RECEPT IE3G01	26
27	SPACE					-	1		B					520				28
29	SPACE					-	1			C	20	2		520			RECEPT IE3L06	30
31	SPACE					-	1	A						520				32
33	SPACE					-	1		B		20	1					SPARE	34
35	SPACE					-	1			C	20	1					SPARE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-D/37-1**

SUBTOTAL CONNECTED KVA	0.0	5.0	0.0	0.0		0.0	6.8	0.0	0.5	SUBTOTAL CONNECTED KVA
						0.0	11.9	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-E/37-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L10		360			20	1	A			20	2		520			RECEPT IE3G01	2
3	RECEPT IE3L10		360			20	1		B					520				4
5	RECEPT IE3L10		540			20	1			C	20	2		520			RECEPT IE3G01	6
7	RECEPT IE3L10		360			20	1	A						520				8
9	RECEPT IE3L10		360			20	1		B		20	2		520			RECEPT IE3G01	10
11	RECEPT IE3L10		360			20	1			C				520				12
13	HOOD IE3L10		1200			20	1	A			20	2		520			RECEPT IE3G01	14
15	HOOD IE3L10		1200			20	1		B					520				16
17	RECEPT IE3L10		540			20	1			C	20	1		360			RECEPT IE3G01	18
19	RECEPT IE3L10		180			20	1	A			20	1		360			RECEPT IE3G01	20
21	**LASER PANEL F0114**				**500**	20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	SPACE					-	1	A			20	1					SPARE	26
27	SPACE					-	1		B		20	1					SPARE	28
29	SPACE					-	1			C	20	1					SPARE	30
31	SPACE					-	1	A			50	2				4000	FUTURE DISCONNECT	32
33	SPACE					-	1		B							4000	COMPRESSOR	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-E/37-1**

SUBTOTAL CONNECTED KVA	0.0	5.5	0.0	0.5		0.0	4.4	0.0	8.0	SUBTOTAL CONNECTED KVA
						0.0	9.8	0.0	8.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/37-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L07		360			20	1	A			20	1		360			RECEPT IE3G01	2
3	RECEPT IE3L07		360			20	1		B		20	1		540			RECEPT IE3G01	4
5	RECEPT IE3L07		540			20	1			C	20	2					SPARE	6
7	RECEPT IE3L07		360			20	1	A										8
9	RECEPT IE3L07		360			20	1		B		30	2					SPARE	10
11	RECEPT IE3L07		540			20	1			C								12
13	RECEPT IE3L07		540			20	1	A			30	2					SPARE	14
15	RECEPT IE3L07		540			20	1		B									16
17	RECEPT IE3L07		540			20	1			C	20	1					SPARE	18
19	RECEPT IE3L07		360			20	1	A			20	1					SPARE	20
21	**LASER PANEL F0108**				**500**	20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	SPARE					20	1	A			30	3		2500			RECEPT IE3G01	26
27	RECEPT IE3L07		2500			30	3		B					2500				28
29			2500							C				2500				30
31			2500					A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-G/37-1**

SUBTOTAL CONNECTED KVA	0.0	12.0	0.0	0.5	0.0	8.4	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	20.4	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/37-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L03		360			20	1	A			20	1		360			RECEPT IE3L03	2
3	RECEPT IE3L03		360			20	1		B		60	2					SPARE	4
5	RECEPT IE3L03		360			20	1			C								6
7	SPARE					60	2	A			20	1		360			RECEPT IE3L03	8
9									B		20	1					SPARE	10
11	**RECEPT G0117**		**180**			20	1			C	20	1					SPARE	12
13	**SPARE**					60	3	A			20	3		1200			RECEPT IE3L03	14
15									B					1200				16
17										C				1200				18
19	RECEPT IE3L03		1200			20	1	A			**20**	**3**				**1600**	**RECEPT G0117**	20
21	RECEPT IE3L03		540			20	1		B							**1600**		22
23	**RECEPT G0117**		**180**			20	1			C						**1600**		24
25	**RECEPT G0117**				**2400**	**30**	**3**	A			**20**	**3**				**1600**	**RECEPT G0117**	26
27					**2400**				B							**1600**		28
29					**2400**					C						**1600**		30
31	**RECEPT G0117**				**2400**	**30**	**3**	A			**20**	**3**				**1600**	**RECEPT G0117**	32
33					**2400**				B							**1600**		34
35					**2400**					C						**1600**		36
37	SPD					15	3	A			**20**	**3**				**1600**	**RECEPT G0117**	38
39	-								B							**1600**		40
41	-									C						**1600**		42

PANELBOARD NO: **B4-3-G/37-2**

SUBTOTAL CONNECTED KVA	0.0	3.2	0.0	14.4		0.0	4.3	0.0	19.2	SUBTOTAL CONNECTED KVA
						0.0	7.5	0.0	33.6	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-D/43-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L17		540			20	1	A			20	3		600			RECEPT IE3L17	2
3	RECEPT IE3L17		540			20	1		B					600				4
5	RECEPT IE3L17		540			20	1			C				600				6
7	RECEPT IE3L17		180			20	1	A			30	3		1600			RECEPT IE3L17	8
9	HOOD IE3L17		1200			20	1		B					1600				10
11	HOOD IE3L17		1200			20	1			C				1600				12
13	RECEPT IE3L17		540			20	1	A			20	1				500	**LASER PANEL E0116**	14
15	RECEPT IE3L17		360			20	1		B		20	1					SPARE	16
17	RECEPT IE3G02		360			20	1			C	20	1					SPARE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-D/43-1**

SUBTOTAL CONNECTED KVA	0.0	5.5	0.0	0.0	0.0	6.6	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	12.1	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-D/43-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L11		540			20	1	A			20	1		360			RECEPT IE3L11	2
3	RECEPT IE3L11		540			20	1		B		20	1		360			RECEPT IE3G03	4
5	RECEPT IE3L11		180			20	1			C	20	1				**500**	**LASER PANEL F0115**	6
7	SPARE					20	1	A			-	1					SPACE	8
9	SPARE					20	1		B		-	1					SPACE	10
11	SPARE					20	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-D/43-2**

SUBTOTAL CONNECTED KVA	0.0	1.3	0.0	0.0	0.0	0.7	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	2.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/43-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	HOOD IE3L21		1200			20	1	A			30	2		2500			RECEPT IE3L21	2
3	HOOD IE3L21		1200			20	1		B					2500				4
5	RECEPT IE3L21		180			20	1			C	30	2		2500			RECEPT IE3L21	6
7	RECEPT IE3L21		540			20	1	A						2500				8
9	RECEPT IE3L21		360			20	1		B		20	1		1200			RECEPT IE3L21	10
11	RECEPT IE3L21		360			20	1			C	20	1				500	**LASER PANEL E0110**	12
13	RECEPT IE3L21		360			20	1	A			20	1					SPARE	14
15	RECEPT IE3L21		360			20	1		B		20	1					SPARE	16
17	RECEPT IE3L21		540			20	1			C	20	1					SPARE	18
19	RECEPT IE3L21		360			20	1	A			30	3		2800			RECEPT IE3L21	20
21	RECEPT IE3G03		540			20	1		B					2800				22
23	DISHWASHER		1200			20	1			C				2800				24
25	RECEPT IE3L21		360			20	1	A			-	1					SPACE	26
27	RECEPT IE3L21		360			20	1		B		-	1					SPACE	28
29	SPARE					20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-G/43-1**

SUBTOTAL CONNECTED KVA	0.0	7.9	0.0	0.0	0.0	19.6	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	27.5	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/43-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L14		360			20	1	A			20	2					SPARE	2
3	RECEPT IE3L14		540			20	1		B									4
5	RECEPT IE3L14		540			20	1			C	30	2					SPARE	6
7	RECEPT IE3L14		540			20	1	A										8
9	RECEPT IE3L14		1200			20	1		B		30	3		2000			RECEPT IE3G03	10
11	RECEPT IE3L14		360			20	1			C				2000				12
13	RECEPT IE3G03		540			20	1	A						2000				14
15	RECEPT IE3G03		1200			20	1		B		30	3		2000			RECEPT IE3L14	16
17	RECEPT IE3L14		360			20	1			C				2000				18
19	RECEPT IE3L14		360			20	1	A						2000				20
21	RECEPT IE3L14		540			20	1		B		20	3		1600			RECEPT IE3L14	22
23	RECEPT IE3L14		540			20	1			C				1600				24
25	RECEPT IE3L14		540			20	1	A						1600				26
27	**LASER PANEL F0109**				**500**	20	1		B		20	3		1600			RECEPT IE3L14	28
29	SPARE					20	1			C				1600				30
31	SPARE					20	1	A						1600				32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-G/43-2**

SUBTOTAL CONNECTED KVA	0.0	7.6	0.0	0.5	0.0	21.6	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	29.2	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-H/43-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L16		360			20	1	A			20	1				**500**	**LASER PANEL F0105**	2
3	RECEPT IE3L16		1200			20	1		B		20	1					SPARE	4
5	RECEPT IE3L16		1200			20	1			C	20	1					SPARE	6
7	RECEPT IE3L16		540			20	1	A			-	1					SPACE	8
9	RECEPT IE3L16		1200			20	1		B		-	1					SPACE	10
11	SPARE					20	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-H/43-2**

SUBTOTAL CONNECTED KVA	0.0	4.5	0.0	0.0		0.0	0.0	0.0	0.5	SUBTOTAL CONNECTED KVA
						0.0	4.5	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-3-D/49-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	3	A			20	1					SPARE	2
3									B		20	1					SPARE	4
5										C	20	1					SPARE	6
7	RECEPT IE3L22		360			20	1	A			**30**	**2**		**1000**			**RECEPT E0113**	8
9	RECEPT IE3L23		360			20	1		B					**1000**				10
11	SPARE					20	2			C		1					SPACE	12
13								A			**30**	**3**		**2000**			**RECEPT E0113**	14
15	SPARE					20	1		B					**2000**				16
17	SPARE					20	1			C				**2000**				18
19	SPACE					-	1	A			**30**	**3**		**2000**			**RECEPT E0113**	20
21	SPACE					-	1		B					**2000**				22
23	SPACE					-	1			C				**2000**				24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-3-D/49-2**

SUBTOTAL CONNECTED KVA	0.0	0.7	0.0	0.0	0.0	14.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	14.7	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B2-3-E/49-2

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L23		1200			20	1	A			60	3					SPARE	2
3	RECEPT IE3L23		180			20	1		B									4
5	SPARE					20	1			C								6
7	SPARE					20	1	A			60	3		1000			SPARE	8
9	SPARE					20	1		B					1000				10
11	SPARE					20	1			C								12
13	SPARE					20	1	A			20	1		2000			SPARE	14
15	SPARE					20	1		B		20	1		2000			SPARE	16
17	SPARE					20	1			C	20	1		2000			SPARE	18
19	**RECEPT E0113**		**1600**			**20**	**2**	A			30	3					**SPARE**	20
21			**1600**						B									22
23	SPACE					-	1			C								24
25	SPACE					-	1	A			30	3					**SPARE**	26
27	SPACE					-	1		B									28
29	SPACE					-	1			C								30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: B2-3-E/49-2

SUBTOTAL CONNECTED KVA	0.0	4.6	0.0	0.0	0.0	8.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	12.6	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-3-F/54-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					60	3	A			20	2					SPARE	2
3									B									4
5										C	20	1					SPARE	6
7	SPARE					60	3	A			20	2					SPARE	8
9									B									10
11										C	20	1		360			RECEPT IE3L42	12
13	RECEPT IE3L42		1200			20	1	A			20	1		1200			RECEPT IE3L42	14
15	RECEPT IE3L42		360			20	1		B		20	1		180			RECEPT IE3L42	16
17	RECEPT IE3L42		180			20	1			C	20	1		**360**			**RECEPT C0106**	18
19	SPARE					60	3	A			20	1					SPARE	20
21									B		20	1					SPARE	22
23										C	20	1					SPARE	24
25	RECEPT IE3L42		180			20	1	A			-	1					SPACE	26
27	RECEPT IE3L42		1200			20	1		B		-	1					SPACE	28
29	RECEPT IE3L42		180			20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	10					SPACE	38
39	-								B		-	11					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-3-F/54-1**

SUBTOTAL CONNECTED KVA	0.0	3.3	0.0	0.0	0.0	2.1	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	5.4	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-3-F/54-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L38		1200			20	1	A			20	3					SPARE	2
3	RECEPT IE3L38		1200			20	1		B									4
5	RECEPT IE3L38		180			20	1			C								6
7	RECEPT IE3L38		180			20	1	A			20	1		180			RECEPT IE3L38	8
9	RECEPT IE3L38		1200			20	1		B		20	1		**360**			**RECEPT D0111**	10
11	RECEPT IE3L38		1200			20	1			C	20	1					SPARE	12
13	RECEPT IE3L38		180			20	1	A			20	3					SPARE	14
15	RECEPT IE3L38		180			20	1		B									16
17	RECEPT IE3L38		1200			20	1			C								18
19	SPACE					-	1	A			20	1					SPARE	20
21	SPACE					-	1		B		20	1					SPARE	22
23	SPACE					-	1			C	20	1					SPARE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-3-F/54-2**

SUBTOTAL CONNECTED KVA	0.0	6.7	0.0	0.0	0.0	0.5	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	7.3	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-3-H/54-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					30	3	A			30	3					SPARE	2
3									B									4
5										C								6
7	**SPARE**					20	1	A			20	1					SPARE	8
9	**SPARE**					20	1		B		20	1					SPARE	10
11	**SPARE**					20	1			C	20	1					SPARE	12
13	SPARE					30	3	A			20	1					SPARE	14
15									B		20	1					SPARE	16
17										C	20	1					SPARE	18
19	**RECEPT C0102**		**180**			20	1	A			30	3					SPARE	20
21	**RECEPT C0102**		**180**			20	1		B									22
23	RECEPT IE3L43		1200			20	1			C								24
25	RECEPT IE3L43		180			20	1	A			20	1					SPARE	26
27	RECEPT IE3L43		1200			20	1		B		20	1					SPARE	28
29	RECEPT IE3L43		180			20	1			C	20	1					SPARE	30
31	SPACE					-	1	A			20	1					SPARE	32
33	SPACE					-	1		B		20	1					SPARE	34
35	SPACE					-	1			C	20	1					SPARE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-3-H/54-1**

SUBTOTAL CONNECTED KVA	0.0	3.1	0.0	0.0		0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	3.1	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-D/49-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L22		360			20	1	A			30	2		2000			RECEPT IE3L23	2
3	RECEPT IE3L23		360			20	1		B					2000				4
5	RECEPT IE3L23		360			20	1			C	30	2					**SPARE**	6
7	RECEPT IE3L22		1200			20	1	A										8
9	RECEPT IE3L22		540			20	1		B		20	3					SPARE	10
11	RECEPT IE3L22		360			20	1			C								12
13	RECEPT IE3L22		360			20	1	A										14
15	RECEPT IE3L23		540			20	1		B		20	1					SPARE	16
17	RECEPT IE3L23		540			20	1			C	20	1					SPARE	18
19	RECEPT IE3G04		360			20	1	A			30	2		2000			RECEPT IE3G04	20
21	**LASER PANEL E0113**				**500**	20	1		B					2000				22
23	SPARE					20	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-D/49-2**

SUBTOTAL CONNECTED KVA	0.0	5.0	0.0	0.5	0.0	8.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	13.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-F/49-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					60	2	A			20	3					SPARE	2
3									B									4
5	RECEPT IE3L32		540			20	1			C	20	1		360			RECEPT IE3G04	6
7	RECEPT IE3L32		540			20	1	A			20	1					SPARE	8
9	RECEPT IE3L32		1200			20	1		B		20	1		540			RECEPT IE3L32	10
11	RECEPT IE3L32		360			20	1			C	20	1		540			RECEPT IE3L32	12
13	RECEPT IE3L32		540			20	1	A			20	1		360			RECEPT IE3L32	14
15	RECEPT IE3L32		540			20	1		B		20	1		540			RECEPT IE3L32	16
17	RECEPT IE3L32		540			20	1			C	20	1					SPARE	18
19	SPACE					20	1	A			20	1		540			RECEPT IE3L32	20
21	SPACE					20	1		B		20	1		540			RECEPT IE3L32	22
23	SPACE					20	1			C	20	1			500		**LASER PANEL D0108**	24
25	SPACE					20	1	A			30	3					SPARE	26
27	SPACE					20	1		B									28
29	SPACE					20	1			C								30
31	DISCONNECT IE3L32		4800			60	3	A			20	1					SPARE	32
33			4800						B		20	1					SPARE	34
35			4800							C	20	1					SPARE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-F/49-1**

SUBTOTAL CONNECTED KVA	0.0	18.7	0.0	0.0	0.0	3.4	0.5	0.0	SUBTOTAL CONNECTED KVA
					0.0	22.1	0.5	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-F/49-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	2		1600			RECEPT IE3L25	2
3	SPARE					20	1		B					1600				4
5	SPARE					20	1			C	20	2		1600			RECEPT IE3L25	6
7	SPARE					20	1	A						1600				8
9	SPARE					20	1		B		20	2		1600			RECEPT IE3L25	10
11	RECEPT IE3L25		540			20	1			C				1600				12
13	RECEPT IE3L25		360			20	1	A			20	1		540			RECEPT IE3L25	14
15	HOOD IE3L25		1200			20	1		B		20	1		360			RECEPT IE3L25	16
17	HOOD IE3L25		1200			20	1			C	20	1		540			RECEPT IE3L25	18
19	RECEPT IE3L25		360			20	1	A			20	3					SPARE	20
21	**LASER PANEL E0113**				**500**	20	1		B									22
23	SPARE					20	1			C								24
25	SPARE					20	1	A			20	3					SPARE	26
27	SPACE					-	1		B									28
29	SPACE					-	1			C								30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-F/49-2** Rev. 1 RFP-109.2 5/24/02

SUBTOTAL CONNECTED KVA	0.0	3.7	0.0	0.5	0.0	11.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	14.7	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/49-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L33		1200			20	1	A			20	1		540			RECEPT IE3L33	2
3	RECEPT IE3L33		540			20	1		B		20	1		540			RECEPT IE3L33	4
5	RECEPT IE3L33		540			20	1			C	20	1		360			RECEPT IE3L33	6
7	**LASER PANEL D0106**				**500**	20	1	A			20	1		540			RECEPT IE3L33	8
9	RECEPT IE3L33		540			20	1		B		20	1		540			RECEPT IE3L33	10
11	RECEPT IE3L33		540			20	1			C	20	1		540			RECEPT IE3L33	12
13	SPARE					20	1	A			20	1		540			RECEPT IE3L33	14
15	RECEPT IE3L33		540			20	1		B		20	1		540			RECEPT IE3L33	16
17	RECEPT IE3L33		360			20	1			C	20	1		540			RECEPT IE3L33	18
19	RECEPT IE3L33		360			20	1	A			20	1		540			RECEPT IE3L33	20
21	RECEPT IE3G04		360			-	1		B		20	1		540			RECEPT IE3L33	22
23	SPACE					-	1			C	20	1		540			RECEPT IE3L33	24
25	SPACE					-	1	A			20	1		360			RECEPT IE3L33	26
27	SPACE					-	1		B		20	1		540			RECEPT IE3L33	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-G/49-1**

SUBTOTAL CONNECTED KVA	0.0	5.0	0.0	0.5	0.0	7.2	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	12.2	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-H/49-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 400 A
MAIN: 400/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L34		540			20	1	A			20	3					SPARE	2
3	RECEPT IE3L34		540			20	1		B									4
5	RECEPT IE3L34		540			20	1			C								6
7	RECEPT IE3L34		540			20	1	A			20	3					SPARE	8
9	RECEPT IE3L34		540			20	1		B									10
11	RECEPT IE3L34		540			20	1			C								12
13	RECEPT IE3L34		360			20	1	A			20	2					SPARE	14
15	SPARE					20	2		B									16
17										C	20	2					SPARE	18
19	SPARE					20	2	A										20
21									B		20	2					SPARE	22
23	RECEPT IE3L34		1200			20	1			C								24
25	RECEPT IE3L34		540			20	1	A			20	2					SPARE	26
27	RECEPT IE3L34		540			20	1		B									28
29	RECEPT IE3L34		540			20	1			C	20	2					SPARE	30
31	RECEPT IE3G04		360			20	1	A										32
33	**LASER PANEL D0106**				**500**	**20**	**1**		B		20	2					SPARE	34
35	**LASER PANEL D0104**				**500**	**20**	**1**			C								36
37	SPD					15	3	A			225	3	0	3700	0	0	B4-3-H/49-1A	38
39	-								B				0	4380	0	0		40
41	-									C			0	4240	0	0		42

PANELBOARD NO: **B4-3-H/49-1**

SUBTOTAL CONNECTED KVA	0.0	6.8	0.0	1.0		0.0	12.3	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	19.1	0.0	1.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-D/54-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L36		360			20	1	A			20	1		360			RECEPT IE3L36	2
3	RECEPT IE3L36		540			20	1		B		20	2		520			RECEPT IE3L36	4
5	RECEPT IE3L36		360			20	1			C				520				6
7	RECEPT IE3G05		360			20	1	A			20	2		520			RECEPT IE3L36	8
9	RECEPT IE3L36		360			20	1		B					520				10
11	RECEPT IE3L36		360			20	1			C	20	1		540			RECEPT IE3L36	12
13	RECEPT IE3G05		360			20	1	A			20	2		520			RECEPT IE3L36	14
15	RECEPT IE3G05		360			20	1		B					520				16
17	RECEPT IE3L36		540			20	1			C	20	2		**1600**			**RECEPT D0117**	18
19	RECEPT IE3L36		540			20	1	A						**1600**				20
21	SPARE					20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	SPACE					-	1	A			**20**	**2**		**1600**			**RECEPT D0117**	26
27	SPACE					-	1		B					**1600**				28
29	SPACE					-	1			C	**20**	**2**		**1600**			**RECEPT D0117**	30
31	SPACE					-	1	A						**1600**				32
33	SPACE					-	1		B		**20**	**2**		**1600**			**RECEPT D0117**	34
35	SPACE					-	1			C				**1600**				36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-D/54-2**

SUBTOTAL CONNECTED KVA	0.0	4.1	0.0	0.0		0.0	16.8	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	21.0	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-E/54-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L38		540			20	1	A			20	1		540			RECEPT IE3L38	2
3	SPARE					20	2		B		20	1		360			RECEPT IE3L38	4
5										C	20	1		1200			RECEPT IE3L38	6
7	SPARE					30	1	A			20	1					SPARE	8
9	HOOD IE3L38		1200			20	1		B		20	1					SPARE	10
11	HOOD IE3L38		1200			20	1			C	20	2					SPARE	12
13	SPARE					20	3	A										14
15									B		20	1					SPARE	16
17										C	20	2					SPARE	18
19	SPARE					20	2	A										20
21									B		20	2					SPARE	22
23	**LASER PANEL D0117**				**500**	20	1			C								24
25	DISCONNECT IE3G05		4800			60	3	A			20	1	**360**				**RECEPT D0115**	26
27			4800						B		20	1	**180**				**RECEPT D0115**	28
29			4800							C	20	2					SPARE	30
31	DISCONNECT IE3G05		4800			60	3	A										32
33			4800						B		20	1					SPARE	34
35			4800							C	20	1					SPARE	36
37	SPD					15	3	A			100	3	0	0	0	0	B4-3-E/54-2A	38
39	-								B				0	0	0	0		40
41	-									C			0	0	0	0		42

PANELBOARD NO: **B4-3-E/54-2**

SUBTOTAL CONNECTED KVA	0.0	31.7	0.0	0.5		0.5	2.1	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.5	33.8	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-F/54-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3G05		2000			30	2	A			30	3		2400			RECEPT IE3L42	2
3			2000						B					2400				4
5	SPARE					20	2			C				2400				6
7								A			30	3					SPARE	8
9	SPARE					20	2		B									10
11										C								12
13	RECEPT IE3G05		360			20	1	A			20	1		360			RECEPT IE3L42	14
15	RECEPT IE3L42		360			20	1		B		20	1		540			FUTURE RECEPT IE3L42	16
17	RECEPT IE3L42		360			20	1			C	20	1		540			FUTURE RECEPT IE3L42	18
19	RECEPT IE3L42		360			20	1	A			20	1		540			FUTURE RECEPT IE3L42	20
21	RECEPT IE3L42		360			20	1		B		20	1		**360**			**RECEPT C0106**	22
23	RECEPT IE3L42		360			20	1			C	20	1				**500**	**LASER PANEL C0106**	24
25	RECEPT IE3L42		360			20	1	A			20	1					SPARE	26
27	RECEPT IE3L42		360			20	1		B		20	1					SPARE	28
29	SPARE					20	3			C	20	1					SPARE	30
31								A			20	1					SPARE	32
33									B		20	1					SPARE	34
35	SPACE					-	1			C	20	1					SPARE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-F/54-1**

SUBTOTAL CONNECTED KVA	0.0	6.9	0.0	0.0	0.0	9.5	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	16.4	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-F/54-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L38		2000			30	3	A			20	1					SPARE	2
3			2000						B		20	1		540			RECEPT IE3L38	4
5			2000							C	20	1		540			RECEPT IE3L38	6
7	RECEPT IE3L38		2000			30	3	A			20	1		540			RECEPT IE3L38	8
9			2000						B		20	1		540			RECEPT IE3L38	10
11			2000							C	20	2					SPARE	12
13	RECEPT IE3L38		2000			30	3	A										14
15			2000						B		20	1		540			RECEPT IE3L38	16
17			2000							C	20	1		540			RECEPT IE3L38	18
19	SPARE					20	3	A			20	2					SPARE	20
21									B									22
23										C	20	1		360			RECEPT IE3G05	24
25	RECEPT IE3G05		360			20	1	A			20	1		540			RECEPT IE3L38	26
27	SPARE					20	2		B		20	1		540			RECEPT IE3L38	28
29										C	20	1		360			RECEPT IE3L38	30
31	SPARE					20	2	A			20	1				500	**LASER PANEL D0111**	32
33									B		**20**	**1**		**180**			**RECEPT D0111**	34
35	RECEPT IE3G05		540			20	1			C	**20**	**1**		**360**			**RECEPT D0111**	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-F/54-2**

SUBTOTAL CONNECTED KVA	0.0	18.9	0.0	0.0	0.0	5.6	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	24.5	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-G/54-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3G05		2000			30	2	A			30	2		2000			RECEPT IE3G05	2
3			2000						B					2000				4
5	SPARE					20	2			C	20	1				**500**	**LASER PANEL C0106**	6
7								A			20	2					SPARE	8
9	RECEPT IE3L42		540			20	1		B									10
11	RECEPT IE3L42		540			20	1			C	20	1					SPARE	12
13	RECEPT IE3G05		360			20	1	A			20	1					SPARE	14
15	RECEPT IE3G05		360			20	1		B		20	1		360			RECEPT IE3L42	16
17	RECEPT IE3L42		540			20	1			C	20	1		540			RECEPT IE3L42	18
19	RECEPT IE3L42		360			20	1	A			20	1		540			RECEPT IE3L42	20
21	RECEPT IE3L42		720			20	1		B		20	1		540			RECEPT IE3L42	22
23	RECEPT IE3L42		540			20	1			C	20	1		540			RECEPT IE3L42	24
25	RECEPT IE3L42		360			20	1	A			20	1		540			RECEPT IE3L42	26
27	RECEPT IE3L42		540			20	1		B		20	1		360			RECEPT IE3L42	28
29	RECEPT IE3L42		540			20	1			C	20	1		540			RECEPT IE3L42	30
31	RECEPT IE3L42		2400			30	3	A			20	1		540			RECEPT IE3L42	32
33			2400						B		20	1		540			RECEPT IE3L42	34
35			2400							C	20	1		540			RECEPT IE3L42	36
37	SPD					15	3	A			**20**	**3**		**1600**			**RECEPT C0106**	38
39	-								B					**1600**				40
41	-									C				**1600**				42

PANELBOARD NO: **B4-3-G/54-1**

SUBTOTAL CONNECTED KVA	0.0	16.6	0.0	0.0		0.0	14.4	0.0	0.5	SUBTOTAL CONNECTED KVA
						0.0	31.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-H/54-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	**SPARE**					20	1	A			20	1		**360**			**RECEPTS C0102**	2
3	**SPARE**					20	1		B		20	1				**500**	**LASER PANEL C0102**	4
5	**RECEPT C0102**		**360**			20	1			C	20	1					SPARE	6
7	RECEPT IE3L43		540			20	1	A			20	1					SPARE	8
9	RECEPT IE3L43		540			20	1		B		30	2					SPARE	10
11	**RECEPT C0102**		**360**			20	1			C								12
13	**RECEPT C0102**		**360**			20	1	A			30	2					SPARE	14
15	RECEPT IE3L43		540			20	1		B									16
17	RECEPT IE3L43		540			20	1			C	30	2					SPARE	18
19	RECEPT IE3L43		540			20	1	A										20
21	RECEPT IE3L43		540			20	1		B		20	1					SPARE	22
23	**RECEPT C0102**		**540**			20	1			C	20	1					SPARE	24
25	**RECEPT C0102**		**360**			20	1	A			20	3					SPARE	26
27	SPACE					-	1		B									28
29	SPACE					-	1			C								30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-H/54-1**

SUBTOTAL CONNECTED KVA	0.0	5.2	0.0	0.0	0.0	0.4	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	5.6	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-H/54-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IE3G05

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IE3L39		720			20	1	A			30	3		2400			RECEPT IE3L39	2
3	RECEPT IE3L39		540			20	1		B					2400				4
5	RECEPT IE3L39		720			20	1			C				2400				6
7	RECEPT IE3L39		360			20	1	A			30	3		2400			RECEPT IE3L39	8
9	RECEPT IE3L39		360			20	1		B					2400				10
11	RECEPT IE3L39		540			20	1			C				2400				12
13	RECEPT IE3L39		540			20	1	A			30	3		2400			RECEPT IE3L39	14
15	RECEPT IE3L39		540			20	1		B					2400				16
17	RECEPT IE3L39		540			20	1			C				2400				18
19	RECEPT IE3L39		360			20	1	A			30	3		2400			RECEPT IE3L39	20
21	RECEPT IE3L39		540			20	1		B					2400				22
23	RECEPT IE3L39		360			20	1			C				2400				24
25	RECEPT IE3L39		360			20	1	A			20	1					SPARE	26
27	RECEPT IE3L39		360			20	1		B		20	1					SPARE	28
29	RECEPT IE3L39		1200			20	1			C	20	1					SPARE	30
31	**LASER PANEL D0101**				**500**	20	1	A			-	1					SPACE	32
33	SPARE					20	1		B		-	1					SPACE	34
35	SPARE					20	1			C	-	1					SPACE	36
37	SPD					15	3	A			150	3	0	3960	0	0	B4-3-H/54-2A	38
39	-								B				0	4080	0	0		40
41	-									C			0	4080	0	0		42

PANELBOARD NO: **B4-3-H/54-2**

SUBTOTAL CONNECTED KVA	0.0	8.0	0.0	0.5		0.0	40.9	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	49.0	0.0	0.5	TOTAL CONNECTED KVA

BUILDING 217
PANEL SCHEDULES

B3-4-V/3-1
B3-4-V/26-1
B3-4-V/8-1
B3-4-V/13-1
B1-3-W/8-1
B1-3-W/13-2
B1-3-V/13-2
B6-3-S/11-1
B6-3-Y/22-1
B6-3-Y/11-1
B4-3-W/3-1
B4-3-W/8-1
B4-3-U/13-1
B4-3-X/13-1
B4-3-T/19-1
B4-3-T/19-2
B4-3-U/19-1
B4-3-U/19-2
B4-3-W/19-1
B4-3-X/19-1
B4-3-U/26-1
B4-3-V/26-1
B4-3-W/26-1

PANELBOARD NO: **B3-4-V/3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW4024
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 100 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					60	3	A			20	1					SPARE	2
3									B		20	1					SPARE	4
5										C	20	1					SPARE	6
7	SPARE					20	1	A			-	1					SPACE	8
9	SPARE					20	1		B		-	1					SPACE	10
11	SPARE					20	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	**UPS1-4-T/3-1**				**4000**	60	2		B		-	1					SPACE	22
23					**4000**					C	-	1					SPACE	24
25	TVSS					15	3	A			-	1					SPACE	26
27	-								B		-	1					SPACE	28
29	-									C	-	1					SPACE	30

PANELBOARD NO: **B3-4-V/3-1**

SUBTOTAL CONNECTED KVA	0.0	0.0	0.0	8.0		0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	0.0	0.0	8.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B3-4-V/26-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW4024
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1					SPARE	2
3	SPARE					20	1		B		20	1					SPARE	4
5	RECEPT IW3G05		1200			20	1			C	20	1					SPARE	6
7	SPARE					20	1	A			-	1					SPACE	8
9	SPARE					20	1		B		-	1					SPACE	10
11	SPARE					20	1			C	-	1					SPACE	12
13	B1-3-T/26-1	**0**	**360**	**0**	**5200**	80	2	A			-	1					SPACE	14
15	**VIA UPS1-4-T/26-1**	**0**	**360**	**0**	**5200**				B		-	1					SPACE	16
17	**UPS1-4-X/26-2**				**6000**	80	2			C	-	1					SPACE	18
19					**6000**			A			20	2				1000	RECEPT IW3G05	20
21	**UPS1-4-W/26-2**				**6000**	80	2		B							1000		22
23					**6000**					C	20	2				1000	RECEPT IW3G05	24
25	TVSS					15	3	A								1000		26
27	-								B		-	1					SPACE	28
29	-									C	-	1					SPACE	30

PANELBOARD NO: **B3-4-V/26-1**

SUBTOTAL CONNECTED KVA	0.0	1.9	0.0	34.4	0.0	0.0	0.0	4.0	SUBTOTAL CONNECTED KVA
					0.0	1.9	0.0	38.4	TOTAL CONNECTED KVA

PANELBOARD NO: **B3-4-V/8-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW4024
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 225/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1					SPARE	2
3	SPARE					20	1		B		20	1					SPARE	4
5	SPARE					20	1			C	20	1					SPARE	6
7	SPARE					20	1	A			20	1					SPARE	8
9	SPACE					-	1		B		-	1					SPACE	10
11	SPACE					-	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	**B1-3-X/8-1**	**0**	**1560**	**0**	**2000**	80	2	A			-	1					SPACE	20
21	**VIA UPS1-4-X/8-1**	**0**	**720**	**0**	**2000**				B		-	1					SPACE	22
23	**B1-3-W/8-1**	**0**	**2200**	**0**	**3000**	80	2			C	-	1					SPACE	24
25	**VIA UPS1-4-W/8-1**	**0**	**360**	**0**	**3000**			A			-	1					SPACE	26
27	**B1-3-V/8-1**	**0**	**360**	**0**	**2000**	80	2		B		-	1					SPACE	28
29	**VIA UPS1-4-V/8-1**	**0**	**1200**	**0**	**2000**					C	-	1					SPACE	30
31	B1-3-T/8-2	0	720	0	4000	150	3	A			-	1					SPACE	32
33	VIA FUTURE UPS1-4-T/8-3	0	1200	0	4000				B		-	1					SPACE	34
35		0	360	0	4000					C	-	1					SPACE	36
37	TVSS					15	3	A			-	1					SPACE	38
39									B		-	1					SPACE	40
41										C	-	1					SPACE	42

PANELBOARD NO: **B3-4-V/8-1**

SUBTOTAL CONNECTED KVA	0.0	8.7	0.0	26.0	0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	8.7	0.0	26.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B3-4-V/13-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW4024
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1		1200			RECEPT IW3LG03	2
3	SPARE					20	1		B		20	1					SPARE	4
5	SPARE					20	1			C	20	1					SPARE	6
7	SPACE					-	1	A			-	1					SPACE	8
9	SPACE					-	1		B		-	1					SPACE	10
11	SPACE					-	1			C	-	1					SPACE	12
13	B1-3-W/13-2	**0**	**1860**	**0**	**3500**	80	2	A			-	1					SPACE	14
15	VIA **UPS1-4-W/13-2**	**0**	**1860**	**0**	**3500**				B		-	1					SPACE	16
17	B1-3-V/13-2	**0**	**1860**	**0**	**3000**	80	2			C	-	1					SPACE	18
19	VIA **UPS1-4-V/13-2**	**0**	**1860**	**0**	**3000**			A			-	1					SPACE	20
21	**UPS1-4-U/13-2**				**3000**	80	2		B		-	1					SPACE	22
23					**3000**					C	-	1					SPACE	24
25	TVSS					15	3	A			-	1					SPACE	26
27	-								B		30	2		2000			RECEPT IW3LG03	28
29	-									C				2000				30

PANELBOARD NO: **B3-4-V/13-1**

SUBTOTAL CONNECTED KVA	0.0	7.4	0.0	19.0	0.0	5.2	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	12.6	0.0	19.0	TOTAL CONNECTED KVA

PANELBOARD NO: B1-3-W/8-1

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G02
VOLTAGE: 208Y/120
PHASE: 1
WIRE: 3
200% NEUTRAL: YES
BUS: 100 A
MAIN: 60/2 SHUNT TRIP
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3G02		1200			20	1	A			60	2				3000	DISCONNECT SWITCH IW3L18	2
3	RECEPT IW3L18		360			20	1			B						3000		4
5	SPARE					20	1	A			20	1					SPARE	6
7	SPARE					20	1			B	-	1					SPACE	8
9	**RECEPT D0108**		**1000**			**30**	**1**	A			-	1					SPACE	10
11	SPACE					-	1			B	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1			B	-	1					SPACE	16
17	SPACE					-	1	A			-	1					SPACE	18
19	SPACE					-	1			B	-	1					SPACE	20
21	SPACE					-	1	A			-	1					SPACE	22
23	SPACE					-	1			B	-	1					SPACE	24
25	TVSS					15	2	A			-	1					SPACE	26
27										B	-	1					SPACE	28
29						-	1	A			-	1					SPACE	30

PANELBOARD NO: B1-3-W/8-1

SUBTOTAL CONNECTED KVA	0.0	2.6	0.0	0.0	0.0	0.0	0.0	6.0	SUBTOTAL CONNECTED KVA
					0.0	2.6	0.0	6.0	TOTAL CONNECTED KVA

PANELBOARD NO: B1-3-W/13-2

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G02
VOLTAGE: 208Y/120
PHASE: 1
WIRE: 3
200% NEUTRAL: YES
BUS: 100 A
MAIN: 60/2 SHUNT TRIP
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L23		360			20	1	A			60	2				3500	DISCONNECT SWITCH IW3L23	2
3	RECEPT IW3L23		360			20	1			B						3500		4
5	SPARE					20	1	A			20	1					SPARE	6
7	SPARE					20	1			B	-	1					SPACE	8
9	**RECEPT D0113**		**1500**			**30**	**2**	A			-	1					SPACE	10
11			**1500**							B	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1			B	-	1					SPACE	16
17	SPACE					-	1	A			-	1					SPACE	18
19	SPACE					-	1			B	-	1					SPACE	20
21	SPACE					-	1	A			-	1					SPACE	22
23	SPACE					-	1			B	-	1					SPACE	24
25	TVSS					15	2	A			-	1					SPACE	26
27										B	-	1					SPACE	28
29						-	1	A			-	1					SPACE	30

PANELBOARD NO: B1-3-W/13-2

SUBTOTAL CONNECTED KVA	0.0	3.7	0.0	0.0	0.0	0.0	0.0	7.0	SUBTOTAL CONNECTED KVA
					0.0	3.7	0.0	7.0	TOTAL CONNECTED KVA

PANELBOARD NO: B1-3-V/13-2

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G02
VOLTAGE: 208Y/120
PHASE: 1
WIRE: 3
200% NEUTRAL: YES
BUS: 100 A
MAIN: 60/2 SHUNT TRIP
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L23		360			20	1	A			60	2				3000	DISCONNECT SWITCH IW3L23	2
3	RECEPT IW3L23		360			20	1			B						3000		4
5	SPARE					20	1	A			20	1					SPARE	6
7	SPARE					20	1			B	-	1					SPACE	8
9	**RECEPT D0113**		**1500**			**30**	**2**	A			-	1					SPACE	10
11			**1500**							B	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1			B	-	1					SPACE	16
17	SPACE					-	1	A			-	1					SPACE	18
19	SPACE					-	1			B	-	1					SPACE	20
21	SPACE					-	1	A			-	1					SPACE	22
23	SPACE					-	1			B	-	1					SPACE	24
25	TVSS					15	2	A			-	1					SPACE	26
27										B	-	1					SPACE	28
29						-	1	A			-	1					SPACE	30

PANELBOARD NO: B1-3-V/13-2

SUBTOTAL CONNECTED KVA	0.0	3.7	0.0	0.0	0.0	0.0	0.0	6.0	SUBTOTAL CONNECTED KVA
					0.0	3.7	0.0	6.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-3-S/11-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: IW3031

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MAIN AND SUBFEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3021		900			20	1	A			20	1		1200			JB IW3012	2
3	RECEPT IW3019		900			20	1		B		20	1		1200			JB IW3012	4
5	RECEPT IW3018		900			20	1			C	20	1		1200			JB IW3012	6
7	RECEPT IW3017		900			20	1	A			20	1		1200			RECEPT IW3012	8
9	RECEPT IW3016		900			20	1		B		20	1		900			RECEPT IW3007	10
11	RECEPT IW3015		900			20	1			C	20	1		900			RECEPT IW3006	12
13	RECEPT IW3014		900			20	1	A			20	1		900			RECEPT IW3005	14
15	RECEPT IW3013		900			20	1		B		20	1		900			RECEPT IW3004	16
17	RECEPT IW3C02		1080			20	1			C	20	1		900			RECEPT IW3003	18
19	RECEPT IW3029		540			20	1	A			20	1		900			RECEPT IW3002	20
21	RECEPT IW3026		900			20	1		B		20	1		720			RECEPT IW3001	22
23	RECEPT IW3G02		900			20	1			C	20	1		540			RECEPT IW3001	24
25	RECEPT IW3C08		540			20	1	A			20	1		1200			JB IW3001	26
27	RECEPT IW3G01		900			20	1		B		20	1		1200			RECEPT IW3008	28
29	RECEPT IW3009		1040			20	2			C	20	1		480			FCU-3 & P-207A	30
31			1040					A			20	1	**900**				**TRACK LIGHT D0114**	32
33	RECEPT IW3009		1200			20	1		B		20	1	300				LTG #IW3L08	34
35	RECEPT IW3012		360			20	1			C	20	1	450				LTG #IW3L22 & 30	36
37	SM-8 IW3C02		1200			20	1	A			20	1	450				LTG #IW3L23	38
39	**TRACK LIGHT C0115**	**900**				20	1		B		20	1	150				LTG #IW3L28	40
41	SPARE					20	1			C	20	1	150				LTG #IW3L29	42

PANELBOARD NO: **B6-3-S/11-1**

SUBTOTAL CONNECTED KVA	0.9	16.9	0.0	0.0	2.4	14.3	0.0	0.0	SUBTOTAL CONNECTED KVA
					3.3	31.2	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B6-3-S/11-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: IW3031

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	*DWH-5 IW3029			1500		20	2	A			20	1					SPARE	44
45				1500					B		20	1					SPARE	46
47	SPARE					20	1			C	20	1					SPARE	48
49	SPARE					20	1	A			-	1					SPACE	50
51	SPARE					20	1		B		-	1					SPACE	52
53	SPARE					20	1			C	-	1					SPACE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60
61	SPACE					-	1	A			-	1					SPACE	62
63	SPACE					-	1		B		-	1					SPACE	64
65	SPACE					-	1			C	-	1					SPACE	66
67	SPACE					-	1	A			-	1					SPACE	68
69	SPACE					-	1		B		-	1					SPACE	70
71	SPACE					-	1			C	-	1					SPACE	72

*PROVIDE GFPE C/B AT 30mA

PANELBOARD NO: B6-3-S/11-1

SUBTOTAL CONNECTED KVA	0.0	0.0	3.0	0.0		0.0	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	0.0	3.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-3-Y/22-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: IW3091

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MAIN AND SUBFEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3066		900			20	1	A			20	1		900			RECEPT IW3078	2
3	RECEPT IW3067		900			20	1		B		20	1		900			RECEPT IW3079	4
5	RECEPT IW3068		900			20	1			C	20	1		900			RECEPT IW3081	6
7	RECEPT IW3069		900			20	1	A			20	1		900			RECEPT IW3082	8
9	RECEPT IW3071		900			20	1		B		20	1		900			RECEPT IW3083	10
11	RECEPT IW3072		900			20	1			C	20	1		900			RECEPT IW3084	12
13	JB IW3073		1200			20	1	A			20	1		540			RECEPT IW3093	14
15	JB IW3073		1200			20	1		B		20	1		540			RECEPT IW3093	16
17	JB IW3073		1200			20	1			C	20	2		1040			RECEPT IW3093	18
19	RECEPT IW3073		1200			20	1	A						1040				20
21	RECEPT IW3074		1200			20	1		B		30	3		2400			RECEPT IW3093	22
23	FCU-3 &P-207D		960			20	1			C				2400				24
25	P-208 IW3C12		960			20	1	A						2400				26
27	JB CLOCK IW3L59		1200			20	1		B		20	1		900			FCU-4 IW3C13	28
29	RECEPT IW3075		1040			20	2			C	20	1		720			RECEPT IW3089	30
31			1040					A			20	1		720			RECEPT IW3C11	32
33	RECEPT IW3075		1200			20	1		B		20	1	600				LTG #IW3L45	34
35	RECEPT IW3073		540			20	1			C	20	1	600				LTG #IW3L46	36
37	RECEPT IW3094		720			20	1	A			20	1	300				LTG #IW3L57	38
39	RECEPT IW3094		720			20	1		B		20	1	**900**				**TRACK LIGHT F0105**	40
41	SM-8 IW3C11		1200			20	1			C	20	1	150				LTG #IW3L72	42

PANELBOARD NO: **B6-3-Y/22-1**

SUBTOTAL CONNECTED KVA	0.0	21.0	0.0	0.0	2.6	18.1	0.0	0.0	SUBTOTAL CONNECTED KVA
					2.6	39.1	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B6-3-Y/22-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: IW3091

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	JB CLOCK AMP IW3087		200			20	1	A			20	1	**900**				**TRACK LIGHT F0105**	44
45	*DWH-5 (IW3089)			1500		20	2		B		20	1					SPARE	46
47				1500						C	20	1					SPARE	48
49	SPARE					20	1	A			-	1					SPACE	50
51	SPARE					20	1		B		-	1					SPACE	52
53	SPARE					20	1			C	-	1					SPACE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60
61	SPACE					-	1	A			-	1					SPACE	62
63	SPACE					-	1		B		-	1					SPACE	64
65	SPACE					-	1			C	-	1					SPACE	66
67	SPACE					-	1	A			-	1					SPACE	68
69	SPACE					-	1		B		-	1					SPACE	70
71	SPACE					-	1			C	-	1					SPACE	72

*PROVIDE GFPE C/B AT 30mA

PANELBOARD NO: B6-3-Y/22-1

SUBTOTAL CONNECTED KVA	0.0	0.2	3.0	0.0	0.9	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.9	0.2	3.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-3-Y/11-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: IW3044

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MAIN AND SUBFEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3034		900			20	1	A			20	1		1200			JB IW3043	2
3	RECEPT IW3035		900			20	1		B		20	1		1200			JB IW3043	4
5	RECEPT IW3036		900			20	1			C	20	1		1200			JB IW3043	6
7	RECEPT IW3037		900			20	1	A			20	1		1200			RECEPT IW3043	8
9	RECEPT IW3038		900			20	1		B		20	1		900			RECEPT IW3054	10
11	RECEPT IW3039		900			20	1			C	20	1		900			RECEPT IW3055	12
13	RECEPT IW3041		900			20	1	A			20	1		900			RECEPT IW3056	14
15	RECEPT IW3042		900			20	1		B		20	1		900			RECEPT IW3057	16
17	RECEPT IW3048		720			20	1			C	20	1		900			RECEPT IW3058	18
19	RECEPT IW3045		780			20	1	A			20	1		900			RECEPT IW3059	20
21	RECEPT IW3C06		1080			20	1		B		20	1		720			RECEPT IW3061	22
23	JB CLOCK IW3L19		1200			20	1			C	20	1		540			RECEPT IW3061	24
25	RECEPT IW3043		540			20	1	A			20	1		1200			JB IW3061	26
27	SM-8 IW3C06		1200			20	1		B		20	1		1200			RECEPT IW3064	28
29	RECEPT IW3C09		900			20	1			C	20	1		480			FCU-3 & P-207B	30
31	**TRACK LIGHT C0103**	**900**				20	1	A			20	1	**900**				**TRACK LIGHT D0104**	32
33	**TRACK LIGHT D0108**	**900**				20	1		B		20	1		540			RECEPT IW3G03	34
35	LTG #IW3L24	450				20	1			C	20	1		1200			RECEPT IW3C10	36
37	LTG #IW3L26	300				20	1	A			20	1		1200			RECEPT IW3063	38
39	LTG #IW3L32	600				20	1		B		20	1		1200			RECEPT IW3063	40
41	LTG #IW3L33	600				20	1			C	20	1		1200			RECEPT IW3063	42

PANELBOARD NO: **B6-3-Y/11-1**

SUBTOTAL CONNECTED KVA	3.8	13.6	0.0	0.0	0.9	19.7	0.0	0.0	SUBTOTAL CONNECTED KVA
					4.7	33.3	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B6-3-Y/11-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: IW3044

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	JB CLOCK IW3L19		200			20	1	A			20	1	**900**				**TRACK LIGHT D0113**	44
45	*DWH-5 (IW3045)			1500		20	2		B		20	1	**900**				**TRACK LIGHT D0113**	46
47				1500						C	20	1					SPARE	48
49	SPARE					20	1	A			-	1					SPACE	50
51	SPARE					20	1		B		-	1					SPACE	52
53	SPARE					20	1			C	-	1					SPACE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60
61	SPACE					-	1	A			-	1					SPACE	62
63	SPACE					-	1		B		-	1					SPACE	64
65	SPACE					-	1			C	-	1					SPACE	66
67	SPACE					-	1	A			-	1					SPACE	68
69	SPACE					-	1		B		-	1					SPACE	70
71	SPACE					-	1			C	-	1					SPACE	72

*PROVIDE GFPE C/B AT 30mA

PANELBOARD NO: B6-3-Y/11-1

SUBTOTAL CONNECTED KVA	0.0	0.2	3.0	0.0		1.8	0.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						1.8	0.2	3.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-W/3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3 SHUNT TRIP
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L05		360			20	1	A			20	1		540			RECEPT IW3L05	2
3	RECEPT IW3L05		1200			20	1		B		20	1		360			RECEPT IW3L05	4
5	RECEPT IW3L05		540			20	1			C	20	1		360			RECEPT IW3L05	6
7	RECEPT IW3G01		540			20	1	A			20	1		540			RECEPT IW3L05	8
9	RECEPT IW3G01		520			20	2		B		20	1		360			RECEPT IW3L05	10
11			520							C	20	1		540			RECEPT IW3L05	12
13	RECEPT IW3G01		520			20	2	A			20	1		540			RECEPT IW3L05	14
15			520						B		20	2					SPARE	16
17	RECEPT IW3G01		520			20	2			C								18
19			520					A			20	1					SPARE	20
21	RECEPT IW3G01		180			20	1		B		20	1					SPARE	22
23	RECEPT IW3G01		520			20	2			C	20	1					SPARE	24
25			520					A			-	1					SPACE	26
27	SPARE					20	1		B		-	1					SPACE	28
29	SPARE					20	1			C	**30**	**2**				**2500**	**RECEPT C0104**	30
31	SPACE					-	1	A								**2500**		32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			**30**	**3**			**2340**		**RECEPT C0104**	38
39	-								B						**2340**			40
41	-									C					**2340**			42

PANELBOARD NO: **B4-3-W/3-1**

SUBTOTAL CONNECTED KVA	0.0	7.0	0.0	0.0	0.0	3.2	7.0	5.0	SUBTOTAL CONNECTED KVA
					0.0	10.2	7.0	5.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-W/8-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3 SHUNT TRIP
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L18		360			20	1	A			20	1		360			RECEPT IW3L18	2
3	RECEPT IW3L18		360			20	1		B		20	1		360			RECEPT IW3L18	4
5	RECEPT IW3L18		540			20	1			C	20	1		1200			RECEPT IW3L18	6
7	RECEPT IW3L18		540			20	1	A			20	1		540			RECEPT IW3L18	8
9	RECEPT IW3L18		360			20	1		B		20	1					SPARE	10
11	RECEPT IW3L18		360			20	1			C	20	1		540			RECEPT IW3L18	12
13	RECEPT IW3G02		180			20	1	A			20	1		540			RECEPT IW3L18	14
15	RECEPT IW3G02		360			20	1		B		20	1		360			RECEPT IW3L18	16
17	**RECEPT D0108**		**360**			20	1			C	20	1		540			RECEPT IW3G02	18
19	SPARE					20	1	A			20	1		360			RECEPT IW3L18	20
21	SPARE					20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	**RECEPT D0108**		**2400**			**30**	**3**	A			-	1					SPACE	26
27			**2400**						B		-	1					SPACE	28
29			**2400**							C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-W/8-1**

SUBTOTAL CONNECTED KVA	0.0	10.6	0.0	0.0	0.0	4.8	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	15.4	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-U/13-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L29		360			20	1	A			20	1		540			RECEPT IW3G03	2
3	RECEPT IW3L29		360			20	1		B		20	2		520			RECEPT IW3G03	4
5	RECEPT IW3L29		360			20	1			C				520				6
7	RECEPT IW3L29		1200			20	1	A			20	1		**720**			**RECEPT E0116**	8
9	SPARE					20	1		B		20	1	**900**				**LIGHTS E0116**	10
11	SPARE					20	1			C	20	1			**1200**		**HEPAS E0116**	12
13	SPACE					-	1	A			20	3		1200			RECEPT IW3L29	14
15	SPACE					-	1		B					1200				16
17	SPACE					-	1			C				1200				18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-U/13-1**

SUBTOTAL CONNECTED KVA	0.0	2.3	0.0	0.0	0.9	5.9	1.2	0.0	SUBTOTAL CONNECTED KVA
					0.9	8.2	1.2	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-X/13-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 400 A
MAIN: 400/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L35		360			20	1	A			30	2		2500			RECEPT IW3G03	2
3	RECEPT IW3L35		540			20	1		B					2500				4
5	RECEPT IW3L35		540			20	1			C	30	2		2500			RECEPT IW3L35	6
7	RECEPT IW3L35		360			20	1	A						2500				8
9	RECEPT IW3L35		360			20	1		B		20	1					SPARE	10
11	SPARE					20	2			C	20	2		**1200**			**RECEPT E0102**	12
13								A						**1200**				14
15	RECEPT IW3L35		360			20	1		B		20	2					SPARE	16
17	RECEPT IW3L35		360			20	1			C								18
19	RECEPT IW3L35		360			20	1	A			20	1					SPARE	20
21	SPARE					20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	SPACE					-	1	A			60	3					SPARE	26
27	SPACE					-	1		B									28
29	SPACE					-	1			C								30
31	SPACE					-	1	A			30	3					SPARE	32
33	SPACE					-	1		B									34
35	SPACE					-	1			C								36
37	SPD					15	3	A			150	3	0	0	0	0	SPARE	38
39	-								B				0	0	0	0		40
41	-									C			0	0	0	0		42

PANELBOARD NO: **B4-3-X/13-1**

SUBTOTAL CONNECTED KVA	0.0	3.2	0.0	0.0		0.0	12.4	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	15.6	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-T/19-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L49		360			20	1	A			20	1		720			RECEPT IW3L49	2
3	JB HOOD IW3L49		1200			20	1		B		20	2		520			RECEPT IW3L49	4
5	JB HOOD IW3L49		1200			20	1			C				520				6
7	RECEPT IW3L49		720			20	1	A			20	3		600			RECEPT IW3L49	8
9	RECEPT IW3L49		520			20	2		B					600				10
11			520							C				600				12
13	RECEPT IW3L49		360			20	1	A			20	1		540			RECEPT IW3L49	14
15	RECEPT IW3L49		540			20	1		B		20	2		520			RECEPT IW3L49	16
17	RECEPT IW3L49		600			20	3			C				520				18
19			600					A			20	1		360			RECEPT IW3L49	20
21	RECEPT IW3L49		2800			30	1		B		20	3					SPARE	22
23	RECEPT IW3L49		360			20	1			C								24
25	RECEPT IW3L49		360			20	1	A										26
27	RECEPT IW3L49		1200			20	2		B		20	1		720			RECEPT IW3L49	28
29			1200							C	20	2		1200			RECEPT IW3L49	30
31	**LASER PANEL F0122**				**500**	20	1	A						1200				32
33	SPARE					20	1		B		20	1					SPARE	34
35	SPARE					20	1			C	20	2		520			RECEPT IW3L49	36
37	SPD					15	3	A						520				38
39	-								B		20	1					SPARE	40
41	-									C	20	1					SPARE	42

PANELBOARD NO: **B4-3-T/19-1**

SUBTOTAL CONNECTED KVA	0.0	12.5	0.0	0.5	0.0	9.7	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	22.2	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-T/19-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L41		540			20	1	A			20	1		360			RECEPT IW3L42	2
3	RECEPT IW3L41		360			20	1		B		20	1		360			RECEPT IW3L42	4
5	RECEPT IW3L41		1200			20	1			C	20	1		1200			RECEPT IW3L42	6
7	RECEPT IW3L41		360			20	1	A			20	2		1040			RECEPT IW3G04	8
9	RECEPT IW3L41		360			20	1		B					1040				10
11	HOOD IW3L41		1200			20	1			C	20	1		360			RECEPT IW3L42	12
13	HOOD IW3L41		1200			20	1	A			20	1		360			RECEPT IW3G04	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					20	1			C	20	1					SPARE	18
19	**TRANSFORMER E0119**				**4800**	**40**	**1**	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-T/19-2**

SUBTOTAL CONNECTED KVA	0.0	5.2	0.0	4.8	0.0	4.7	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	9.9	0.0	4.8	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-U/19-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L50		540			20	1	A			20	2		520			RECEPT IW3L50	2
3	RECEPT IW3L50		520			20	2		B					520				4
5			520							C	20	1		360			RECEPT IW3L50	6
7	RECEPT IW3L50		360			20	1	A			20	2		520			RECEPT IW3L50	8
9	RECEPT IW3L50		600			20	2		B					520				10
11			600							C	20	2		520			RECEPT IW3L50	12
13	SPARE					20	1	A						520				14
15	RECEPT IW3L50		360			20	1		B		20	1		360			RECEPT IW3L50	16
17	RECEPT IW3L50		1040			20	2			C	20	1		360			RECEPT IW3L50	18
19			1040					A			20	1		360			RECEPT IW3L50	20
21	SPARE					20	3		B		20	1		360			RECEPT IW3L50	22
23										C	20	1		360			RECEPT IW3L50	24
25								A			20	1		360			RECEPT IW3L50	26
27	RECEPT IW3L50		360			20	1		B		20	1		360			RECEPT IW3L50	28
29	RECEPT IW3L50		1040			20	2			C	-	1					SPACE	30
31			1040					A			-	1					SPACE	32
33	**LASER PANEL F0118**				**500**	20	1		B		-	1					SPACE	34
35	SPARE					20	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-U/19-1** Rev. 1 RFP-109.5 8/9/02

SUBTOTAL CONNECTED KVA	0.0	8.0	0.0	0.5		0.0	6.0	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	14.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-U/19-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L43		360			20	1	A			20	2		1040			RECEPT IW3G04	2
3	RECEPT IW3L43		360			20	1		B					1040				4
5	RECEPT IW3L43		360			20	1			C	20	1		360			RECEPT IW3G04	6
7	RECEPT IW3L43		360			20	1	A			20	1		360			RECEPT IW3L43	8
9	RECEPT IW3L43		1200			20	1		B		20	1		360			RECEPT IW3L43	10
11	RECEPT IW3L43		360			20	1			C	20	1					SPARE	12
13	**RECEPT E0115**		**500**			20	1	A			20	1					SPARE	14
15	**RECEPT E0115**		**500**			20	1		B		20	1					SPARE	16
17	**RECEPT E0115**		**500**			20	1			C	20	1					SPARE	18
19	**RECEPT E0115**		**500**			**20**	**1**	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-U/19-2**

SUBTOTAL CONNECTED KVA	0.0	5.0	0.0	0.0	0.0	3.2	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	8.2	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-W/19-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L52		360			20	1	A			20	1		180			RECEPT IW3L52	2
3	RECEPT IW3L52		360			20	1		B		20	1		1200			JB HOOD IW3L52	4
5	SPARE					20	3			C	20	1		1200			JB HOOD IW3L52	6
7								A			20	1		1200			RECEPT IW3L52	8
9									B		20	1		360			RECEPT IW3L52	10
11	RECEPT IW3L52		1200			20	1			C	20	2					SPARE	12
13	RECEPT IW3L52		360			20	1	A										14
15	**LASER PANEL F0112**				**500**	20	1		B		20	1		180			RECEPT IW3L52	16
17	SPARE					20	1			C	20	1					SPARE	18
19	SPARE					20	1	A			20	1					SPARE	20
21	SPARE					20	2		B		20	1					SPARE	22
23										C	20	1					SPARE	24
25	SPARE					20	1	A			-	1					SPACE	26
27	SPARE					20	1		B		-	1					SPACE	28
29	SPARE					20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-W/19-1**

SUBTOTAL CONNECTED KVA	0.0	2.3	0.0	0.5	0.0	4.3	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	6.6	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-X/19-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L53		1200			20	1	A			20	1		1200			RECEPT IW3L53	2
3	RECEPT IW3L53		1200			20	1		B		20	1		360			RECEPT IW3L53	4
5	RECEPT IW3L53		1200			20	3			C	20	1		360			RECEPT IW3L53	6
7			1200					A			20	1		360			RECEPT IW3L53	8
9			1200						B		20	1		1200			RECEPT IW3L53	10
11	RECEPT IW3L53		540			20	1			C	20	1		720			RECEPT IW3L54	12
13	RECEPT IW3L53		360			20	1	A			20	1		540			RECEPT IW3L54	14
15	RECEPT IW3L53		360			20	1		B		20	1		360			RECEPT IW3L53	16
17	RECEPT IW3L53		360			20	1			C	20	1		1200			RECEPT IW3L53	18
19	RECEPT IW3L53		360			20	1	A			20	1		360			RECEPT IW3L53	20
21	**LASER PANEL**				**500**	**20**	**1**		B		20	1		360			RECEPT IW3L53	22
23	SPACE					-	1			C	20	1		1200			RECEPT IW3L54	24
25	RECEPT IW3L54		360			20	1	A			20	1		720			RECEPT IW3L54	26
27	RECEPT IW3L54		360			20	1		B		20	1		180			RECEPT IW3L54	28
29	RECEPT IW3L54		360			20	1			C	20	1		360			RECEPT IW3L54	30
31	RECEPT IW3L54		360			20	1	A			30	3		1200			RECEPT IW3L53	32
33	RECEPT IW3L54		1200			20	1		B					1200				34
35	RECEPT IW3L54		360			20	1			C				1200				36
37	SPD					15	3	A			30	3		1200			RECEPT IW3L53	38
39	-								B					1200				40
41	-									C				1200				42

PANELBOARD NO: **B4-3-X/19-1**

SUBTOTAL CONNECTED KVA	0.0	11.0	0.0	0.5		0.0	16.7	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	27.7	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-U/26-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L68		540			20	1	A			20	1		360			RECEPT IW3L67	2
3	RECEPT IW3L68		720			20	1		B		20	1		1200			JB HOOD IW3L67	4
5	RECEPT IW3L68		540			20	1			C	20	1		1200			JB HOOD IW3L67	6
7	RECEPT IW3L68		1200			20	1	A			20	1		720			RECEPT IW3L67	8
9	RECEPT IW3L68		540			20	1		B		20	1		360			RECEPT IW3L67	10
11	RECEPT IW3L68		360			20	1			C	20	1		360			RECEPT IW3L67	12
13	RECEPT IW3L68		360			20	1	A			20	1		540			RECEPT IW3L67	14
15	RECEPT IW3L68		360			20	1		B		20	1		180			RECEPT IW3L67	16
17	SPARE					20	1			C	20	1		360			RECEPT IW3G05	18
19	RECEPT IW3L68		1800			30	3	A			20	1		180			RECEPT IW3G05	20
21			1800						B		20	1				500	**LASER PANEL G0118**	22
23			1800							C	20	1					SPARE	24
25	RECEPT IW3L68		1800			30	3	A			20	1					SPARE	26
27			1800						B		**20**	**2**		**1600**			**RECEPT G0118**	28
29			1800							C				**1600**				30
31	SPACE					-	1	A			**20**	**2**		**1600**			**RECEPT G0118**	32
33	SPACE					-	1		B					**1600**				34
35	SPACE					-	1			C	**20**	**2**		**1600**			**RECEPT G0118**	36
37	SPD					15	3	A						**1600**				38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-3-U/26-1**

SUBTOTAL CONNECTED KVA	0.0	15.4	0.0	0.0	0.0	15.1	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	30.5	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-V/26-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 400 A
MAIN: 400/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L69		540			20	1	A			20	1		1200			RECEPT IW3L69	2
3	RECEPT IW3L69		1040			20	2		B		20	1		1200			JB HOOD IW3L69	4
5			1040							C	20	1		1200			JB HOOD IW3L69	6
7	RECEPT IW3L69		1040			20	2	A			20	1		360			RECEPT IW3L69	8
9			1040						B		20	1		180			RECEPT IW3L69	10
11	RECEPT IW3L69		1200			20	1			C	20	1		360			RECEPT IW3G05	12
13	DISCONNECT SWITCH IW3L69				4800	60	3	A			20	1		360			RECEPT IW3G05	14
15					4800				B		30	2		2500			RECEPT IW3G05	16
17					4800					C				2500				18
19	DISCONNECT SWITCH IW3L69				4200	60	2	A			30	2		2500			RECEPT IW3G05	20
21					4200				B					2500				22
23	DISCONNECT SWITCH IW3L69				4200	60	2			C	20	1		720			RECEPT IW3L69	24
25					4200			A			20	1		360			RECEPT IW3L69	26
27	DISCONNECT SWITCH IW3L69				4800	60	3		B		20	1		540			RECEPT IW3L69	28
29					4800					C	20	1		540			RECEPT IW3L69	30
31					4800			A			20	1		540			RECEPT IW3G05	32
33	SPARE					20	1		B		20	1				500	**LASER PANEL G0114**	34
35	SPARE					20	1			C	20	2		1200			RECEPT IW3L69	36
37	SPD					15	3	A						1200				38
39	-								B		20	2		1200			RECEPT IW3L69	40
41	-									C				1200				42

PANELBOARD NO: **B4-3-V/26-1**

SUBTOTAL CONNECTED KVA	0.0	5.9	0.0	45.6	0.0	22.4	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	28.3	0.0	46.1	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-3-W/26-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: IW3G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 400 A
MAIN: 400/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT IW3L72		360			20	1	A			60	3					SPARE	2
3	RECEPT IW3L72		380			20	1		B									4
5	RECEPT IW3L72		540			20	1			C								6
7	RECEPT IW3L72		540			20	1	A			20	2		**1200**			**RECEPT G0108**	8
9	RECEPT IW3G05		360			20	1		B					**1200**				10
11	RECEPT IW3G05		360			20	1			C	20	2		**1200**			**RECEPT G0108**	12
13	RECEPT IW3G05		520			20	2	A						**1200**				14
15			520						B		20	1		180			RECEPT IW3L72	16
17	RECEPT IW3L72		360			20	1			C	20	1		360			RECEPT IW3L72	18
19	RECEPT IW3L72		360			20	1	A			20	1					SPARE	20
21	RECEPT IW3L72		360			20	1		B		20	1					SPARE	22
23	**LASER PANEL G0104**				**500**	20	1			C	20	1					SPARE	24
25	**RECEPT G0104**		**1660**			**20**	**2**	A			-	1					SPACE	26
27	**RECEPT G0104**		**1660**						B		-	1					SPACE	28
29	**RECEPT G0104**		**1660**			**20**	**2**			C	-	1					SPACE	30
31	**RECEPT G0104**		**1660**					A			-	1					SPACE	32
33	**RECEPT G0104**		**1660**			**20**	**2**		B		-	1					SPACE	34
35	**RECEPT G0104**		**1660**							C	-	1					SPACE	36
37	SPD					15	3	A			225	3	0	3480	0	0	B4-3-W/26-1A	38
39	-								B				0	2460	0	0		40
41	-									C			0	2640	0	0		42

PANELBOARD NO: **B4-3-W/26-1**

SUBTOTAL CONNECTED KVA	0.0	14.6	0.0	0.5		0.0	13.9	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	28.5	0.0	0.5	TOTAL CONNECTED KVA

BUILDING 218
PANEL SCHEDULES

B1-2-X/37.1-1
B1-2-X/49.3-1
B1-1-W/46.5-1A
B6-1-DD/49.3-1
B6-1-T/52.1-1
B2-1-V/37.1-2
B2-1-X/37.1-1
B4-1-V/37.1-2
B2-1-V/49.3-1
B2-1-W/49.3-2
B2-1-W/46.5-2A
B4-1-W/43.4-2
B4-1-Y/43.4-1
B4-1-Z/43.4-1
B4-1-CC/43.4-1
B4-1-W/49.3-1
B4-1-W/49.3-2
B4-1-W/46.5-2A
B4-1-X/49.3-1
B4-1-CC/54.8-1

PANELBOARD NO: **B1-2-X/37.1-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME2017
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L01		360			20	1	A			20	1					**SPARE**	2
3	RECEPT ME1L03		360			20	1		B		20	1					SPARE	4
5	RECEPT ME1L03		1200			20	1			C	20	1		1200			RECEPT ME1L27	6
7	RECEPT ME1L03		540			20	1	A			20	1		1200			RECEPT ME1L27	8
9	RECEPT ME1L03		360			20	1		B		20	1					SPARE	10
11	RECEPT ME1L03		540			20	1			C	20	1		360			RECEPT ME1G02	12
13	RECEPT ME1L05		360			20	1	A			20	3					SPARE	14
15	RECEPT ME1L05		360			20	1		B									16
17	RECEPT ME1G01		1200			20	1			C								18
19	SPARE					20	1	A			20	1		1200			RECEPT ME1L05	20
21	RECEPT ME1L05		360			20	1		B		20	1		1200			RECEPT ME1L05	22
23	RECEPT ME1L15		1200			20	1			C	20	1		360			RECEPT ME1L05	24
25	RECEPT ME1L05		520			20	2	A			20	1		360			RECEPT ME1L05	26
27			520						B		20	1		360			RECEPT ME1L05	28
29	SPACE									C	20	1		360			RECEPT ME1L05	30
31	RECEPT ME1L15		1200			20	1	A			20	1					SPARE	32
33	RECEPT ME1L15		1200			20	1		B		20	1					SPARE	34
35	RECEPT ME1L15		1200			20	1			C	20	1		**360**			**RECEPT E0005**	36
37	TVSS					15	3	A			**30**	**3**				**2100**	**PUMP CONTROLLER E0016**	38
39									B							**2100**	**SPACE**	40
41										C						**2100**	**SPACE**	42

PANELBOARD NO: **B1-2-X/37.1-1**

SUBTOTAL CONNECTED KVA	0.0	11.5	0.0	0.0	0.0	7.0	0.0	6.3	SUBTOTAL CONNECTED KVA
					0.0	18.4	0.0	6.3	TOTAL CONNECTED KVA

PANELBOARD NO: **B1-2-X/49.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME2017
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L39		360			20	1	A			20	1		1200			RECEPT ME1L42	2
3	RECEPT ME1L39		360			20	1		B		20	1		180			RECEPT ME1L42	4
5	RECEPT ME1L39		1200			20	1			C	20	1		1200			RECEPT ME1L42	6
7	RECEPT ME1L39		1200			20	1	A			20	1		180			RECEPT ME1L42	8
9	RECEPT ME1L52		360			20	1		B		20	1					SPARE	10
11	RECEPT ME1L52		360			20	1			C	20	1					SPARE	12
13	RECEPT ME1L52		1200			20	1	A			**50**	**3**	**0**	**540**	**0**	**0**	**B1-1-W/46.5-1A**	14
15	SPARE					20	1		B				**0**	**360**	**0**	**0**	**VIA POWER FILTER**	16
17	SPARE					20	1			C			**0**	**180**	**0**	**0**		18
19	SPARE					20	1	A			30	2		2000			FUTURE PANEL ME1L42	20
21	SPARE					20	1		B					2000				22
23	SPARE					20	1			C	20	2		1000			RECEPT ME1L42	24
25	RECEPT ME1L46		520			20	2	A						1000				26
27			520						B		20	2		1000			RECEPT ME1L42	28
29	RECEPT ME1G03		600			20	2			C				1000				30
31			600					A			20	3		1200			RECEPT ME1G03	32
33	RECEPT ME1G03		600			20	2		B					1200				34
35			600							C				1200				36
37	TVSS					15	3	A			20	3		1200			RECEPT ME1G03	38
39									B					1200				40
41										C				1200				42

PANELBOARD NO: **B1-2-X/49.3-1**

SUBTOTAL CONNECTED KVA	0.0	8.5	0.0	0.0	0.0	19.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	27.5	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: B1-1-W/46.5-1A

SECTION: 1 OF 1 **VOLTAGE:** 208Y/120 **BUS:** 125A
MOUNTING: SURFACE **PHASE:** 3 **MAIN:** MLO
WIRE: 4 **INTERRUPTING RATING:** 10 KAIC
LOCATION: D0017 **200% NEUTRAL:** YES **ELECTRONIC GRADE PANEL:** YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1		360			RECEPT D0017	2
3	SPARE					20	1		B		20	1		360			RECEPT D0017	4
5	SPARE					20	1			C	20	1		180			RECEPT D0017	6
7	SPARE					20	1	A			20	1		180			RECEPT D0017	8
9	SPARE					20	1		B		20	1					SPARE	10
11	SPARE					20	1			C	20	1					SPARE	12
13	SPACE							A			20	1					SPARE	14
15	SPACE								B		20	1					SPARE	16
17	SPACE									C	20	1					SPARE	18
19	SPACE							A									SPACE	20
21	SPACE								B								SPACE	22
23	SPACE									C							SPACE	24
25								A										26
27									B									28
29										C								30
31								A										32
33									B									34
35										C								36
37								A										38
39									B									40
41										C								42

PANELBOARD NO: B1-1-W/46.5-1A

SUBTOTAL CONNECTED KVA	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	1.1	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-1-DD/49.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1011

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 100 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1011		540			20	1	A			20	1					SPARE	2
3	P-516C			700		20	1		B		20	1					SPARE	4
5	P-517C			700		20	1			C	20	1					SPARE	6
7	P-515C			700		20	1	A			20	1					SPARE	8
9	P-512C			700		20	1		B		20	1		900			RECEPT ME3C01	10
11	AHU-523 LTS & REC	800	180			20	1			C	20	1		900			LTG #ME1L46	12
13	AHU-524 LTS & REC	800	180			20	1	A			20	1	800	180			AHU-516 LTS & REC	14
15	AHU-525 LTS & REC	800	180			20	1		B		20	1	800	180			AHU-517 LTS & REC	16
17	AHU-512 LTS & REC	800	180			20	1			C	20	1	800	180			AHU-515 LTS & REC	18
19	P-508B			860		20	1	A			20	1			860		P-508C	20
21	P-508D			860		20	1		B		20	1	**900**				**TRACK LIGHTS C0002**	22
23	SF-530 ME3002			700		20	1			C	20	1					SPARE	24
25	RECEPT ME3002		180			20	1	A			-	1					SPACE	26
27	**TRACK LIGHTS C0010**	**900**				20	1		B		-	1					SPACE	28
29	**TRACK LIGHTS C0006**	**900**				20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPACE					-	1	A			-	1					SPACE	38
39	SPACE					-	1		B		-	1					SPACE	40
41	SPACE					-	1			C	-	1					SPACE	42

PANELBOARD NO: **B6-1-DD/49.3-1**

SUBTOTAL CONNECTED KVA	5.0	1.4	5.2	0.0		3.3	2.3	0.9	0.0	SUBTOTAL CONNECTED KVA
						8.3	3.8	6.1	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B6-1-T/52.1-1**

SECTION: 1 OF 2
MOUNTING: SURFACE
LOCATION: ME1017

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: 225/3 AND THRU-FEED LUGS
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	JB ME1016		1200			20	1	A			20	1		1200			RECEPT ME1014	2
3	JB ME1016		1200			20	1		B		30	1				2160	ROLL-UP DOOR ME1G07	4
5	JB ME1016		1200			20	1			C	20	1					SPARE	6
7	RECEPT ME1016		1200			20	1	A			20	1		720			RECEPT ME1L67	8
9	RECEPT ME1018		540			20	1		B		20	1		540			RECEPT ME1L67	10
11	JB ME1018		1200			20	1			C	20	1		540			RECEPT ME1C06	12
13	RECEPT ME1018		540			20	1	A			20	1		1080			RECEPT ME1G04	14
15	RECEPT ME1019		540			20	1		B		20	1		900			RECEPT ME1C03	16
17	JB SM-2 ME1C01		1200			20	1			C	20	1		1200			JB SM-3 ME1C03	18
19	RECEPT ME1C01		900			20	1	A			20	1		1200			RECEPT ME1016	20
21	RECEPT ME1G03		1080			20	1		B		20	1		360			RECEPT ME1016	22
23	RECEPT ME1C05		540			20	1			C	30	1				2160	MOTOR AREAWAY 5	24
25	RECEPT ME1G02		1080			20	1	A			20	1		900			RECEPT IE1C01	26
27	PUMP P-506B & FCU-3			380		20	1		B		20	1		1200			RECEPT ME2021	28
29	PUMP P-506A			100		20	1			C	20	1		1200			RECEPT ME2019	30
31	JB CLOCK ME1L49		1000			20	1	A			20	1		1400			EF-508E & FCU	32
33	JB CLOCK AMP ME1021		200			20	1		B		20	1		900			RECEPT ME2017	34
35	RECEPT ME2017		540	700		20	1			C	20	1		900			RECEPT ME2017	36
37	**TRACK LIGHTS C0022**	**900**				20	1	A			20	1		540			RECEPT ME2017	38
39	**TRACK LIGHTS C0016**	**900**				20	1		B		20	1		1200			RECEPT ME2022	40
41	SPARE					20	1			C	20	1		1200			RECEPT ME2018	42

PANELBOARD NO: **B6-1-T/52.1-1**

SUBTOTAL CONNECTED KVA	1.8	14.2	1.2	0.0	0.0	17.2	0.0	4.3	SUBTOTAL CONNECTED KVA
					1.8	31.3	1.2	4.3	TOTAL CONNECTED KVA

PANELBOARD NO: B6-1-T/52.1-1

SECTION: 2 OF 2
MOUNTING: SURFACE
LOCATION: ME1017

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4

BUS: 225 A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
43	LTG #ME1L48	900				20	1	A			20	1			1200		SLAB HEATING ME1L34	44
45	LTG #ME1L43	900				20	1		B		20	1			800		SLAB HEATING ME1L62	46
47	SPARE					20	1			C	20	1	240	180			RECEPT ISOL. SLAB	48
49	SPACE					-	1	A			20	1	180	180			RECEPT ISOL. SLAB	50
51	SPACE					-	1		B		20	1	120	180			RECEPT ISOL. SLAB	52
53	SPACE					-	1			C	20	1					SPARE	54
55	SPACE					-	1	A			-	1					SPACE	56
57	SPACE					-	1		B		-	1					SPACE	58
59	SPACE					-	1			C	-	1					SPACE	60
61	SPACE					-	1	A			-	1					SPACE	62
63	SPACE					-	1		B		-	1					SPACE	64
65	SPACE					-	1			C	-	1					SPACE	66
67	SPACE					-	1	A			-	1					SPACE	68
69	SPACE					-	1		B		-	1					SPACE	70
71	SPACE					-	1			C	-	1					SPACE	72

PANELBOARD NO: B6-1-T/52.1-1

SUBTOTAL CONNECTED KVA	1.8	0.0	0.0	0.0	0.5	0.5	2.0	0.0	SUBTOTAL CONNECTED KVA
					2.3	0.5	2.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-1-V/37.1-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L01		360			20	1	A			20	1					SPARE	2
3	SPARE					20	1		B		20	1					SPARE	4
5	SPARE					20	1			C	20	1					SPARE	6
7	SPACE					-	1	A			**60**	**2**				**1500**	**DYNAMIC REGULATOR F0023**	8
9	SPACE					-	1		B							**1500**		10
11	SPACE					-	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-1-V/37.1-2**

SUBTOTAL CONNECTED KVA	0.0	0.4	0.0	0.0	0.0	0.0	0.0	3.0	SUBTOTAL CONNECTED KVA
					0.0	0.4	0.0	3.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-1-X/37.1-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G01

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L17		180			20	1	A			20	1		360			RECEPT ME1L17	2
3	RECEPT ME1L17		1200			20	1		B		20	1					SPARE	4
5	SPARE					20	1			C	20	1					SPARE	6
7	SPARE					20	1	A			**20**	**3**		**1600**			**RECEPT E0014**	8
9	SPARE					20	1		B					**1600**				10
11	SPARE					20	1			C				**1600**				12
13	RECEPT ME1G01		1000			20	2	A			**20**	**3**		**1600**			**RECEPT E0014**	14
15			1000						B					**1600**				16
17	RECEPT ME1G01		1000			20	2			C				**1600**				18
19			1000					A			-	1					SPACE	20
21	RECEPT ME1G01		1000			20	2		B		-	1					SPACE	22
23			1000							C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-1-X/37.1-1**

SUBTOTAL CONNECTED KVA	0.0	7.4	0.0	0.0	0.0	10.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	17.3	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-V/37.1-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G01
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L01		360			20	1	A			20	1		360			RECEPT ME1L03	2
3	RECEPT ME1L01		1200			20	1		B		20	1		1200			RECEPT ME1L03	4
5	RECEPT ME1L01		360			20	1			C	20	1		1200			JB ME1L03	6
7	RECEPT ME1L01		540			20	1	A			20	1		**1200**			**RECEPT F0023**	8
9	RECEPT ME1L01		360			20	1		B		20	1					SPARE	10
11	HOOD ME1L01		1200			20	1			C	20	1					SPARE	12
13	HOOD ME1L01		1200			20	1	A			**30**	**3**		**1920**			**RECEPT F0025**	14
15	SPARE					20	1		B					**1920**				16
17	SPARE					20	1			C				**1920**				18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPARE	26
27	SPACE					-	1		B		-	1					SPARE	28
29	SPACE					-	1			C	-	1					SPARE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-V/37.1-2**

SUBTOTAL CONNECTED KVA	0.0	5.2	0.0	0.0	0.0	9.7	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	14.9	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-1-V/49.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 50/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L48		1200			20	1	A			20	1		1200			RECEPT ME1L48	2
3	RECEPT ME1L48		1200			20	1		B		20	1		1200			RECEPT ME1L48	4
5	RECEPT ME1L48		1200			20	1			C	20	1		1200			RECEPT ME1L48	6
7	**RECEPT C0022**		**3000**			**60**	**2**	A			20	1					SPARE	8
9			**3000**						B		**30**	**1**		**1500**			**RECEPT C0022**	10
11	SPACE					-	1			C	-	1					SPACE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-1-V/49.3-1**

SUBTOTAL CONNECTED KVA	0.0	9.6	0.0	0.0	0.0	5.1	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	14.7	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-1-W/49.3-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1G03		1200			20	1	A			20	1		1200			RECEPT ME1G03	2
3	SPARE					20	1		B		20	1					SPARE	4
5	SPARE					20	1			C	20	1					SPARE	6
7	SPARE					20	1	A			20	1					SPARE	8
9	SPARE					20	1		B		20	1					SPARE	10
11	SPARE					20	1			C	20	1					SPARE	12
13	SPARE					20	1	A			20	1					SPARE	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					20	1			C	20	1					SPARE	18
19	SPARE					30	2	A			-	1					SPACE	20
21									B		-	1					SPACE	22
23	SPARE					20	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	RECEPT ME1G03		1400			20	2		B		-	1					SPACE	34
35			1400							C	-	1					SPACE	36
37	SPD					15	3	A			**50**	**3**	**0**	**540**	**0**	**2400**	**B2-1-W/46.5-2A**	38
39	-								B				**0**	**720**	**0**	**2400**	**VIA POWER FILTER**	40
41	-									C			**0**	**720**	**0**	**2400**		42

PANELBOARD NO: **B2-1-W/49.3-2**

SUBTOTAL CONNECTED KVA	0.0	4.0	0.0	0.0	0.0	3.2	0.0	7.2	SUBTOTAL CONNECTED KVA
					0.0	7.2	0.0	7.2	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-1-W/46.5-2A**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT DOO17		180			20	1	A			20	2				1200	RECEPT D0017	2
3	RECEPT DOO17		360			20	1		B							1200		4
5	RECEPT DOO17		360			20	1			C	20	2				1200	RECEPT D0017	6
7	RECEPT DOO17		360			20	1	A								1200		8
9	RECEPT DOO17		360			20	1		B		20	2				1200	RECEPT D0017	10
11	RECEPT DOO17		360			20	1			C						1200		12
13	SPARE					20	1	A			20	1					SPARE	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					20	1			C	20	1					SPARE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25								A										26
27									B									28
29										C								30
31								A										32
33									B									34
35										C								36
37								A										38
39									B									40
41										C								42

PANELBOARD NO: **B2-1-W/46.5-2A**

SUBTOTAL CONNECTED KVA	0.0	2.0	0.0	0.0	0.0	0.0	0.0	7.2	SUBTOTAL CONNECTED KVA
					0.0	2.0	0.0	7.2	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-W/43.4-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G02

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L23		540			20	1	A			30	3				1200	RECEPT ME1L23	2
3	RECEPT ME1L23		540			20	1		B							1200		4
5	RECEPT ME1L23		540			20	1			C						1200		6
7	RECEPT ME1L23		360			20	1	A			20	1		540			RECEPT ME1L24	8
9	RECEPT ME1L23		360			20	1		B		20	1		540			RECEPT ME1L24	10
11	RECEPT ME1L23		360			20	1			C	20	1		540			RECEPT ME1L24	12
13	RECEPT ME1L23		360			20	1	A			20	1		540			RECEPT ME1L24	14
15	RECEPT ME1L24		360			20	1		B		20	1		540			RECEPT ME1L24	16
17	RECEPT ME1L24		540			20	1			C	20	1		360			RECEPT ME1L24	18
19	RECEPT ME1G02		360			20	1	A			20	1		540			RECEPT ME1L24	20
21	RECEPT ME1G02		1200			20	1		B		20	1		540			RECEPT ME1L24	22
23	RECEPT ME1G02		360			20	1			C	20	1		540			RECEPT ME1L24	24
25	**LASER PANEL E0017**				**500**	20	1	A			**30**	**2**		**1456**			**RECEPT E0011**	26
27	SPARE					20	1		B					**1456**				28
29	SPARE					20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-W/43.4-2**

SUBTOTAL CONNECTED KVA	0.0	5.9	0.0	0.5		0.0	7.6	0.0	3.6	SUBTOTAL CONNECTED KVA
						0.0	13.5	0.0	4.1	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-Y/43.4-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L35		1200			20	1	A			20	1		540			RECEPT ME1L34	2
3	RECEPT ME1L35		360			20	1		B		20	1		540			RECEPT ME1L34	4
5	RECEPT ME1L35		360			20	1			C	20	1		360			RECEPT ME1L34	6
7	RECEPT ME1L35		360			20	1	A			20	1		360			RECEPT ME1L34	8
9	RECEPT ME1L35		540			20	1		B		20	1		**360**			**RECEPT D0012**	10
11	RECEPT ME1L35		360			20	1			C	20	1		**360**			**RECEPT D0012**	12
13	SPARE					20	1	A			20	1		360			RECEPT ME1L34	14
15	SPARE					20	1		B		20	1		360			RECEPT ME1L34	16
17	SPARE					20	1			C	20	1		360			RECEPT ME1G02	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-Y/43.4-1**

SUBTOTAL CONNECTED KVA	0.0	3.2	0.0	0.0	0.0	3.6	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	6.8	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-Z/43.4-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L36		540			20	1	A			20	1		1200			RECEPT ME1L36	2
3	RECEPT ME1L36		540			20	1		B		20	1		1200			RECEPT ME1L36	4
5	RECEPT ME1L36		540			20	1			C	20	1		1200			RECEPT ME1L36	6
7	RECEPT ME1L36		540			20	1	A			20	1		540			RECEPT ME1L36	8
9	RECEPT ME1L36		180			20	1		B		20	1		540			RECEPT ME1L36	10
11	RECEPT ME1L36		180			20	1			C	20	1		**360**			**RECEPT D0006**	12
13	SPARE					20	1	A			20	1		**360**			**RECEPT D0006**	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					20	1			C	20	1					SPARE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-Z/43.4-1**

SUBTOTAL CONNECTED KVA	0.0	2.5	0.0	0.0	0.0	5.4	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	7.9	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-CC/43.4-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G02
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES		CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L37		540			20	1		20	1				**500**	**AIR SPRING CONTROL**	2
3	RECEPT ME1L37		540			20	1		20	1					SPARE	4
5	RECEPT ME1L37		540			20	1		20	1					SPARE	6
7	RECEPT ME1L37		540			20	1		-	1					SPACE	8
9	RECEPT ME1L37		540			20	1		-	1					SPACE	10
11	RECEPT ME1L37		540			20	1		-	1					SPACE	12
13	**RECEPT D0004**		**360**			20	1		-	1					SPACE	14
15	**RECEPT D0004**		**1200**			20	1		-	1					SPACE	16
17	RECEPT ME1L37		1200			20	1		-	1					SPACE	18
19	SPARE					20	1		-	1					SPACE	20
21	SPARE					20	1		-	1					SPACE	22
23	SPARE					20	1		-	1					SPACE	24
25	SPACE					-	1		-	1					SPACE	26
27	SPACE					-	1		-	1					SPACE	28
29	SPACE					-	1		-	1					SPACE	30
31	SPACE					-	1		-	1					SPACE	32
33	SPACE					-	1		-	1					SPACE	34
35	SPACE					-	1		-	1					SPACE	36
37	SPD					15	3		-	1					SPACE	38
39	-								-	1					SPACE	40
41	-								-	1					SPACE	42

PANELBOARD NO: **B4-1-CC/43.4-1**

SUBTOTAL CONNECTED KVA	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	6.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-W/49.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L51		540			20	1	A			30	3		2880			RECEPT ME1G03	2
3	SPARE					20	2		B					2880				4
5										C				2880				6
7	SPARE					20	2	A			20	1		1200			RECEPT ME1G03	8
9									B		20	1		360			RECEPT ME1G03	10
11	RECEPT ME1L51		1200			20	1			C	20	1		360			RECEPT ME1L51	12
13	SPARE					20	2	A			20	1		360			RECEPT ME1L51	14
15									B		20	1		360			RECEPT ME1L51	16
17	RECEPT ME1L51		540			20	1			C	20	1		360			RECEPT ME1L51	18
19	SPARE					30	2	A			**20**	**2**		**1200**			**RECEPT C0020**	20
21									B					**1200**				22
23	RECEPT ME1L51		1200			20	1			C	-	1					SPACE	24
25	SPARE					20	1	A			-	1					SPACE	26
27	SPARE					20	1		B		-	1					SPACE	28
29	SPARE					20	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-W/49.3-1**

SUBTOTAL CONNECTED KVA	0.0	3.5	0.0	0.0	0.0	14.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	17.5	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-W/49.3-2**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			60	2					SPARE	2
3	SPARE					20	1		B									4
5	RECEPT ME1L41		540			20	1			C	20	1					SPARE	6
7	SPARE					20	1	A			20	1					SPARE	8
9	SPARE					20	1		B		20	1					SPARE	10
11	SPARE					20	2			C	20	1					SPARE	12
13								A			20	1					SPARE	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					30	2			C	20	1		360			RECEPT ME1G03	18
19								A			20	3					SPARE	20
21	SPARE					20	1		B									22
23	SPARE					20	1			C								24
25	SPARE					20	1	A			20	1		360			RECEPT ME1G03	26
27	SPARE					20	1		B		20	1		360			RECEPT ME1G03	28
29	SPARE					20	1			C	20	1		1200			RECEPT ME1G03	30
31	SPARE					20	1	A			20	1					SPARE	32
33	SPARE					20	1		B		20	1					SPARE	34
35	SPARE					20	1			C	20	1					SPARE	36
37	SPD					15	3	A			**50**	**3**	**0**	**720**	**0**	**0**	**B4-1-W/46.5-2A**	38
39	-								B				**0**	**720**	**0**	**0**	**VIA POWER FILTER**	40
41	-									C			**0**	**360**	**0**	**0**		42

PANELBOARD NO: **B4-1-W/49.3-2**

SUBTOTAL CONNECTED KVA	0.0	0.5	0.0	0.0		0.0	4.1	0.0	0.0	SUBTOTAL CONNECTED KVA
						0.0	4.6	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-W/46.5-2A**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: DOO17

VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES

BUS: 125A
MAIN: MLO
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	SPARE					20	1	A			20	1		360			RECEPT DOO17	2
3	SPARE					20	1		B		20	1		360			RECEPT DOO17	4
5	SPARE					20	1			C	20	1		360			RECEPT DOO17	6
7	SPARE					20	1	A			20	1		360			RECEPT DOO17	8
9	SPARE					20	1		B		20	1		360			RECEPT DOO17	10
11	SPARE					20	1			C	20	1					SPARE	12
13	SPACE					-	1	A			20	1					SPARE	14
15	SPACE					-	1		B		20	1					SPARE	16
17	SPACE					-	1			C	20	1					SPARE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25								A										26
27									B									28
29										C								30
31								A										32
33									B									34
35										C								36
37								A										38
39									B									40
41										C								42

PANELBOARD NO: **B4-1-W/46.5-2A**

SUBTOTAL CONNECTED KVA	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	1.8	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-X/49.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L52		360			20	1	A			20	1		540			RECEPT ME1L52	2
3	SPARE					60	2		B		20	1		360			RECEPT ME1G03	4
5										C	20	1		360			RECEPT ME1G03	6
7	RECEPT ME1L52		540			20	1	A			**20**	**2**		**1200**			**RECEPT C0016**	8
9	RECEPT ME1L52		360			20	1		B					**1200**				10
11	RECEPT ME1L52		360			20	1			C	**20**	**1**		.		**500**	**AIR SPRING CONTROL**	12
13	RECEPT ME1L52		360			20	1	A			-	1					SPACE	14
15	**RECEPT C0016**		**2400**			**30**	**1**		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPARE					-	1			C	-	1					SPACE	30
31	SPARE					-	1	A			-	1					SPACE	32
33	SPARE					-	1		B		-	1					SPACE	34
35	SPARE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-X/49.3-1**

SUBTOTAL CONNECTED KVA	0.0	4.4	0.0	0.0	0.0	3.7	0.0	0.5	SUBTOTAL CONNECTED KVA
					0.0	8.0	0.0	0.5	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-CC/54.8-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: ME1G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT ME1L64		360			20	1	A			20	2		500			RECEPT ME1L66	2
3	RECEPT ME1L64		1200			20	1		B					500				4
5	RECEPT ME1L64		360			20	1			C	20	1		1200			HOOD ME1L66	6
7	RECEPT ME1L64		540			20	1	A			20	1		1200			HOOD ME1L66	8
9	RECEPT ME1L64		540			20	1		B		20	1		360			RECEPT ME1L66	10
11	RECEPT ME1L64		540			20	1			C	20	1		1200			RECEPT ME1L66	12
13	RECEPT ME1L64		540			20	1	A			20	1		1200			RECEPT ME1L66	14
15	RECEPT ME1L64		540			20	1		B		20	1		360			RECEPT ME1L66	16
17	RECEPT ME1L64		360			20	1			C	20	1		360			RECEPT ME1L65	18
19	RECEPT ME1L64		540			20	1	A			20	1		1200			RECEPT ME1L65	20
21	RECEPT ME1L64		540			20	1		B		20	1		360			RECEPT ME1L65	22
23	RECEPT ME1L64		360			20	1			C	20	1		540			RECEPT ME1L65	24
25	**RECEPTS C0005**		**180**			20	1	A			20	1		360			RECEPT ME1L65	26
27	SPARE					20	1		B		20	1					SPARE	28
29	SPARE					20	1			C	20	1					SPARE	30
31	SPACE					-	1	A			**30**	**2**		**2400**			**RECEPT C0001**	32
33	SPACE					-	1		B					**2400**				34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-CC/54.8-1**

SUBTOTAL CONNECTED KVA	0.0	6.6	0.0	0.0	0.0	14.1	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	20.7	0.0	0.0	TOTAL CONNECTED KVA

BUILDING 219
PANEL SCHEDULES

B1-2-EE.4/19-1
B2-2-CC/26.3-1
B4-1-FF.8/11.3-1
B4-1-FF.8/27.7-1
B4-1-EE.4/20.8-1

PANELBOARD NO: **B1-2-EE.4/19-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: MW2012
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT MW1L02		360			20	1	A			20	1		360			RECEPT MW1L02	2
3	RECEPT MW1L02		180			20	1		B		20	1		360			RECEPT MW1L02	4
5	RECEPT MW1L02		360			20	1			C	20	1		540			RECEPT MW1L02	6
7	RECEPT MW1L02		360			20	1	A			20	1		360			RECEPT MW1L02	8
9	RECEPT MW1L02		360			20	1		B		20	1		**1200**			**RECEPT MW2001**	10
11	RECEPT MW1L02		360			20	1			C	20	1		**1200**			**RECEPT MW2001**	12
13	**RECEPT MW2004**		**1200**			20	1	A			20	1		**1200**			**RECEPT MW2001**	14
15	**RECEPT MW2004**		**1200**			20	1		B		20	1		**1200**			**RECEPT MW2001**	16
17	**RECEPT MW2004**		**1200**			**20**	**1**			C	**20**	**1**		**1200**			**RECEPT MW2017**	18
19	**RECEPT MW2004**		**1200**			**20**	**1**	A			**20**	**1**		**1200**			**RECEPT MW2017**	20
21	**RECEPT MW1008**		**1200**			**20**	**1**		B		**20**	**1**		**1200**			**RECEPT MW2017**	22
23	**RECEPT MW1008**		**1200**			**20**	**1**			C	**20**	**1**		**1200**			**RECEPT MW2017**	24
25	**RECEPT MW1008**		**1200**			**20**	**1**	A			-	1					SPACE	26
27	**RECEPT MW1027**		**1200**			**20**	**1**		B		-	1					SPACE	28
29	**RECEPT MW1027**		**1200**			**20**	**1**			C	-	1					SPACE	30
31	**RECEPT MW1027**		**1200**			**20**	**1**	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	TVSS					15	3	A			-	1					SPACE	38
39									B		-	1					SPACE	40
41										C	-	1					SPACE	42

PANELBOARD NO: **B1-2-EE.4/19-1**

SUBTOTAL CONNECTED KVA	0.0	14.0	0.0	0.0	0.0	11.2	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	25.2	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B2-2-CC/26.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: MW2019
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT #MW2001		1200			20	1	A			20	1		1200			RECEPT #MW2017	2
3	RECEPT #MW2001		1200			20	1		B		20	1		1200			RECEPT #MW2017	4
5	RECEPT #MW2001		1200			20	1			C	20	1		1200			RECEPT #MW2017	6
7	RECEPT #MW2001		1200			20	1	A			20	1		1200			RECEPT #MW2017	8
9	RECEPT #MW2002		1200			20	1		B		20	1		1200			RECEPT #MW2018	10
11	RECEPT #MW2004		1200			20	1			C	20	1		1200			RECEPT #MW2015	12
13	RECEPT #MW2004		1200			20	1	A			20	1		1200			RECEPT #MW2013	14
15	RECEPT #MW2004		1200			20	1		B		20	1		1200			RECEPT #MW1027	16
17	RECEPT #MW2004		1200			20	1			C	20	1		1200			RECEPT #MW1027	18
19	RECEPT #MW2005		1200			20	1	A			20	1		1200			RECEPT #MW1027	20
21	RECEPT #MW2008		1200			20	1		B		20	1					SPARE	22
23	RECEPT #MW2009		1200			20	1			C	20	1					SPARE	24
25	RECEPT #MW1008		1200			20	1	A			20	1					SPARE	26
27	RECEPT #MW1008		1200			20	1		B		20	1					SPARE	28
29	RECEPT #MW1008		1200			20	1			C	20	1					SPARE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B2-2-CC/26.3-1**

SUBTOTAL CONNECTED KVA	0.0	18.0	0.0	0.0	0.0	12.0	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	30.0	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-FF.8/11.3-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: MW1G05
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 100/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT MW1L13		360			20	1	A			20	1		360			RECEPT MW1L13	2
3	RECEPT MW1L13		180			20	1		B		20	1		180			RECEPT MW1L13	4
5	RECEPT MW1L14		360			20	1			C	20	1		180			RECEPT MW1L14	6
7	RECEPT MW1L14		180			20	1	A			20	1		180			RECEPT MW1L14	8
9	RECEPT MW1L13		180			20	1		B		20	1					SPARE	10
11	SPARE					20	1			C	20	1					SPARE	12
13	SPARE					20	1	A			20	1					SPARE	14
15	SPARE					20	1		B		20	1					SPARE	16
17	SPARE					20	1			C	20	1					SPARE	18
19	RECEPT MW1L13		1200			20	2	A			50	2			3600		DISCONNECT SWITCH MW1L13	20
21			1200						B						3600			22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			**50**	**3**			**3600**		**CHILLER MW1014**	26
27	SPACE					-	1		B						**3600**			28
29	SPACE					-	1			C					**3600**			30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-FF.8/11.3-1**

SUBTOTAL CONNECTED KVA	0.0	3.7	0.0	0.0	0.0	0.9	18.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	4.6	18.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-FF.8/27.7-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: MW1G04
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT MW1L45		1200			20	1	A			20	1		360			RECEPT MW1L46	2
3	RECEPT MW1L45		1200			20	3		B		20	1		1200			RECEPT MW1L46	4
5			1200							C	30	3		2880			RECEPT MW1L46	6
7			1200					A						2880				8
9	RECEPT MW1L45		360			20	1		B					2880				10
11	RECEPT MW1L45		2400			30	1			C	20	1		360			RECEPT MW1L46	12
13	RECEPT MW1L45		360			20	1	A			20	1		360			RECEPT MW1L46	14
15	RECEPT MW1L45		360			20	1		B		20	1					SPARE	16
17	RECEPT MW1L45		360			20	1			C	20	1					SPARE	18
19	RECEPT MW1L45		1200			20	1	A			20	1					SPARE	20
21	RECEPT MW1L45		360			20	1		B		20	1					SPARE	22
23	SPARE					20	1			C	20	1					SPARE	24
25	SPACE					-	1	A			**20**	**3**		**1500**			**RECEPT G0038**	26
27	SPACE					-	1		B					**1500**				28
29	SPACE					-	1			C				**1500**				30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-FF.8/27.7-1**

SUBTOTAL CONNECTED KVA	0.0	10.2	0.0	0.0	0.0	15.4	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	25.6	0.0	0.0	TOTAL CONNECTED KVA

PANELBOARD NO: **B4-1-EE.4/20.8-1**

SECTION: 1 OF 1
MOUNTING: SURFACE
LOCATION: MW1G03
VOLTAGE: 208Y/120
PHASE: 3
WIRE: 4
200% NEUTRAL: YES
BUS: 225 A
MAIN: 150/3
INTERRUPTING RATING: 10 KAIC
ELECTRONIC GRADE PANEL: YES

CKT NO.	DESCRIPTION	LOAD (VA) LTS	REC	MECH	MISC	CIRCUIT BREAKER AMPS	POLES				CIRCUIT BREAKER AMPS	POLES	LOAD (VA) LTS	REC	MECH	MISC	DESCRIPTION	CKT NO
1	RECEPT MW1L34		2880			30	3	A			30	3		2880			RECEPT MW1L34	2
3			2880						B					2880				4
5			2880							C				2880				6
7	**AIR SPRING CONTROL**				**500**	20	1	A			20	1					SPARE	8
9	SPARE					20	1		B		20	1					SPARE	10
11	SPARE					20	1			C	20	1					SPARE	12
13	SPACE					-	1	A			-	1					SPACE	14
15	SPACE					-	1		B		-	1					SPACE	16
17	SPACE					-	1			C	-	1					SPACE	18
19	SPACE					-	1	A			-	1					SPACE	20
21	SPACE					-	1		B		-	1					SPACE	22
23	SPACE					-	1			C	-	1					SPACE	24
25	SPACE					-	1	A			-	1					SPACE	26
27	SPACE					-	1		B		-	1					SPACE	28
29	SPACE					-	1			C	-	1					SPACE	30
31	SPACE					-	1	A			-	1					SPACE	32
33	SPACE					-	1		B		-	1					SPACE	34
35	SPACE					-	1			C	-	1					SPACE	36
37	SPD					15	3	A			-	1					SPACE	38
39	-								B		-	1					SPACE	40
41	-									C	-	1					SPACE	42

PANELBOARD NO: **B4-1-EE.4/20.8-1**

SUBTOTAL CONNECTED KVA	0.0	8.6	0.0	0.5	0.0	8.6	0.0	0.0	SUBTOTAL CONNECTED KVA
					0.0	17.3	0.0	0.5	TOTAL CONNECTED KVA