

Specification For:

Hall D FDC Clean room- Blue Crab Road Warehouse

Owner:

**THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY
NEWPORT NEWS, VIRGINIA
UNITED STATES DEPARTMENT OF ENERGY**

JUNE 9, 2010

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

- A. This scope of work is for the design and installation of Class 10,000 modular hard wall clean room at the warehouse Jefferson Lab is renting.
- B. Related Sections:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Work under separate contracts.
 - 4. Access to site.
 - 5. Coordination with occupants.
 - 6. Work restrictions.
 - 7. Specification and drawing conventions.
 - 8. Terminology

1.2 PROJECT INFORMATION

- A. Project Identification: <HALL D FDC Clean room>.
 - 1. Project Location: 727 Blue Crab Road, Newport News, Virginia>.
- B. Owner: Jefferson Lab managed and operated by Jefferson Science Associates (JSA) on behalf the Department of Energy, Office of Science.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of the Project is defined by the Contract Documents and consists of the following:
 - 1. Work includes all labor, materials and services necessary to design and install a field assembled class 10,000 hard wall clean room. Clean room will occupy approximately 2000 square feet of floor space and consist of four (4) segregated areas. denoted as follows:
 - a. Test and Assembly Area #2
 - b. Gowning Area #3
 - c. Cathode Protection Area #4
 - d. SLDR/Wind 5 Area #5
 - 2. Field assembly will consist of assembling all clean room components including all walls, ceilings, electrical components, mechanical components, controls, fire protection components, start-up and commissioning, test and balance, clean room certification
 - a. Itemize bid so that the following is listed as a separate item:

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- 1) Cost for factory assembly/disassembly.

- 2) Cost for field assembly including start-up/commissioning
- 3) Cost for test and balance
- 4) Cost for clean room certification

1.4 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Preceding Work: JSA will be setting up an adjacent area for storage consisting of shelving and racks anchored to the floor. The contractor is advised that this area will be active and will require coordination with JSA personnel during the field erection/start-up to prevent interference with or delaying work in these areas.
- C. Concurrent Work: JSA will award separate contract(s) for the following construction operations at Project site. Those operations will be conducted simultaneously with work under this Contract.
 1. Main warehouse HVAC unit
 2. Electrical power feeds to main warehouse HVAC unit.
 3. Electrical power feeds to clean room.
 4. Fire Sprinkler main feed to clean room
 5. Main communications(phone and internet services) lines to clean room

1.5 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.
- B. ACCESS RESTRICTIONS AND BADGING
 1. Any individual needing access to the site must complete the online [Subcontractor Registration Form](#). Each person requiring access shall complete the Subcontractor Registration Form and required training prior performing work. Data on the Registration Form includes birth date, citizenship, birthplace, and employer's address. Non US Citizens will be required to fill out an additional form, Foreign National Information Sheet and provide documentation of a right to work in United States. Approval for accessing the site for a Non US Citizen can take one (1) week or longer depending on citizenship and country of birth. The Forms will be provided by JLab. See Division 01 Section "Safety and Health Requirements" for training requirements.
 2. Access will be through the use of a door key assigned to the following JLAB personnel
 - a. JLAB SOTR (Subcontracting Officer Technical Representative)

SECTION 011000 - SUMMARY

- C. Use of Site: Limit use of Project site is to work in the area where the clean room area will be located. Do not disturb the adjacent storage areas. The front part of the building is used by another tenant and must be avoided.
 - 1. Limits: Confine construction operations to area where the clean room will be installed. Adjacent bathrooms in the warehouse area will be available for installation personnel.
 - 2. Parking: Four (4) parking spaces will be available for installation personnel, located in the adjacent parking area for the building. Exact location will be determined when the project is awarded.
 - 3. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- D. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weather tight condition throughout construction period. Repair damage caused by construction operations.

1.6 COORDINATION WITH OCCUPANTS

- A. Partial Owner Occupancy: Owner will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's operations. Maintain existing exits unless otherwise indicated.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Subcontracting Officer/SOTR.
 - 2. Provide not less than 24 hours' notice to Owner of activities that will affect Owner's operations.
- B. Other building area Occupancy: The front part of the building is occupied by another tenant and is “off limits” to all construction personnel.
 - 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities.
- C. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

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1. SOTR will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Subcontracting Officer's acceptance of the completed Work.
2. Before limited Owner occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
3. On occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.7 WORK RESTRICTIONS

A. WORK SCHEDULE

1. Normal Work Hours – Normal working hours at Jefferson Lab are 7:00 am to 5:00 pm, Monday through Friday, excluding holidays and shutdown period. Work at the Project Site outside of normal working hours requires approval from the Subcontracting Officer. Requests to work outside normal working hours should be submitted at least 48 hours in advance.
2. Holidays - Eleven days are designated as JSA/Jefferson Lab holidays and during the period between Christmas Day and New Year's Day Jefferson Lab will be closed. All subcontractor personnel will follow the JSA/Jefferson Lab holiday and shutdown schedule.
 - a. The holidays observed by JSA/Jefferson Lab are:

New Year's Day	Independence Day
Martin Luther King's Birthday	Labor Day
Presidents' Day	Thanksgiving Day
Memorial Day	Day after Thanksgiving
Christmas Eve	Christmas Day
New Year's Eve	

B. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Subcontracting Officer not less than 2 days in advance of proposed disruptive operations.
2. Obtain Subcontracting Officer's written permission before proceeding with disruptive operations.

C. Nonsmoking Building: Smoking is not permitted within any building or within **25 feet** of entrances, operable windows, or outdoor air intakes.

D. Controlled Substances: Use of tobacco products within buildings and controlled substances, illegal drugs (and associated paraphernalia), and other items prohibited by law anywhere on Lab property is not permitted.

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- E. Unauthorized Items: weapons (including hunting knives), explosives, pyrotechnics, or other dangerous instruments or materials likely to produce substantial injury or damage to persons or property.

1.8 SCHEDULES:

- A. The planned project schedule is as follows:
 1. Award the contract: on or about June 25, 2010
 2. Submittals due: on or about July 5, 2010
 3. Approved submittals: on or about July 8, 2010
 4. Delivery of clean room to site: on or about August 31, 2010
 5. Installation complete/system start-up & commissioning: on or about Sept. 13, 2010

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on the Drawings are described in detail in the Specifications. One or more of the following are used on the Drawings to identify materials and products:
 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.10 TERMINOLOGY

- A. Specification Terminology:
 1. Any reference to Architect within this subcontract shall be interpreted as Subcontracting Officer and/or SOTR.

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2. Any reference to Contractor shall be interpreted as Subcontractor. Jefferson Science Associates (JSA) is a Contractor to the Department of Energy for the Operation and Maintenance of Thomas Jefferson National Accelerator Facility (Jefferson Lab). Therefore, a Contract issued by JSA is referred to as a Subcontract.
3. Any reference to Owner within this subcontract shall be interpreted as Jefferson Lab/Jefferson Science Associates (JSA).
4. Reference to SOTR refers to the Subcontracting Officer's Technical Representative.

END OF SECTION 011000

SECTION 012900 - PAYMENT PROCEDURES

PART 2 - GENERAL

2.1 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment. These procedures supplement Subcontract Clause “Payments under Fixed-Price Construction Subcontracts”.
- B. See Division 01 Section "Construction Progress Documentation" for submitting the construction schedule.

2.2 SCHEDULE OF VALUES

- A. The schedule of values shall be prepared in conjunction with the development of the performance schedule. Installed components of work and their associated tasks listed in the Schedule of Values shall match the activities in the construction schedule. Once approved the activity values listed in the Schedule of Values shall not be changed.
- B. Format & Content:
 - 1. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each activity listed. Jefferson Lab/JSA will provide the Subcontractor with a MS Excel Spreadsheet electronic file.
 - a. ID number – The identification or activity number shall match the identification used on the performance schedule.
 - b. Activity Description – The activity description shall match the description used on the performance schedule.
 - c. Number of Units
 - d. Units – The units identified for an activity shall be suitable to determine the activity’s percent complete on a monthly basis.
 - e. Material Unit Value and Total Material Value for each activity
 - f. Labor Unit Value and Total Labor Value for each activity
 - g. Total Value for each activity
 - 2. Round amounts to nearest whole dollar; total shall equal the Subcontract Sum.
 - 3. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - 4. Each item in the Schedule of Values and Application for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may not be shown as separate line items in the Schedule of Values.

SECTION 012900 - PAYMENT PROCEDURES

- b. Distribute the cost as general overhead expense across actual work-in-place activities.
 - c. The amount of premiums paid for performance and payment bonds may be a line item of the Schedule of Values.
 - d. Mobilization line items are acceptable provided there is an equal value demobilization line item.
 - e. Items indicated as lump sum for the unit will be paid only when the Item is 100% complete.
5. Updating: Update and resubmit the Schedule of Values before the next Application for Payment when Subcontract Modifications change the Subcontract Sum.
- a. Submit the Schedule of Values to the JLAB SOTR (Subcontracting Officer's Technical Representative) at earliest possible date. No Applications for Payment will be accepted until after the JLAB SOTR has approved the Schedule of Values.
- C. Schedule of Values will not be approved without an approved construction schedule.

2.3 PAYMENT FOR STORED MATERIALS

- A. Typically, Jefferson Lab/JSA doesn't pay for material received but not installed. Upon the Subcontractor's request and the JLAB SOTR's concurrence, the Subcontracting Officer may consider payment for materials received but not installed. The authorized payment for stored material will be based on the lesser of the following: (1) The total value of all invoices submitted for the activity or (2) the material value listed in the Schedule of Values.
1. Material invoices shall be legible and clearly document the type, quantity, and cost of the materials covered in the Application for Payment.

PART 3 - PRODUCTS (Not Used)

PART 4 - EXECUTION

4.1 APPLICATIONS FOR PAYMENT

- A. Applications for Payment may be submitted no more than monthly. Each Application for Payment shall be consistent with previous applications and payments as certified by the SOTR and paid for by Jefferson Lab/JSA. Use Jefferson Lab/JSA's provided form for Applications for Payment.
- B. Prior to preparation and submission of an Application for Payment, the Subcontractor's representative and the SOTR shall meet and agree on the percent complete of each activity in the Schedule of Values.

SECTION 012900 - PAYMENT PROCEDURES

- C. Application Preparation: Submit a signed original and [2] > copies of each Application for Payment to the Subcontracting Officer. The Subcontracting Officer will return incomplete applications without action. With each application, submit the following items:
1. Application for Payment Form
 2. Monthly voucher identifying the work complete.
 3. Updated Performance Schedule. Percent complete on the performance schedule shall be supported by the Monthly voucher. Use updated schedules if revisions were made.
 4. Copies of stored material invoices.
- D. Administrative actions and submittals that must precede or coincide with submittal of Application for Payment include the following:
1. Approved Schedule of Values including updates.
 2. Performance Schedule.
 3. Submittals Schedule.
 4. Technical Submittals up-to-date. Work without approved submittals will not be paid.
 5. As-Builds' up-to-date.
 6. Payroll submissions up-to-date.

4.2 SUBCONTRACT MODIFICATIONS

- A. Each subcontract modification shall be added to the end of the approved Schedule of Values. The modification shall be broken into a sufficient number of activities to adequately identify the percent complete of each activity.

END OF SECTION 012900

SECTION 013300 - SUBMITTAL PROCEDURES

PART 5 - GENERAL

5.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals in accordance with Subcontract Clause “Specifications and Drawings for Construction” and the Technical Provisions. Prepare and submit submittals required by individual Specifications Sections.
- B. See Division 01 Section "Quality Requirements" for submitting test and inspection reports and Delegated-Design Submittals.
- C. See Division 01 Section "Closeout Procedures" for submitting warranties Project Record Documents and operation and maintenance manuals.
- D. JSA shall have unrestricted rights in all shop drawings, as-built drawings and other data submitted pursuant to this Subcontract.

5.2 TYPES OF SUBMITTALS

- A. Shop Drawings: Drawings, schedules, diagrams, and other data prepared specifically for this subcontract to illustrate a portion of the work.
- B. Product Data: Preprinted material such as illustrations, standard schedules, performance charts, instructions, brochures, diagrams, manufacturer’s descriptive literature, MSDS’, catalog data, and other data to illustrate a portion of work, but not prepared exclusively for this subcontract.
- C. Samples: Physical examples of products, materials, equipment, assemblies, or workmanship that are physically identical to a portion of work, illustrating portion of work or establishing standards for evaluating appearance of finished work or both.
- D. Certifications: Statements signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of subcontract and clearly name the project.
- E. Administrative Submittals: Data presented for review and approval to ensure that administrative requirements of the Project are adequately met but not to ensure directly that work is in accordance with design concept and in compliance with subcontract documents. These submittals are typically required by a Division 01 Section.
- F. Informational Submittals: Written information that does not require responsive action from Jefferson Lab. Submittals may be rejected for not complying with requirements.

SECTION 013300 - SUBMITTAL PROCEDURES

5.3 SUBMITTAL PROCEDURES

- a. Submittal Register: Within 7 calendar days after receipt of Notice-to-Proceed, the Subcontractor shall submit to the JLAB SOTR (Subcontracting Officer Technical Representative) 1 copy of the Submittal Register listing all the data submittals required by the subcontract. A sample page of a Submittal Register is attached to the end of this Section.
 2. The completed Submittal Register shall include the Item No., Specification Section/Paragraph Number, Submittal Description, Submittal Type as defined above, and the Approval Needed By date. The Approval needed by date shall be coordinated with the Construction Schedule and the specified review times.
 3. Each individual submittal item shall be listed separately on the Register even though multiple items may be submitted under one Transmittal.
 4. The Subcontractor shall submit 1 copy of the updated Submittal Register monthly to the SOTR. The updated Register shall include action dates, action codes, and changes to Approval Needed By dates.
 5. Submittals will not be accepted for review until the Submittal Register is complete.
- B. Contractor's Review: The Subcontractor shall review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submission.
- C. Transmittal Form: The Subcontractor shall complete and submit the form, "Transmittal of Shop Drawings, Equipment Data, Material Samples or Manufacturer's Certificate of Compliance, with each submittal. A sample Transmittal Form is attached to the end of this Section. The Project No. Block is for the Subcontractor's use.
1. Transmittal forms shall be number consecutively.
 2. Each item included in the Submittal shall be listed individually with the item number from the Register and the applicable specification paragraph.
 3. Only one specification section shall be listed on an individual Transmittal form.
 4. The Subcontractor shall certify on each Transmittal form that he has reviewed each submittal and it is in conformance with the subcontract drawings and specifications except as otherwise explicitly stated.
- D. Submission: Package each submittal appropriately for transmittal and handling using the Transmittal Form. Transmit submittals required by Division 01 to the SOTR. Transmit submittals required by Divisions 02 through 49 to the SOTR. Each copy of the submittal shall be identified with the following information:
1. Project Name.
 2. Subcontractor Name.
 3. Subcontract Number.
 4. Specification Section Number.
- E. Number of Copies: Submit the number of copies as identified below. If the Subcontractor requires additional copies to be returned, submit the additional copies as necessary.

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1. Shop Drawings: Submit 2 copies. 1 will be returned to the Subcontractor.
2. Product Data: Submit 2 copies. 1 will be returned to the Subcontractor.
3. Samples: Submit 2 copies. 1 will be returned to the Subcontractor.
4. Certifications: Submit 2 copies. 1 will be returned to the Subcontractor.
5. Administrative Submittals: Submit 2 copies. 1 will be returned to the Subcontractor
6. Closeout Submittals: Submit 2 copies. See Division 01 Section “Closeout Procedures” for additional requirements.

F. Review Time: Allow 2 calendar days for review of each submittal. The Subcontractor is responsible to ensure the submittals are complete and coordinated with subsequent submittals to permit proper and timely reviews. Incomplete or improperly prepared submittals may be returned to the Subcontractor without review action. No extension of the Subcontract time will be authorized because of failure to transmit complete submittals enough in advance of the Work to permit processing.

G. Action Codes: Each submittal will be assigned Approved, Approved as Noted, Disapproved and Resubmittal Required, or Receipt Acknowledged.

1. Approved and Approved as Noted: Approval of submittals shall not be construed as a complete check, but will indicate only the general method of construction; materials, detailing, and other information are satisfactory. Approval will not relieve the Subcontractor of the responsibility for any error which may exist. The subcontractor is responsible for dimensions, the design of adequate connections and details, coordination with other trades/materials, and the satisfactory construction of all work.
2. Disapproved and Resubmittal Required: The Subcontractor shall make all corrections required and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. If the Subcontractor considers any correction indicated on the submittal to constitute a change to the subcontract, a notice in accordance with the Subcontract Clause “Changes – Fixed Price” shall be given promptly to the Subcontracting Officer.
3. Receipt Acknowledged: Normally submittals for information only will not be returned. A signed Transmittal with this action code will be returned to Subcontractor to acknowledge receipt.

5.4 SUBSTITUTIONS

A. Any submittals which include a proposed substitution must clearly be identified in the Submittal and on the Transmittal. Submittals with substitutions without the information below may be returned as incomplete and not reviewed. JSA reserves the right to rescind inadvertent approval of submittals containing unnoted substitutions. Proposed Substitutions shall include the following information as part of the submittal.

1. Statement indicating the reason for the proposed substitution and the benefits.
2. Detailed comparison of the proposed substitution with the specified material.
3. Cost information, including a proposed change, if any, in the Subcontract Amount.
4. Subcontractor’s certification that the proposed substitution is appropriate for the application indicated and compatible with other elements of work.

SECTION 013300 - SUBMITTAL PROCEDURES

- B. The time to review a submittal with a substitution is extended 2 additional calendar days. If additional information or documentation is requested from the Subcontractor to complete the evaluation, the review time will be extended another 2 calendar days for a maximum review time of submittal with a proposed substitution of 6 calendar days.
- C. Proposed substitutions should be submitted with a separate Transmittal. Otherwise, the review time for the other items on the same Transmittal will be extended with the proposed substitution.
- D. The Subcontractor is responsible for any delays and/or costs associated with the proposed substitution.

5.5 CONTRACTOR'S USE OF ARCHITECT'S CAD FILES

- A. General: At Contractor's written request, copies of Designer of Record's CAD files will be provided to Contractor for Contractor's use in connection with Project.

PAYMENT: Payment of material will not be made without an approved submittal.

END OF SECTION 013300

SECTION 013529 - SAFETY AND HEALTH REQUIREMENTS

PART 7 - GENERAL

7.1 JEFFERSON LAB'S ES&H POLICY

Jefferson Lab considers no activity to be so urgent or important that we will compromise our standards for environmental protection, safety, or health (ES&H).

7.2 REFERENCES – The publications listed below form a part of this specification to the extent referenced.

- A. 29 CFR 1926, Occupational Safety and Health Standards for Construction
- B. 29 CFR 1904, Record Keeping Guidelines for Occupational Injuries and Illnesses
- C. 10 CFR 851, Department of Energy Worker Safety and Health Program
- D. NFPA 70E, Standard for Electrical Safety in the Workplace (2004)
- E. JSA/Jefferson Lab (JLab) ES&H Manual. This document is available electronically through Jefferson Lab's www homepage at <http://www.jlab.org/ehs/ehsmanual/index.html>.
- F. 10 CFR 708, Department of Energy Contractor Employee Protection Program
- G. American Conference of Governmental Industrial Hygienists (ACGIH), "Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices" (2005)

7.3 DEFINITIONS

- A. Safety Program: Company policies and procedures to ensure operations comply with applicable safety and occupational health laws and regulations and to protect the safety and health of employees and members of the public.
- B. Safety Plan: Written document of the Subcontractor's Safety Program as applicable to the construction worksite including activity hazard analyses.
- C. Construction Worksite: The area within the limits necessary to perform the work described in this subcontract.
- D. Imminent Danger: A hazard which, if allowed to persist, is quite likely to cause an accident that will result in death, serious injury, significant property damage, or environmental impairment.
- E. Stop-Work Order: A definitive statement made openly to another individual that an imminent danger situation exists and thus all related work must stop immediately.

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- F. Subcontracting Officer's Technical Representative (SOTR): The individual or firm responsible to JSA, for the supervision and administration of the construction project to ensure the construction contractor's compliance with technical specifications, ES&H requirements, and serves as the primary liaison between the subcontractor and Jefferson Lab.
- G. Competent Person: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions and has the authorization to take prompt corrective measures to eliminate the hazards.

7.4 SUBMITTALS

- A. Safety Plan
- B. Activity Hazard Analysis (AHA)
- C. Material Safety Data Sheets (MSDS)
- D. Tabulation of On-site Work Hours
- E. Incident Investigation Reports
- F. Crane annual inspection reports.
- G. Lift Plans

7.5 GENERAL REQUIREMENTS

- A. In addition to the detailed requirements included in the provisions of this subcontract, work performed shall comply with OSHA 1926. The Subcontractor shall take all reasonable precautions in the performance of the work under this subcontract to protect safety and health of employees and of members of the public. During construction, all operations and personnel shall comply with all applicable safety and health regulations and requirements (including reporting requirements) of JSA and the Government. Where the requirements of this specification, applicable regulations, and referenced documents vary, the most stringent requirements shall apply.
- B. No work shall commence on the construction worksite until Jefferson Lab issues a work permit based on the approved Safety Plan.
- C. Stop-Work Actions and Interventions – In accordance with the JLab ES&H Manual, every Jefferson Lab employee, subcontractor, user, and DOE employee has the authority and responsibility to stop work for conditions that pose imminent hazard or danger.
 - 1. The Subcontractor shall accept and respond immediately to directions from anyone to cease any activity or condition that is deemed unsafe. This applies to work by other subcontractors or by Jefferson Lab staff. This judgment shall be based upon subcontractors' experience, training, or knowledge of Jefferson Lab work-safety rules. Subcontractors shall immediately notify the Construction Manager/SOTR or if

SECTION 013529 - SAFETY AND HEALTH REQUIREMENTS

2. Unavailable contact 269-7400 any time work is stopped under the above described conditions.
3. In the event that the Subcontractor fails to comply with applicable regulations or requirements, JSA may, without prejudice to any other legal or contractual rights, issue an order stopping all or any part of the work. Thereafter, a start order for resumption of the work may be issued at the discretion of JSA.

7.6 SUBCONTRACTOR'S SAFETY PROGRAM

A. The ultimate responsibility for compliance with all applicable federal, state, and local safety and health laws and regulations and the requirements referenced herein rests with the Subcontractor. It is the Subcontractor's responsibility to provide a safe and healthful place for carrying out the work on this subcontract.

1. To ensure compliance with applicable regulations and project safety requirements, the subcontractor and lower tier subcontractors are subject to periodic scheduled and unscheduled review by the Construction Manager/SOTR and/or Jefferson Lab ES&H professionals during the course of this subcontract.
2. Failure of the Subcontractor or its subcontractors to comply with the referenced safety regulations contained herein will be considered a safety violation and will result in the action(s) listed below. There shall be no recourse by the Subcontractor for compensation due to lost time, claims for time extensions, or for excess costs or damages resulting from the initiation of these actions.
 - a. For serious violations, which pose an immediate risk to life or property, an order will be issued to stop immediately part or all of the Subcontractor's work until compliance is achieved.
 - b. For all other violations, the Subcontracting Officer or Construction Manager/SOTR may issue a written notice to the Subcontractor, stating the violation and the corrective action required. If the Subcontractor does not correct the violation within a stated abatement period, the following actions may be initiated:
 - 1) Subcontract payment retention may be held until the deficiency is corrected.
 - 2) An order may be issued to stop part or the entire Subcontractor's work until the deficiency is corrected.
 - 3) The Subcontracting Officer may make the necessary arrangements to correct the violation and the cost thereof will be charged to the Subcontractor. Costs of such corrections may be retained and deducted from the final payment amount otherwise due the Subcontractor.

B. SITE SAFETY AND HEALTH REPRESENTATIVE

1. The Subcontractor shall have a designated representative on the construction worksite that is knowledgeable of the project's hazards and has full authority to act on behalf of

SECTION 013529 - SAFETY AND HEALTH REQUIREMENTS

2. The Subcontractor and direct lower tier Subcontractor employees regarding Safety and Health in accordance with 10 CFR 851.
 - a. The designated Site Safety and Health Representative shall have the experience and training to qualify him/her as a competent person for this duty.
 - b. The designated Site Safety and Health Representative cannot have any other assigned duties such as Superintendent or Foreman. .
 3. The designated Site Safety and Health Representative must make daily inspections of the construction worksite to identify and correct any instances of noncompliance with project safety and health requirements. These inspections shall detect and/or verify correction of hazardous conditions or hazardous work that impacts the Subcontractor and lower-tier Subcontractor employees.
 4. No work shall be performed when the designated Site Safety and Health Representative is not present on the construction worksite.
- C. WRITTEN SAFETY PLAN – In accordance with 10 CFR 851 the Subcontractor shall submit a written project specific Safety Plan encompassing all pertinent aspects of the Subcontractor’s Safety Program. The Plan shall encompass the work of any and all lower tier subcontractors involved in activities under this Subcontract, and it shall include the Subcontractor’s methods to enforce the elements of the Safety Program for all personnel on the construction worksite.
1. Time for Submissions - Within twenty-one (21) calendar days after receipt of the subcontract award.
 2. Work at the construction worksite shall not commence until the Subcontractor’s Safety Plan has been approved by the Construction Manager/SOTR.
 3. Preliminary Safety Plan Meeting: The Construction Manager/SOTR and JLab ES&H professionals will meet with the Subcontractor to discuss the elements of the Subcontractor’s Safety Program and the requirements of this section. To maximize the efficiency of the meeting, it is recommended that the Subcontractor have a draft of his Safety Plan.
 4. The Subcontractor’s Safety Plan shall include the following, at a minimum:
 - a. A statement of the subcontractor’s commitment to provide a safe and healthful construction worksite for all employees including subcontractors’ employees and Jefferson Lab personnel.
 - 1) Include a policy statement concerning substance abuse on the construction worksite.
 - b. Name, title and qualifications of the designated Site Safety and Health Representative and designated alternates.
 - 1) Include the frequency and format for documentation of inspections.
 - c. Procedures for coordinating safety and health with lower tier subcontractor’s and Jefferson Lab personnel on the construction worksite.

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- d. Procedures for communicating and coordinating safety and health requirements to non-English speaking subcontractor personnel.
- e. Preliminary task safety and health analysis (Activity Hazard Analysis).
- f. Identify safety and health training requirements and procedures including but not limited to:
 - 1) Orientations of new workers prior to beginning work on the construction worksite.
 - 2) Each worker acknowledging work hazards.
 - 3) Frequency of tool-box safety meetings.
 - 4) Updates or changes on safety practices relevant to the construction worksite, discussions of lessons learned from incidents at the construction worksite and elsewhere.
- g. The Subcontractor's hazard communication program and the specifics for the construction worksite.
- h. Procedures for communicating and coordinating safety and health requirements to non-English speaking subcontractor personnel (if applicable).
- i. Identification of the activities on the construction worksite that will require employees to be under an occupational medical or exposure-monitoring program. Upon Jefferson Lab's request, the Subcontractor shall submit documentation of compliance.
- j. An emergency response plan that sets forth the procedures to be followed upon the occurrence of serious injuries, illnesses, fatalities, fires, structural failures, or other emergencies, including procedures for the administration of first aid and/or other necessary medical treatment. This shall include a list of nearby medical care providers available to the Subcontractor's employees.
- k. Procedures for recording and reporting safety incidents and maintaining safety and health records in accordance with Occupational Safety and Health Administration (OSHA) requirements and in accordance with Jefferson Lab reporting requirements.
 - 1) Procedures for the investigation of job-related incidents to determine possible cause and corrective action.
 - 2) Specific designation of management persons responsible for review of injury and illness reports.

D. ACTIVITY HAZARD ANALYSIS

- 1. The Subcontractor shall prepare an Activity Hazard Analysis (AHA) of the safety and health hazards expected on the project which are common to all phases of work (conventional hazards) and special hazards that may be expected during the course of the project. Additional AHAs shall be required if the nature of work changes or there is a new work task. The JLAB AHA form will be turned over to the Subcontractor prior to starting field assembly.

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The Subcontractor shall retain on the construction site a copy of all AHA for the duration of the contract.

- a. Conventional Hazards: The Subcontractor’s Safety Plan may include the company’s standard policies and practices for the following conventional hazards as they pertain to the project:

Storage & use of compressed gases	Concrete work
	Cranes
Electrical hazards*	
Fall prevention & protection	
Hand & power tools	Hazard communication
Construction worksite housekeeping	Ladders
Lockout/tagout*	Material handling & storage
Mechanized equipment	Occupational health hazards
Thermal Stress	Personal protective equipment
Respiratory protection	Rigging & hoisting *
Scaffolds[dlb1]* & powered man-lifts	Signs, signals & barricades
Ventilation & exhaust	Welding, cutting & grinding*

* Procedures are to be aligned with Jefferson Lab’s ES&H Manual which has specific, mandatory practices and authorization permits

- b. Special Hazards: The AHA for Special Hazards shall be written specifically for the construction worksite conditions. These hazards include, but are not limited to the following activities:
- Work at heights >6 feet from ground level
 - Fire hazard (“hot”) work
 - Work on energized electrical equipment (See NFPA 70E section)
 - Use of explosive-cartridge-actuated fastening systems

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- Use of chemicals in a quantity or manner such that MSDS or other manufacturer information recommends use of special ventilation and/or respiratory protection
 - Use of motorized cranes, or other motorized industrial equipment
 - Use of flammable or toxic materials inside buildings
 - Other activities in occupied buildings that present a risk to personnel, equipment, or property
2. The AHA shall identify the activity hazard(s) by project phase, the people, or equipment at risk, the appropriate controls to mitigate the risk, and the specific work practices to be followed.
 3. The AHA shall also address any special training or certification requirements, and shall identify by name the competent or qualified person(s) who will be responsible for the safe conduct of the activity. This includes documentation of CPR and First Aid training for all personnel performing work on energized electrical equipment.
 4. When the AHA is approved, and prior to start of work, the Subcontractor shall brief affected employees on the identified hazards and the mitigating measures specified. All briefed employees shall acknowledge briefings on hazards in writing.
 5. Special Requirements for Fall Protection and Excavation Activities
 - a. Fall protection hazards shall be addressed via a Fall Protection Plan that encompasses all sequential phases of the planned project. The specific fall protection measures may evolve according to the work in progress so long as they meet applicable OSHA standards for the activity underway at any given time. The Fall Protection Plan shall be specific in describing conditions and activities that necessitate changes in methods of fall-protection during the course of the project.
- E. 100% EYE, HEAD, AND FOOT PROTECTION - All construction workers and other personnel on the construction worksite shall wear at all times eye, head, and foot protection that complies with applicable ANSI Standards. The type of protective eyewear shall be selected as appropriate for the hazard.
- F. OCCUPATIONAL HEALTH –The Subcontractor shall insure the availability of medical personnel for advice and consultation on matters of occupational health. Subcontractors shall work with Jefferson Lab Occupational Medicine to assess occupational medical needs including medical surveillance and occupational case management.
1. All workers shall be physically and medically qualified for performing the duties to which they are assigned.
 2. Exposure of workers to inhalation, ingestion, skin absorption, or contact with any material or substance in excess of acceptable limits specified in the American Conference of Governmental Industrial Hygienists (ACGIH), “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,” (2005) or by OSHA, whichever is more stringent, is prohibited.

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- a. The Subcontractor shall comply with all applicable standards and regulation to reduce contaminant concentration levels as low as is reasonably achievable.
 3. Thermal Stress Hazards – In situations where heat/cold stress may impact worker safety and health, the Subcontractor shall minimize the associated hazards with one of the following programs:
 - a. Company established procedures as documented in the approved Safety Plan, or
 - b. Procedures documented in the JLab ES&H Manual.
 4. First Aid – Jefferson Lab will provide first-aid services for all workers on the construction worksite. Services are available at Building 28, VARC.
- G. JEFFERSON LAB PERMITS/PLANS – The Subcontractor must obtain a permit from Jefferson Lab to specifically authorize an activity to proceed under conditions recognized to be hazardous and requiring additional control. Permits will be issued based on approved Activity Hazard Analysis and completed permit application forms. Display the Activity Hazard Analysis and Work Permit at the construction worksite during entire duration of the work activity. Not complying with the requirement for a permit may result in JSA stopping work and assessing a penalty. See paragraph 1.8 for safety penalties. In accordance with the JLab ES&H manual, obtain the following permits before the start of the activity at the construction worksite:
1. Work Permit - No work shall commence on the construction site until Jefferson Lab issues a work permit. Issuance of the permit is based upon submission and acceptance of the necessary plans and permits to perform the planned work.
 2. Dig/Blind Penetration Permit is required prior to commencement of excavation, digging, boring into soil, drilling or cutting blind penetrations into floors, walls or roofs and demolition. All utilities must be located in accordance with Division 01 *Work Restrictions* section.
 3. Fire Hazard Work Permit (FHWP) – All work activities that use welding, hot cutting, brazing and abrasive grinding require a FHWP (hot work permit).
 4. Energized Electrical Work Permit (EWPP) – Work on electrical distribution systems will be performed de-energized to the maximum extent possible. This is defined as Mode 1. Other types of electrical work include:
 - a. Mode 2 – Non-manipulative work such as diagnostics, troubleshooting, power verification, testing, and measurements.
 - b. Mode 3 – Energized electrical work that does not fall into the Mode 2 category. Jefferson Lab practice is not to issue permits for Mode 3 work.
 5. Crane Lift Plans - Use of mobile cranes on Site or use of Jefferson Lab overhead cranes (if allowed under the contract) requires submission of a lift plan for approval prior to work being performed as described in paragraph J.2 of this section.
- H. MATERIAL SAFETY DATA SHEETS - The Subcontractor shall have a copy on-hand of Material Safety data Sheet (MSDS) for material brought or used on construction worksite. Jefferson Lab may request a copy of individual MSDS for any product at any time. For any

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material to be used in occupied spaces, submit a copy of the MSDS to the Construction Manager/SOTR before use of the material.

I. WORK ON ENERGIZED ELECTRICAL CIRCUITS AND SYSTEMS – (NFPA 70E)

1. Work on energized electrical circuits and systems shall be performed in accordance with NFPA 70E. This includes all start-up and commissioning activities.
2. All work on energized electrical circuits and systems shall be performed by a two or more-person team, at least one of which shall be a qualified person. A qualified person is someone familiar with the construction and operation of the equipment in question and the hazards involved with the authorized work. Qualification for operating or servicing hazardous devices, systems, and facilities shall be documented in the Activity Hazard Analysis. This includes documentation of successful completion of CPR and First Aid training.
3. The electrical work team shall verify zero voltage using a meter before any work is performed on de-energized equipment. Personal protective equipment in accordance with NFPA 70E and Jefferson Lab applicable standard operating procedures shall be used until zero voltage has been verified. All electrical connections shall be inspected and approved by a qualified person prior to testing equipment and installing/reinstalling protective covers. Equipment may be de-energized for non-electrical work by one person using appropriate lock, tag and try methods.
4. Personal protective equipment (PPE) – non-melting inner and outer garments (per ASTM F1506-00) or untreated natural fibers is required as regular work attire. Additional protective clothing and protective gear shall be worn as specified in NFPA 70E table 130.7(c) (10), Protective Clothing and PPE Matrix.

J. MATERIAL HANDLING EQUIPMENT

1. Prior to use of material handling equipment on the construction worksite, the Subcontractor shall ensure:
 - a. The equipment meets the requirements of OSHA and ANSI regulations.
 - b. Operators are trained and qualified to recognize the associated hazards.
 - c. A competent person is designated and qualified to perform inspections as required by OSHA.
 - d. Annual inspection documentation has been submitted to the SOTR.
2. Lift plans - Submit crane lift plans for structural steel erection and when crane loads meet or exceed 75 percent of the crane load capacity in any configuration; lifts involving more than one crane or hoist; and lifts involving below the hook lifting device(s), or unusual safety risks. The plan shall include the following, as applicable:

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- a. The plan shall specify the size and weight of the load to be lifted and all crane and rigging components which add to the weight. The crane manufacturer's maximum load limits for the entire range of the lift as listed in the load charts shall also be specified for mobile cranes.
- b. The plan shall specify the lift geometry and procedures including the crane position, height of the lift, and the load radius. When using a mobile crane include outrigger positions and the boom length and angle for the entire range of the lift.
- c. The plan shall designate the Crane Operator, Lift Supervisor, and Rigger, and state their qualifications.
- d. The plan shall include a rigging plan that shows the lifts points and describes rigging procedures and hardware requirements (sling specifications, length, angles, shackle size, swivel eye hoist rings...) and details for any below the hook lifting device.
- e. The plan shall describe the ground conditions, outrigger or crawler track requirements, and, if necessary, the design of mats necessary to achieve a level, stable foundation of sufficient bearing capacity for the lift.
- f. The plan shall list environmental conditions under which lift operations are to be stopped.
- g. The plan shall specify coordination and communication requirements for the lift operation.
- h. The plan shall specify the lifting area perimeter where those not directly involved with the lift will be kept out.
- i. For lifts of personnel the plan shall demonstrate compliance with the requirements of 29 CFR 1926.550, paragraph (g) "Crane or Derrick Suspended Personnel Platforms."

7.7 JEFFERSON LAB TRAINING REQUIREMENTS

- A. Jefferson Lab Provided Training – Contractor and Subcontractor personnel working at Jefferson Lab on this project are required to attend the following training prior to performance of any work on construction worksite. The training is provided at no cost.

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Course	Course Number	Approx. Duration	Required to Attend
ES&H Orientation for Construction Subcontractors	SAF 100C	2 hours	All Personnel
EMS awareness	SAF127		
Jefferson Lab Lock, Tag, and Try	SAF 104	2 hours	All personnel at risk from sudden release of energy
NFPA-70E Basic Electrical Training	SAF603N	1.5 hours	All personnel working on energized electrical systems over 50 volts
Fire Safety	SAF 108	1.5 hours	All personnel involved in welding, cutting, or burning

- B. Access Escort in Lieu of Training: As a temporary measure for deliveries or other short-duration access (less than 8 hours), and with the authorization of the Construction Manager/SOTR, the Subcontractor may provide continuous escort for personnel who have not completed the requisite ES&H training. The escort shall have current training for the areas to be entered. Escorted personnel shall not perform tasks or use equipment for which Jefferson Lab training is required, and they shall remain in sight of the escort at all times.
- C. The SOTR will provide the Contractor a list of contractor and subcontractor personnel training that has been completed on a monthly basis.

7.8 SAFETY PENALTIES

- A. In addition to the other safety provisions of this Subcontract, a financial penalty assessment program will be utilized to reinforce compliance with those safety provisions and reduce the frequency of safety violations and accidents. The determinations regarding assessment of the fines will be made unilaterally by Jefferson Lab/JSA and are not subject to the Disputes clause.
- B. Fines for Safety Violations. Monetary penalties will be assessed to the Subcontractor when violations are found based on the associated risk. All violations will be assigned a risk code between 1 and 4 based on the severity of the potential injury and the likelihood of its occurrence. More information on the risk code assignments can be found in the JSA/Jefferson Lab ES&H Manual.

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Assessment of Fines - When a violation is noted a determination will be made as to the risk posed by the deficiency. The amount of the fine increases with risk. The time allowed for abating a deficiency decreases with increasing risk. Imminent dangers (risk code 4) are stop-work situations, and immediate mitigation is required. The Subcontracting Officer, SOTR, or their authorized representatives can assess fines. Fines will be assessed to the following schedule:

Risk Code	Fine per Occurrence
1	\$500
2	\$1,000
3	\$5,000
4	\$10,000

1. Common violations are listed in the table below with the risk codes most frequently associated with the deficiency. This list is **not comprehensive**. The actual risk code assigned to a safety deficiency is dependent on the circumstances at the time of the violation.

	Safety Deficiency	Typical Risk Code
1.	Performance of work without an activity hazard analysis and/or work permit.	3
2.	No hard hat – working beneath suspended load	3
3.	No hard hat within posted area – no imminent hazard	1
4.	Suitable eye protection not used while engaged in work that presents eye hazards (grinding, power-sawing, chipping, spraying, etc.)	3
5.	Suitable eye protection not worn within posted area	1
6.	No safety shoes	2
7.	Failure to install adequate fall protection	3
8.	Worker inadequately protected by fall protection.	3-4
9.	Compressed gas bottles not secured	2-3
10.	Ladder not tied off	2

Hall D FDC Project – Blue Crab Road warehouse - Clean room

	Safety Deficiency	Typical Risk Code
11.	Temporary electric panel improperly configured, lacking GFCI protection, or overloaded	2-3
12.	Improper installation and use of electric power systems and/or equipment violation	2
13.	Defective electrical cords – not in use (e.g. in “gang box” or trailer)	1
14.	Defective electrical cords – in use	2
15.	Incorrect operation or rigging of crane and load	3-4
16.	Fire extinguisher not present when needed (e.g. during “hot work”) or is not usable	2-3
17.	Fire extinguisher... inspection is out of date missing seal or pin too far from required location	1
18.	Inadequate daily housekeeping/cleanup in areas subject to foot traffic	2
19.	Inadequate daily removal of debris from construction worksite	1
20.	MSDS not available for products on construction worksite	1-2
21.	Chemicals being handled in manner inconsistent with manufacturer’s recommendations (i.e. MSDS)	2-3
22.	Failure to provide/ replace floor or roof opening cover(s)	3-4
23.	Excavations without proper shoring/cutbacks – no work in progress	2
24.	Excavations without proper shoring/cutbacks - workers in excavation	3-4

	Safety Deficiency	Typical Risk Code
25.	Tools and other equipment have missing or defective components	2-3
26.	Working without a current Hot Work permit or failure to follow provisions stipulated in it	3
27.	Confined space work without adequate hazard-control measures	3-4
28.	Imminent danger/ threat of life or permanent disability or threat to loss of property over \$100,000	4
29.	Inadequate Erosion & Sediment Control Measures	2-3
30.	Inadequate measures for preventing and containing hazmat spills	2
31.	Miscellaneous violations that pose no immediate hazard. Examples: Incorrect, defaced, or missing construction worksite safety notices Defective or inappropriate tools and equipment on JLab premises, but not in use for this project	1

2. Payment of Fines - These fines will be assessed to the Subcontractor by deductions on the monthly invoices regardless of whether the safety violations were directly caused by the Subcontractor or were caused by a lower-tier subcontractor.
3. Amount of Work Activity and Fines - Fines for safety violations may be assessed during all months when work is performed on construction worksite, regardless of the value of work that is performed during that monthly period.
4. Correction of Violations - Assessment of fines for any safety violation does not relieve the Subcontractor from its responsibility for correcting the safety violation in a time period that is consistent with the seriousness of the violation.
5. Posting of Violations - The Subcontractor shall post these safety violations and associated fines at the construction worksite in a prominent location.

PART 8 - PRODUCTS – Not used.

PART 9 - EXECUTION

SECTION 013529 - SAFETY AND HEALTH REQUIREMENTS

9.1 REPORTING REQUIREMENTS

- A. In addition to the reporting and record keeping requirements of OSHA 1904, the Subcontractor shall submit to the Subcontracting Officer original forms of the reports as described below.
1. Each report shall be timely, accurate, legible, and complete with respect to all work performed within the scope of this subcontract – including administrative and subcontracted work. Failure to comply for any reason shall be considered just cause either for issuance of an order to stop all or any part of the work covered by this subcontract and/or the retention of funds in payment for such work.
- B. Incident Investigation Worksheet, JLab Form No. 5200-T1 of the JLab ES&H manual. (To be provided electronically by the SOTR)
1. "Incident Investigation Worksheet" shall be completed by the Site Safety and Health Representative and submitted to the Construction Manager/SOTR no later than 24 hours following:
 - a. All personal injury accidents or illnesses that involve medical treatment beyond first aid.
 - b. All fires and/or property/equipment-damage incidents that appear to have replacement repair, or cleanup costs of \$5,000 or more or that takes longer than 10 minutes to extinguish.
 - c. Spills of oil, chemicals or hazardous materials of any amount into a sanitary sewer, storm sewer, site drainage ditches, or that may contaminate surface water or ground water.
 - d. All accidents involving Government-owned or leased motor vehicles.
 - e. An event or circumstance which has the potential to cause serious physical injury, unexpected death, or significant property damage, but did not occur due to chance or to unique circumstances that cannot reasonably be expected to reoccur in the future. (Near Miss)
 2. Telephone notice to the Construction Manager/SOTR is required immediately. If you cannot contact the Construction Manager/SOTR, call 757-269-7400 to report the incident.
 3. The Subcontractor shall provide to the Construction Manager/SOTR updated information at least weekly concerning the lost or restricted workdays status of any Subcontractor employee injured at Jefferson Lab. These updates shall continue until the attending physician has cleared the employee for resumption of unrestricted work.
- C. Report first aid cases to the SOTR – no investigation required.
- D. "Tabulation of On-Site Work Hours," Form No., PD Form 29, 1 Copy
1. This report is due from Subcontractor five (5) days following each quarter.

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9.2 CONCERN REPORTING PROCESS

- A. Whistleblower Protection for Subcontractor Employees
 - 1. The Subcontractor shall comply with the requirements of the "DOE Contractor Employee Protection Program" at 10 CFR Part 708.
 - 2. The Subcontractor shall insert or have inserted the substance of this clause, including this paragraph (b), in lower tier subcontracts, at all tiers, with respect to work performed on any construction worksite at a DOE-owned or leased facility, as provided for at 10 CFR part 708.

- B. Concern Reporting Processes - Subcontractor employees on the construction worksite are entitled to use any of the means available to communicate concerns about ES&H conditions and practices. Information about concern reporting is available on ES&H bulletin boards throughout Jefferson Lab, and shall be included with Jefferson Lab-provided materials for the construction worksite postings for this project. The options for reporting concerns include:
 - 1. Jefferson Lab Concern-Reporting Process
 - 2. DOE Concern Reporting Processes

9.3 LOWER TIER SUBCONTRACTOR COMPLIANCE

- A. In all lower-tier subcontracts involving performance of work at the construction worksite, the Subcontractor shall include the provisions of paragraphs 1.7, 3.1, and 3.2 above. However, such provisions in the subcontracts shall not relieve the Subcontractor of its obligations to assure compliance with the provisions of this clause for all aspects of the work.

END OF SECTION 013529

SECTION 017700 - CLOSEOUT PROCEDURES

PART 10 - GENERAL

10.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Project As-built Documents.
 - 4. Operation and maintenance manuals
 - 5. Warranties.
 - 6. Instruction of Jefferson Lab's personnel
 - 7. Final cleaning.

- B. Related Sections:
 - 1. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 2. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 3. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
 - 4. Divisions 02 through 49 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

10.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.
 - 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 - 2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 3. Prepare and submit Project Record Documents, operation and maintenance manuals, damage or settlement surveys, and similar final record information.
 - 4. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 5. Complete startup testing of systems.
 - 6. Submit test/adjust/balance records.
 - 7. Submit clean room certification report.
 - 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 9. Complete final cleaning requirements, including touchup painting.

SECTION 017700 - CLOSEOUT PROCEDURES

10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

10.3 FINAL COMPLETION

- A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:
 1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
 2. Submit the copy of Substantial Completion inspection list of items to be completed or corrected (punch list) signed off by the SOTR. The copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. [**Submit demonstration and training video recordings.**]
- B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, the Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

10.4 WARRANTIES

- A. Submittal Time: Submit written warranties for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
 4. Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
- C. Provide additional copies of each warranty to include in operation and maintenance manuals.

SECTION 017700 - CLOSEOUT PROCEDURES

10.5 PROJECT AS-BUILT DOCUMENTS

- A. General: Do not use Project As-Built Documents for construction purposes. Protect As-Built Documents from deterioration and loss. Provide access to Project As-built Documents for SOTR's review during normal working hours at the construction site.
- B. As-built Drawings: Maintain and submit one set of blue- or black-line white prints of Subcontract Drawings and Shop Drawings.
 - 1. Mark As-Built Prints in red to show the actual installation where installation varies from that shown originally.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Record data with construction progress. Record and check the markup before enclosing concealed installations.
 - 2. Note Construction Change Request numbers, Request for Information numbers, and similar identification where applicable.
 - 3. Mark Shop Drawings in a similar manner and submit with the Subcontract Drawings. Also, provide electronic files of the approved Shop Drawing.
 - 4. Electronic CAD files of the Subcontract Drawings with amendments may be made available to the Subcontractor upon request for use in development of the as-built drawings.
- C. As-Built Record Drawings
 - 1. Submit Electronic CAD files, in AutoCAD version 2009 format, of the Drawings with amendments to the Owner.
 - a. Include Fire suppression drawings with calculations.

10.6 OPERATION AND MAINTENANCE MANUALS

- A. Assemble three (3) sets of complete operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:
 - 1. Operation Data shall include the following as applicable to the equipment:
 - a. Design operating conditions
 - b. Limiting operating parameters
 - c. Routine test requirements
 - d. Trouble shooting procedures
 - e. Normal operating procedures including start-up and shutdown
 - f. Calibration instructions.
 - 2. Maintenance Data shall include the following as applicable to the equipment:

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- a. Preventive maintenance requirements
 - b. Disassembly procedures including special tool requirements
 - c. Procedure for inspecting disassembled parts
 - d. Reassembly and any special tool requirements
 - e. Manufacturers' warranties
3. Test Reports
- a. Test and Balance report
 - b. Clean Room certification report:
- B. Organize operation, maintenance manuals and test reports into suitable sets of manageable size. Bind and index data in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL", TEST REPORTS" Project name, and subject matter of contents.

10.7 INSTRUCTION OF JEFFERSON LAB PERSONNEL

- A. Instruction: Instruct Jefferson Lab's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
1. Provide instructors experienced in operation and maintenance procedures.
 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 3. Schedule training with Jefferson Lab, through SOTR, with at least seven days advance notice.
 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content. Provide a copy of the teaching outline to the SOTR prior to scheduling the training.
- B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline.
1. Include instruction for system design and operational philosophy, review of documentation, operations, adjustments, troubleshooting, maintenance, and repair.

PART 11 - PRODUCTS

11.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
1. Use cleaning products that meet Green Seal GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

SECTION 017700 - CLOSEOUT PROCEDURES

PART 12 - EXECUTION

12.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
 - 1. Clean Room “Top-down” cleaning shall be included as part of final cleaning.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including areas of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - d. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - e. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - f. Sweep concrete floors broom clean in unoccupied spaces.
 - g. Clean transparent materials, including mirrors and glass in doors and windows. Remove labels that are not permanent.
 - h. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates.
 - i. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - j. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 - k. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - l. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and

Hall D FDC Project – Blue Crab Road warehouse - Clean room

SECTION 017700 - CLOSEOUT PROCEDURES

defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

- m. Leave Project clean and ready for occupancy.

END OF SECTION 017700

SECTION 132115 – MODULAR CLEANROOM

PART 13 - GENERAL

13.1 SUMMARY

This Section outlines the work scope for designing, installing and starting up/commissioning, including test and balance/clean room certification, a free standing class 10,000 modular clean room. in normal operation with all services functioning and with production equipment and personnel present and performing their normal work functions within the clean room The modular clean room is to be a factory designed/built, field erected construction which includes an integral Air Conditioning/Humidifier unit, integral fire sprinklers, integral FFU's, integral lighting, emergency lighting, integral power receptacles, integral voice and data jacks, integral exhaust for soldering stations, integral control system with control panel for controlling temperature/humidity and multiple room pressures. The room is to consist of four separate room areas. The clean room will be installed inside an existing warehouse that will be climate controlled in the summer to a maximum. of 76 Deg. F D.B and 62.8 Deg. F WB and in the winter to a minimum of 68 Deg. F with no humidification. As this work falls under the City of Newport News Department of Codes Compliance, 2400 Washington Ave, Newport News, VA 23607; Office (757) 926-8861 Fax (757) 926-9831, the contractor shall be required to secure all necessary building permits from the City BEFORE installation commences.

13.2 CLEAN ROOM REQUIREMENTS

- A. Occupancy Classification for Fire Protection: Ordinary Hazard Group 1
- B. The clean room shall be an ISO/Federal standard 209E class 10,000 (SI M5.5)with the following requirements:
 - 1. Temperature to be maintained: 68 Deg. F +or – 2 Deg. F
 - 2. Humidity to be maintained: 48 % + or – 2 %
 - 3. Clear ceiling height to be 8'-0"
- C. The clean room shall be sub-divided as follows(NOTE: Dimensions are internal):
 - 1. Gowning area measuring 7'-8" wide x 11'-8" long
 - 2. Cathode Production area measuring 31'-8" wide x 39'-8" long
 - 3. Soldering/Winding area measuring 19'-8" wide x 19'-0" long
 - 4. Test/Assembly area measuring 19'-8" wide x 11'-6" long
- D. The clean room differential pressure, using the surrounding warehouse area as the 0" reference point, shall be sub-divided as follows:
 - 1. Soldering/Winding area - +0.01"
 - 2. Test/Assembly area: +0.02"
 - 3. Cathode Production area: +0.02"
 - 4. Gowning area: +0.01"
- E. Electrical power available to power the clean room is as follows:
 - 1. Power connection points to the clean room should be as minimal as possible preferably to what is shown on the attached drawing.
 - 2. Electrical power available to power the clean room is as follows:
 - a. 1/60/120VAC

SECTION 132115 – MODULAR CLEANROOM

b. 3/60/208VAC

F. Minimum illumination to be as follows:

1. Gowning area: 40 – 50 Ft-Candles
2. Cathode Production area: 40 – 50 Ft-Candles
3. Soldering/Winding area: 50 -60 Ft-Candles
4. Test/Assembly area: 50 -60 Ft-Candles
 - a. NOTE: Walls of this area MUST be completely “Blacked out” to prevent any light from penetrating the walls for tool testing requirements
 - b. Must have a separate light switch located beside entry door for workers to turn lights off in just this area.
5. Emergency Lighting: As required by local building codes

G. The following areas will require the following services:

1. Gowning area:
 - a. One (1) 120 VAC, 20 amp duplex outlet mounted on the wall in area as shown on the attached drawing
2. Cathode Production area:
 - a. Six(6) 120 VAC, 20 amp duplex outlets mounted on the wall in the areas as shown on the attached drawing
 - b. Two(2) 120 VAC, 20 amp duplex outlets suspended from the ceiling in the areas as shown on the attached drawing
 - c. One (1) phone jack mounted on the wall in the area as shown on the attached drawing
 - d. Three(3) data jacks mounted on the wall in the areas as shown on the attached drawing
 - e. Two(2) 120 VAC, 20 amp duplex outlets mounted on the exterior wall in the areas as shown on the attached drawing
3. Test and Assembly area:
 - a. Two(2) 120 VAC, 20 amp duplex outlets mounted on the wall in the areas as shown on the attached drawing
 - b. One(1) data jack mounted on the wall in the areas as shown on the attached drawing
 - c. One (1) Light switch mounted on the wall beside the entry door as shown on the attached drawing
4. Soldering/Winding area:
 - a. Four(4) 120 VAC, 20 amp duplex outlets mounted on the wall in the areas as shown on the attached drawing
 - b. One(1) data jack mounted on the wall in the areas as shown on the attached drawing
 - c. Exhaust system to draw soldering fumes from a work bench area and include:
 - 1) An on/off switch located in the area to allow workers to turn the system on-off
 - 2) An external exhaust port to route the exhaust system external of the warehouse.
 - a) Ducting external of the clean room will be “by others”, however, duct size, length and number of fittings restrictions needs to be called out for in bid.

SECTION 132115 – MODULAR CLEANROOM

- H. The following areas will require “swing” type doors with door closure:
 - 1. Gowning area:
 - a. Two (2) double doors measuring 81” high x 72” wide on opposite ends of room as shown on the attached drawing
 - 2. Cathode Production area:
 - a. Two (2) double doors measuring 81” high x 72” wide as shown on the attached drawing
- I. Materials:
 - 1. Walls –
 - a. Panels - Static-Dissipative PVC, Surface resistivity to be 10,000,000 – 10,000,000 ohms/sq. cm per ASTM-D257.
 - b. Wall Frame – Interlocking powdered coated steel.
 - c. Wall material can be hard or soft, but wall is NOT to be “hanging curtain” type.
 - 2. Ceiling –
 - a. Wall Frame – Interlocking powdered coated steel
 - b. Include a single plenum above the FFU’s for A/C unit supply
 - 3. Doors –
 - a. Panels - Static-Dissipative PVC, Surface resistivity to be 10,000,000 – 10,000,000 ohms/sq. cm per ASTM-D257.
 - b. Frame – Aluminum or powdered coated steel
 - c. Strip Type prohibited.
- J. Air Conditioning and humidity control
 - 1. Air Conditioning unit
 - a. Externally mounted beside the clean room as shown on the attached drawing
 - b. Include a single plenum above the FFU’s for A/C unit supply
 - c. Designed to provide fresh air requirements for up to twelve (12) people working inside in accordance with ASHRAE 62.1
 - 1) Fresh air shall be drawn for surrounding warehouse area.
 - 2) Fresh air volumes should be incorporated with a lockable balancing damper to provide the owner the option of changing the airflows if occupancy volume changes.
 - d. DX type unit with no CFC’s or HCFC’s
 - e. Split (condenser/compressor & air handler/evaporator) so condenser/compressor is outdoors is preferred
 - 2. Humidification
 - a. Provide humidification equipment to provide the necessary moisture addition for winter conditions. Area surrounding clean room will NOT be humidity controlled in the winter.
- K. Control panel with operation status system
 - 1. Externally mounted in beside the gown area entry door as shown on the attached drawing
 - 2. Include an Ethernet port for remote monitoring of an alarm condition.
 - 3. Adjustable temperature setting to control the A/C unit. Cathode room temperature shall be the controlling point.
 - 4. To include alarm indicator lights for
 - a. Room Temperature
 - b. Room Humidity

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- a. Room pressure
- b. A/C unit failure, condenser unit
- c. A/C unit failure, main air handler
- d. FFU failure
2. To include readouts for
 - a. Room Temperature(Cathode room)
 - b. Room Humidity(Cathode room)
 - c. Room differential pressure as referenced to external reference pressure for each room)

14.2 DRAWINGS

- A. The following drawings are included as part of this specification. The successful bidder will be forwarded electronic copies upon request in AutoCAD 2009 version format.
 1. Drawing Number 100027-001-A1-BC2 – Hall D FDC Project – Blue Crab Warehouse Layout
 2. Drawing Number 100027-001-A2-BC2 – Hall D FDC Project – Blue Crab Clean room Layout

14.3 SUBMITTALS

- A. Provide calculations showing how clean room was designed regarding airflow, pressures, cooling/dehumidification, humidification
- B. Provide seismic calculations verifying room meets or exceeds City of Newport News requirements.
- C. Product Data: Provide manufacturer’s technical literature for each component (i.e. clean room A/C unit, clean room control panel, clean room FFU, etc.) of the clean room. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, field connection points and installation and startup instructions.
- D. Shop Drawings: Detail assemblies and indicate dimensions, weights, loads, required clearances for maintenance, method of field assembly, components, and location and size of each field connection. NOTE: Size of each field assembled component is required as the warehouse will be occupied BEFORE clean room is assembled and a “rigging” path to allow sufficient room to move the clean room pieces will be established ahead of delivery.
 1. Schematic flow diagrams showing controller, meters, ETHERNET details, etc.
 2. Power, signal, and control wiring diagrams. Differentiate between clean room contractor installed and subcontractor-installed devices and wiring.
 3. Fire Sprinkler system layout and field connection point.
 4. Details of monitoring and control panel including controls, instruments, and labeling.
 5. Written description of sequence of monitoring and operation.
 6. Written description of start-up/commissioning including test and balance and clean room certification.

SECTION 132115 – MODULAR CLEANROOM

- E. Provide MSDS sheets for all proposed materials that will be used for construction, field installation and cleaning
- F. Proposed clean room protocol procedures during construction and start-up/commissioning.
- G. Operation and maintenance data shall include the following items:
 - 1. Maintenance instructions and list of spare parts for each type of device
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices
 - 3. Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances. Include recommended clean room protocols.
 - 4. Calibration records
 - 5. Revise shop drawings to reflect actual installation.
 - 6. Licenses, guarantee, and warranty documents for all equipment and systems

14.4 INSTALLATION

- A. Provide all services, materials, tools, equipment, and labor necessary to erect the clean room in the owner’s warehouse space.
- B. The existing warehouse has only two (2) 15 amp 115 VAC duplex outlets located in the Northeast corner. If additional power is required, the installation contractor shall provide the necessary power generation equipment. Equipment **MUST** be located outdoors during operation. Owner reserves the right to inspect the equipment **PRIOR** to use for conditions that pose a safety/environmental risk. Equipment rejected shall be either repaired or replaced depending upon the nature of the rejection and re-inspected by the Owner for approval. Equipment shall **NOT** be operated until it has been approved for use by the Owner.
- C. If a Fork Truck is required, contractor shall furnish it. Fork truck furnished must be either electric (preferred) or propane powered. Diesel and gasoline are **PROHIBITED**. Fork truck **MUST** be inspected by JLAB equipment inspection personnel **BEFORE** it is placed into operation. Contractor shall coordinate this inspection with the JLAB SOTR.
- D. All pre-installation “staging” space required by the contractor shall be submitted in the bid.
- E. Any additional service/space requirements necessary to erect, start-up and commission the clean room shall be submitted in the bid.

14.5 QUALITY ASSURANCE

- A. Comply with the City of Newport News Building including securing all necessary permits.
- B. Comply with ASHRAE 62.1 "Ventilation for Acceptable Indoor Air Quality”

SECTION 132115 – MODULAR CLEANROOM

14.6 WARRANTY

- A. Provide for a period of one (1) year after JSA system acceptance. All preventative maintenance will be done by others.

14.7 MANUFACTURER’S

- A. The following is a list of acceptable manufacturer’s of modular clean rooms:
 1. Terra-Universal, Fullerton, CA
 2. Servicor Clean rooms, San Carlos, CA
 3. Liberty Industries, East Berlin, CA.
 4. Advance TEC, Richmond, VA
 5. Clean Air Technology, Canton, MI

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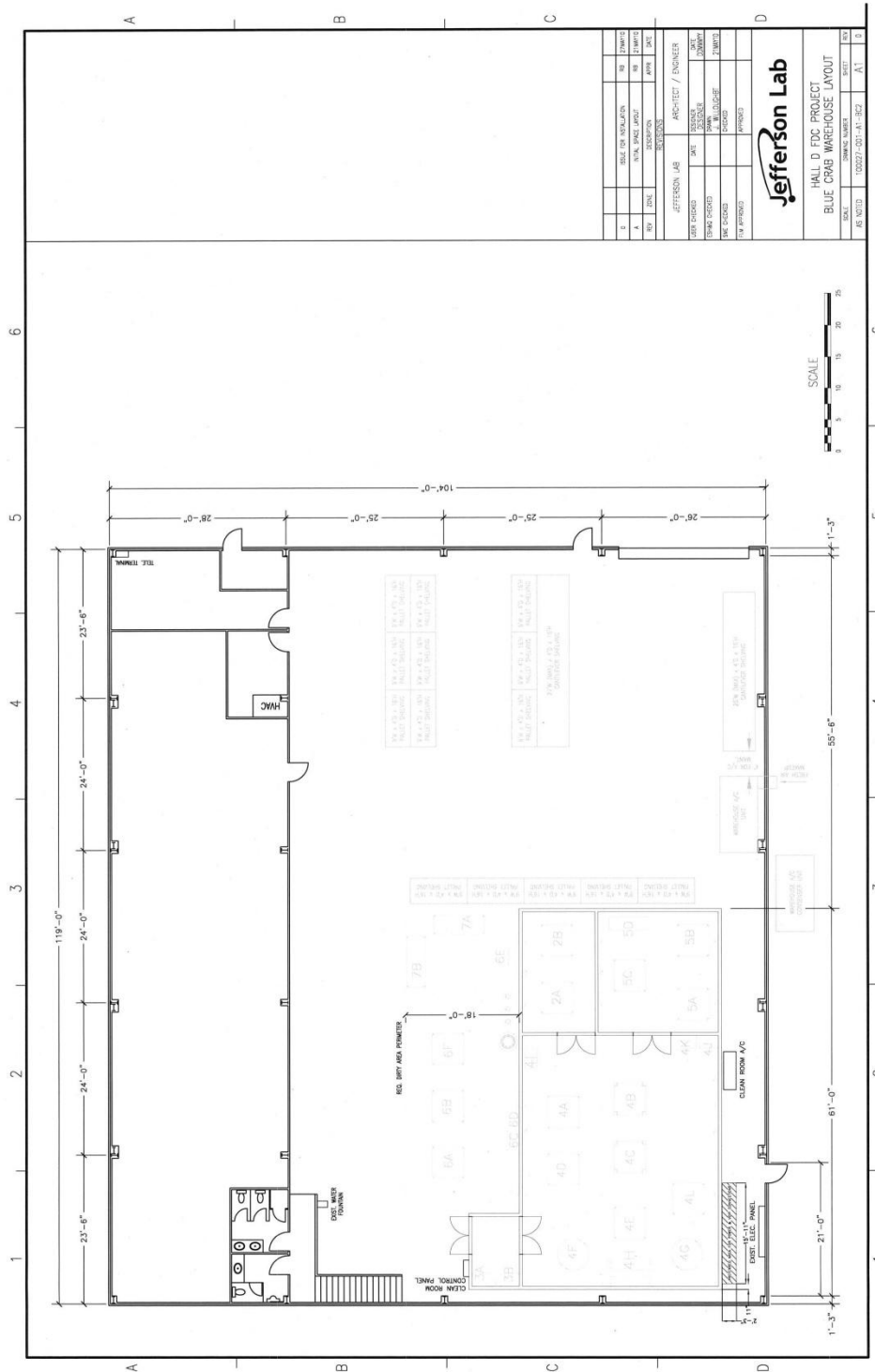
SECTION 132115 – MODULAR CLEANROOM

14.8 DRAWINGS

Hall D FDC Project – Blue Crab Road warehouse - Clean room

SECTION 132115 – MODULAR CLEANROOM

Drawing Number 100027-001-A1-BC2 – Hall D FDC Project – Blue Crab Warehouse Layout



14.9 Warehouse

- A. Clean room will be installed *in the area shown in red* in an existing warehouse as shown in the photos below:

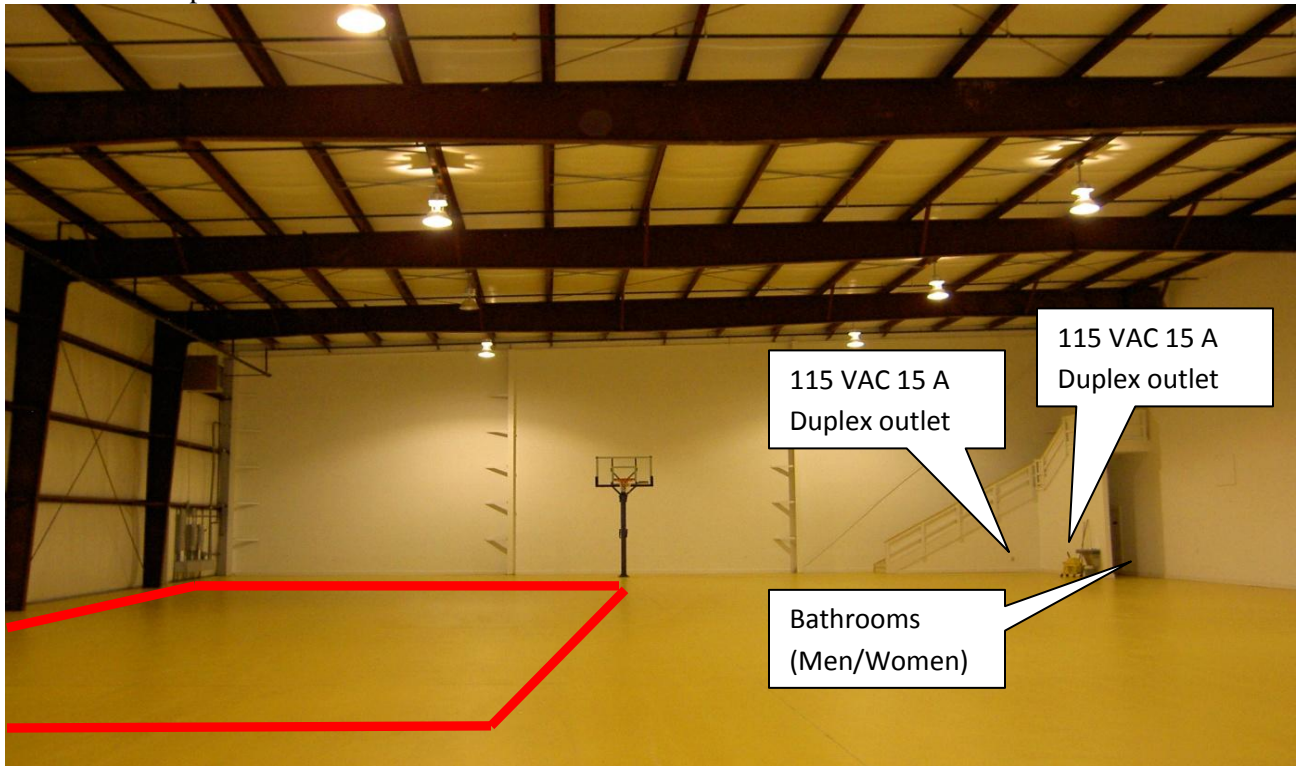


PHOTO TAKEN FROM SOUTH WALL LOOKING NORTH

SECTION 132115 – MODULAR CLEANROOM



PHOTO TAKEN FROM NORTH WALL LOOKING SOUTH

SECTION 132115 – MODULAR CLEANROOM



PHOTO TAKEN FROM NORTHEAST CORNER LOOKING SOUTHWEST

SECTION 132115 – MODULAR CLEANROOM



PHOTO TAKEN FROM NORTHEAST CORNER LOOKING WEST

SECTION 132115 – MODULAR CLEANROOM



PHOTO TAKEN OUTSIDE WEST WALL LOOKING SOUTH

END OF SECTION 132115

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 15 - GENERAL

15.1 SUMMARY

- A. Section includes split-system air-conditioning consisting of separate evaporator-fan and compressor-condenser components.

15.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

15.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

15.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

15.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

15.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units which fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: 10 year(s) from date of Substantial Completion.
 - b. For Parts: 5 year(s) from date of Substantial Completion.
 - c. For Labor: 1 year from date of Substantial Completion.

PART 16 - PRODUCTS

16.1 INDOOR UNITS (5 TONS (18 kW) OR LESS)

- A. Concealed Evaporator-Fan Components:
 - 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 2. Insulation: Faced, glass-fiber duct liner.
 - 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
 - 4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for over current protection.
 - 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 - 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 - 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 8. Filters: Minimum Arrestance: As required to maintain desired clean room conditions.
 - 1) Permanent cleanable type
 - 2) Initial Resistance: 0 inches wg.
 - 3) Recommended Final Resistance: 1 inch wg.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

- 4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles
 - b. Extended-Surface, Disposable Panel Filters
 - 1) Initial Resistance: 0 inches wg.
 - 2) Recommended Final Resistance: 0.5 inches wg.
 - 3) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
9. Condensate Drain Pans:
- a. Fabricated with 1 percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Depth: A minimum of 2” deep.
 - b. Single-wall galvanized steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: 1” NPT.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for over current protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - f. Mount unit-mounted disconnect switches on exterior of unit.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

- a. Fabricated with 1 percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Depth: A minimum of 2” deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: 1” NPT.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
8. Filters: Minimum Arrestance: As required to maintain desired clean room conditions.
- 1) Permanent cleanable type
 - 2) Initial Resistance: 0 inches wag.
 - 3) Recommended Final Resistance: 1 inch wag.
 - 4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles
- b. Extended-Surface, Disposable Panel Filters
 - 1) Initial Resistance: 0 inches wag.
 - 2) Recommended Final Resistance: 0.5 inches wag.
 - 3) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

16.2 OUTDOOR UNITS (5 TONS (18 kW) OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Owner with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: Non CFC’s or HCFC’s
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub cooler. Comply with ARI 210/240.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

16.3 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."
- B. Temperature sensor: Low voltage with sub base to control compressor and evaporator fan. Temperature sensor to be mounted in the Cathode room

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Additional Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable-frequency-drive operation.
 - 3. Monitor economizer cycle.
 - 4. Monitor cooling load.
 - 5. Monitor air distribution static pressure and ventilation air volumes.

16.4 CHARACTERISTICS

- 1. Electric Heating Coil:
 - a. Volts: 208
 - b. Phase: three.
 - c. Hertz: 60.
- B. Indoor Unit:
 - 1. Fan Motor Electrical Characteristics:
 - a. Volts: 208
 - b. Phase: three.
 - c. Hertz: 60.
- C. Outdoor Unit:
 - 1. Type: Air Cooled
 - 2. Electrical Characteristics:
 - a. Volts: 208
 - b. Phase: three.
 - c. Hertz: 60.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 17 - EXECUTION

17.1 INSTALLATION

- A. Install unit's level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

17.2 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- B. Duct Connections Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors.

17.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

17.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 18 - GENERAL

18.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

18.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 19 - PRODUCTS

19.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

19.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

19.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- D. Rotor: Random-wound, squirrel cage.
 - E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 - F. Temperature Rise: Match insulation rating.
 - G. Insulation: Class F
 - H. Code Letter Designation:
 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

19.4 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 1. Permanent-split capacitor.
 2. Split phase.
 3. Capacitor start, inductor run.
 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 20 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 21 - GENERAL

21.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

21.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

21.3 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified TAB reports.

21.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB. Qualified firm shall specialize in air systems testing and balancing and be in current and active status in good standing with NEBB. Firms proposed shall have been in business a minimum of 5 years specializing in air system measurement, adjustment, and balancing work, and must have successfully completed a minimum of five similar projects during this time A list shall be provided in the Bid documents showing projects similar to this project in size, complexity, and system types that the firm has completed. This list shall included the project name, description of air systems, range of services provided, the name and phone number of the design consultant and owner who were responsible for final acceptance of the certifying service, and the TABC's project manager and field engineer.
 1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB and. shall hold a management position within the firm having a minimum of 5 years of combined education and experience adjusting and balancing air systems as a field engineer
 2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB as a TAB technician and shall have completed previous training in air system operations and

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balancing procedures, shall have a thorough demonstrable knowledge of test procedures and equipment, shall have worked in this capacity on at least one other similar project, and shall only perform field work under direct supervision of the field engineer.

- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing." PRODUCTS (Not Applicable)

PART 22 - EXECUTION

22.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design."
Compare results with the design data and installed conditions.

- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine operating safety interlocks and controls on HVAC equipment.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

22.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

22.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

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- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

22.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.

22.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:

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- a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, sub main ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of sub main and branch ducts.
 - a. Where sufficient space in sub main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each sub main and branch duct after all have been adjusted. Continue to adjust sub main and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

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- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

22.6 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

22.7 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 3. Airflow.
 - 4. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

22.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

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1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent
2. Air Outlets and Inlets: Plus or minus 10 percent.

22.9 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

22.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.

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- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Contractor's name and address.
 6. Report date.
 7. Signature of TAB supervisor who certifies the report.
 8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 9. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.

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- c. Description of system operation sequence if it varies from the Contract Documents.
10. Nomenclature sheets for each item of equipment.
11. Notes to explain why certain final data in the body of reports vary from indicated values.
12. Test conditions for fan performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
 1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Balancing stations.
 4. Position of balancing devices.

END OF SECTION 230593

SECTION 230594 – CLEAN ROOM CERTIFICATION

PART 23 - GENERAL

23.1 SUMMARY

- A. This section provides services required by a clean room testing and certification agency, hereinafter referenced as the clean room certification contractor (CCC), to measure and record the conditions prevailing at the completion of clean room construction in the as built and operating condition

23.2 DEFINITIONS

- A. CCC: Clean room Certification Contractor
- B. AABC: Associated Air Balance Council.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TAB Specialist: An entity engaged to perform TAB Work.

23.3 ACTION SUBMITTALS

- A. Provide the following information with the Bid:
 - 1. Qualifications of the CCC:
 - a. Include a short chronicle of the history, staff size, ownership, and milestones in the firm's development.
 - b. Provide a list of project names, description of clean rooms, range of certification services, and the name and phone number of the design consultant or Owner responsible for final inspection and acceptance of the certification service.
 - 2. Qualifications of field technicians, the field engineer, and the Project Manager proposed for this project.
 - a. Include name, assignment, expected duties, work experience, and advanced training.
 - b. Provide a list of projects managed by the Project Manager similar in size and scope to this project.
 - c. Provide documentation that the CCC's key staff is in current active status with IES and NEBB.
 - 3. Written method statement outlining the testing and certification procedures and the specific sequence to be performed for the entire final acceptance and benchmark performance tests on this project. Indicate test procedures

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planned for particle counting, whether statistical sample or sequential sample counting.

4. A sample test report of a similar project for inspection by the Engineer only to verify the CCC's expertise collecting, interpreting, and recording data.
5. Description of all instrumentation and test equipment to be used, complete with model and serial numbers and calibration records (include procedure, source of the standard, last three calibration dates, recommended interval, and curves).
6. Samples of all field reports, charts, and forms proposed to document measured field conditions.
7. A cost proposal to produce a computerized statistical analysis of all field tests, delivered on floppy disks compatible with the Owner's management information system. This analysis shall include averages, standard deviation, ranges, and distribution curves that will permit database trend analysis. Owner is prepared to provide licensed software to develop the database.

23.4 INFORMATIONAL SUBMITTALS

- A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit strategies and step-by-step procedures as specified in "Preparation" Article.
- B. Certified reports.
 1. The final as built and operating certification report shall include a statement that all certification work was performed in accordance with the Contract Documents
 2. The final completed as built and operating certification report shall include the following documentation at a minimum:
 - a. Typed or computerized field reports, charts, and forms complete with all measured data referenced to sample location.
 - b. Written description of operating condition of all clean areas.
 - c. Reduced set of architectural floor plan drawings, maximum size 11 by 17 inches, made from the project AutoCAD Contract Documents, obtained on floppy disks from the Engineer (after review and clearance by Owner), showing all test and sample locations referred to on other field data sheets, as well as test results of all final field conditions.
 - d. Separate section in the report outlining any operating or contamination problems remaining at the end of the testing and certifying procedures. Describe the condition and its effect on clean room performance.
 - e. A list of all instrumentation and test equipment actually used in the certifying process, including manufacturer, model and serial numbers, and last calibration date.
 - f. Written description of all tests performed, including the purpose, instrumentation, procedure, results, and analysis of the data. All data shall be properly presented and graphically displayed to permit full understanding of all tests. Include the date tests were taken and the names of field technicians performing the tests.
 - g. One hard-bound copy and one loose, unbound reproducible copy of the completed certification report, submitted for Owner's review and acceptance.

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- h. The entire certification report including all charts, drawings, tables, and graphs, assembled and stored on floppy computer disks. Drawing files shall be in DXF format, and word files shall be in MS Word 2007 format.

23.5 QUALITY ASSURANCE

- A. All clean room air systems shall be tested and certified by a qualified firm specializing in clean room certification. The CCC and key staff shall be in current and active status in good standing with the Institute of Environmental Sciences (IES), and shall be National Environmental Balancing Bureau (NEBB) certified.
 - 1. Firms proposing on this service shall have been in business a minimum of 5 years, specializing in clean room testing and certification work and it must have successfully completed a minimum of five similar projects during this time.
 - a. Field Supervisor shall have a minimum of 2 years of experience testing and certifying clean rooms as a field engineer or field technician. He shall supervise all field technicians assigned to complete the testing and certifying of the work, shall have a basic knowledge of clean room systems and adjustments, and shall be responsible for all onsite testing and data acquisition. No field tests shall be taken without the field engineer's jobsite
 - b. TAB Technician shall have completed previous training in clean room operations and certifying procedures, shall have a thorough, demonstrable knowledge of test procedures and equipment, shall have worked in this capacity on at least one other similar project, and shall only perform field work under direct supervision of the field supervisor.
- B. All measurement and test equipment used for field readings shall be the most current generation. All sampling shall be based upon accepted industry sampling and statistical procedures
- C. Equipment shall be calibrated in accordance with manufacturer's requirements at the beginning of certification work and be traceable by serial number to the National Institute for Standards and Technology (NIST) within the previous 6 months. Any test equipment with an upcoming recalibration due date that falls within this project work schedule shall be recalibrated before any tests are performed with the instrument
- D. All filter challenges shall be accomplished with polystyrene latex (PSL) spheres only.
- E. Particle counters for installed ceiling filter media leakage tests as well as airborne particle count test shall be optical laser particle counter.
- F. The reference standards for all field tests and project record documents shall be the IES RP-CC-006, Testing Clean rooms, and NEBB Procedural Standards for Certified Testing of Clean rooms

SECTION 230594 – CLEAN ROOM CERTIFICATION

PART 24 - EXECUTION

24.1 CERTIFICATION AND FIELD TESTS

A. Installed Ceiling HEPA/ULPA Filter Leakage Test

1. Purpose of Test:
 - a. Determine integrity of ceiling HEPA/ULPA filter modules after installation in the ceiling grid.
 - b. Determine leakage through any component in the ceiling assembly.
 - c. Locate all leaks created by ceiling defects.
2. Test Procedure
 - a. Test the entire ceiling assembly
 - b. Provide optical laser particle counters, PSL aerosol generator, and accessories.
 - c. Introduce polystyrene latex PSL spheres from the generator into the inlet of the recirculation air blower or into the test port of each individual ducted filter. An average challenge of 100,000 particles per cubic foot sized 0.2 to 0.3 micron is required at the filter
 - d. Measure and record the upstream challenge at the filter at least once every hour. Measure upstream filter challenge at two test ports in each packaged ceiling plenum module.
 - e. Scan the entire downstream filter face area isokinetically in overlapping strokes, moving the probe at 2 inches per second or 1 square fpm at a distance 1 inch below the filter face. Scan the entire perimeter and all corners. Automatic filter scanning equipment will not be acceptable.
 - f. Scan all joints in the ceiling assembly, including the gap between the ceiling grid and filter module, wall-to-ceiling joint, sprinkler pipe and electrical conduit penetrations, and blank panel edge seals.
 - g. Extend test time under any portion of the filter showing a single leak by sampling directly under the leak. A reading of 150 counts in a 10-second time span constitutes a significant leak requiring repair.
3. Acceptance Procedure
 - a. Reject all filter modules with direct leaks detected at the perimeter frame, center divider, center test ports, or within the media pack.
 - b. Reject any filter module when aerosol penetration exceeds 0.1 percent of the upstream challenge concentration.
 - c. Retest all repaired filter modules.

B. Airborne Particle Count Test

1. Purpose of Test: Determine particle count levels on reference particle size to ensure systems operate within design criteria
2. Test Procedure:
 - a. Measure and record the airborne particle counts throughout.
 - b. Complete the installed ceiling HEPA/ULPA filter leakage test, parallelism test, pressurization test, air velocity uniformity test, and the enclosure induction leak test before starting airborne particle count sampling.

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- c. Measure and record the particle count at a distance 42 inches above the floor in the center of each 8 feet by 8 feet test grid, allowing ample time span and sample volume as stated in Federal Standard 209E, paragraph 5.1.3.4.
 - d. Retest all test stations or grids that require corrective modifications in order to achieve design criteria
3. Acceptance Procedure:
- a. Secure airborne particle counts in accordance with the table below:

Class		Class Limits									
		Size 0.02 µm		Size 0.1 µm		Size 0.2 µm		Size 0.3 µm		Size 0.5 µm	
		Volume		Volume		Volume		Volume		Volume	
SI		m ³	ft ³	m ³	ft ³	m ³	ft ³	m ³	ft ³	m ³	ft ³
M5.5	(10,000)			--	--	--	--	--	--	353,000	10,000

- b. Compute the following data to establish compliance with these acceptance criteria for each room classification
 - 1) The average of particle concentrations measured at each location falls at or below the values listed in the table.
 - 2) If sample size is less than ten readings per test area, calculate 95 percent upper confidence limit, and this value shall fall below the specified area class limits
 - 3) If sequential sampling is used, sample techniques shall follow Appendix F of Federal Standard 209E criteria
- c. Complete the installed ceiling HEPA/ULPA filter leakage test, parallelism test, pressurization test, air velocity uniformity test, and the enclosure induction leak test before starting airborne particle count sampling.
- d. Measure and record the particle count at a distance 42 inches above the floor in the center of each 8 feet by 8 feet test grid, allowing ample time span and sample volume as stated in Federal Standard 209E, paragraph 5.1.3.4.
- e. Retest all test stations or grids that require corrective modifications in order to achieve design criteria

C. Pressurization Test

- 1. Purpose of Test
 - a. Confirm capability of clean room air handling systems to maintain cascaded air pressure regime within the Clean Zone.
 - b. Verify performance of pressure controls as doors are activated
- 2. Test Procedure
 - a. Measure and record the relative pressurization for every area in the clean room relative to the warehouse reference pressure.

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- b. Measure and record the relative positive pressure between each clean aisle/clean room and the adjacent area when just one of the doors to the clean room is open.
- c. Measure and record the relative positive pressure sequentially from the area with the highest cleanliness requirement outward through contiguous spaces to the warehouse area.
- 3. Acceptance Procedure
 - a. Achieve continuous positive pressure regime from the clean room to adjacent areas in compliance with design criteria when all doors are in the normally closed position.
 - b. Maintain positive pressure from the clean aisle/clean room to adjacent areas of higher contamination with one door open

D. Environmental Uniformity/Stability/Recovery Test

- 1. Purpose of Test
 - a. Confirm the capability of the facility support systems to control temperature and absolute humidity to meet the project criteria
 - b. Verify uniformity of environmental conditions throughout contiguous areas of the Clean Zone
 - c. Confirm stability of environmental conditions at control sensing points.
 - d. Determine ability of facility support systems to recover to design environmental conditions after an internal thermal upset.
 - e. Demonstrate ability of the clean room air handling and control systems to achieve a continuous 7-day environmental profile in conformance with project design criteria.
- 2. Test Procedure
 - a. Measure and record the temperature and absolute dew point uniformity/stability. Environmental tests can be set up and run concurrent with other tests where results are not jeopardized. All support systems shall have been in normal automatic operation.
 - b. Place test probes uniformly around the space, with at least one-fourth of the probe sites adjacent to sample points of the facility monitoring/control system.
 - c. Measure and record temperature and absolute dew point readings. Samples from all probe sites shall be recorded simultaneously to verify uniformity. Time span for test intervals and overall duration of documentation shall be:

Cleanliness Class	Recording Interval	Recording Duration
M5.5	6 minutes	6 hours

- d. Adjust temperature and humidity control set points in the same critical clean aisle/test sector to place the space environmental conditions beyond required criteria. From the operating set point, the temperature shall be adjusted upward by 3 degrees F and the relative humidity upward by 3 percent. The CCC is authorized to use a portable heater and humidifier which can be energized to create internal upset conditions in lieu of adjusting control settings. Repeat the point data recording on a continuous basis for 2-hour duration during adjustment period.

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- e. Readjust temperature control set point only back to desired operating condition. Repeat the point data recording on a continuous basis for 2-hour duration.
 - f. Readjust humidity control set point only back to desired operating condition. Repeat the point data recording on a continuous basis for 2-hour duration.
 3. Acceptance Criteria
 - a. Achieve temperature uniformity throughout contiguous areas of the clean room within plus or minus 2 degree F of the mean temperature value from all readings.
 - b. Achieve absolute humidity uniformity throughout contiguous areas of the clean room within plus or minus 2 percent of the mean humidity value from all readings.
 - c. Verify recovery time is less than 15 minutes for both temperature and relative humidity to return to normal control set points after an internal upset of both conditions equal to 3 percent of set point.
- E. Lighting Level Test
1. Purpose of Test
 - a. Determine the lighting intensity levels provided by the normal lighting system.
 - b. Determine the lighting intensity levels provided by the emergency lighting system.
 2. Test Procedure \
 - a. Measure and record the white-light lighting levels.
 - b. Measure lighting intensity at 42 inches above the finish floor on a nominal 10- by 10-foot grid
 3. Acceptance Criteria
 - a. Achieve foot-candle values within plus or minus 20 percent of those indicated in design criteria
 - b. Verify uniformity of illumination.

24.2 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into the following separate sections.
 1. Installed Ceiling HEPA/ULPA Filter Leakage Test
 2. Airborne Particle Count Test
 3. Pressurization Test
 4. Environmental Uniformity/Stability/Recovery Test
 5. Lighting Level Test
- B. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing engineer
 1. Include a list of instruments used for procedures, along with proof of calibration

END OF SECTION 230594

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 25 - GENERAL

25.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

25.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

25.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

25.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 26 - PRODUCTS

26.1 CONDUCTORS AND CABLES

- A. Aluminum and Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN,-THWN, XHHW UF, USE and SO.
- C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type ACmetal-clad cable, Type MC mineral-insulated, metal-sheathed cable, Type MI nonmetallic-sheathed cable, Type NM Type SO and Type USE with ground wire.

26.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Hubbell Power Systems, Inc.
 3. O-Z/Gedney; EGS Electrical Group LLC.
 4. 3M; Electrical Products Division.
 5. Tyco Electronics Corp.>
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 27 - EXECUTION

27.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Provide no more than four (4) duplex outlets per breaker.

27.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN-THWN, single conductors in raceway; Armored cable, Type AC; Metal-clad cable, Type MC; Mineral-insulated, metal-sheathed cable, Type MI; Nonmetallic-sheathed cable, Type NM.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway; Armored cable, Type AC; Metal-clad cable, Type MC; Mineral-insulated, metal-sheathed cable, Type MI; Nonmetallic-sheathed cable, Type NM.
- C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway; Armored cable, Type AC; Metal-clad cable, Type MC; Mineral-insulated, metal-sheathed cable, Type MI; Nonmetallic-sheathed cable, Type NM
- D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.
- E. Class 1 Control Circuits: Type THHN-THWN, in raceway.

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- F. Class 2 Control Circuits: Type THHN-THWN, in raceway Power-limited cable, concealed in building finishes Power-limited tray cable, in cable tray.

27.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

27.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

27.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Test Reports: Prepare a written report to record the following:

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 28 - GENERAL

28.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

28.2 PERFORMANCE REQUIREMENTS

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

28.3 ACTION SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings. Show fabrication and installation details and include calculations for the following:
1. Trapeze hangers. Include Product Data for components.
 2. Steel slotted channel systems. Include Product Data for components.
 3. Equipment supports.

28.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

28.5 QUALITY ASSURANCE

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

PART 29 - PRODUCTS

29.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 6. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 2. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 3. Toggle Bolts: All-steel springhead type.
 - 4. Hanger Rods: Threaded steel.

29.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 30 - EXECUTION

30.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacing's less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps single-bolt conduit clamps single-bolt conduit clamps using spring friction action for retention in support channel.

30.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

- B. Raceway Support Methods: In addition to methods described in NECA 1, [EMT] [IMC] [RMC] [EMT, IMC, and RMC] may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Steel: [Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts] [Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69] [Spring-tension clamps].
 - 2. To Light Steel: Sheet metal screws.
 - 3. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate[by means that meet seismic-restraint strength and anchorage requirements].

30.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

30.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 31 - GENERAL

31.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

31.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

31.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 32 - PRODUCTS

32.1 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil or 14 strands of No. 17 AWG conductor or **1/4 inch (6 mm)** in diameter copper.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; **1-5/8 inches (41 mm)** wide and **1/16 inch (1.6 mm)** thick.

32.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 33 - EXECUTION

33.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

33.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters,

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a **1/4-by-4-by-12-inch (6.3-by-100-by-300-mm)** grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- D. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install **[tinned] bonding** jumper to bond across flexible duct connections to achieve continuity.

33.3 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer **[and** at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

33.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:

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1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, See
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panel boards Serving Electronic Equipment: 3 ohm(s).
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 34 - GENERAL

34.1 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

34.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

34.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 35 - PRODUCTS

35.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
1. Black letters on an orange field
 2. Legend: Indicate voltage and system or service type.

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- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, **2 inches (50 mm)** long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm) to 0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

35.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; **2 inches (50 mm)** wide; compounded for outdoor use.

35.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

- C. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm) to 0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, **2 inches (50 mm)** long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

35.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than **3 mils (0.08 mm)** thick by **1 to 2 inches (25 to 50 mm)** wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- D. Write-On Tags: Polyester tag, **0.010 inch (0.25 mm) to 0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

35.5 FLOOR MARKING TAPE

- A. **2-inch- (50-mm-)** wide, **5-mil (0.125-mm)** pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

35.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.

- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

35.7 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

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35.8 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be **3/8 inch (10 mm)**. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be **3/8 inch (10 mm)**.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be **1 inch (25 mm)**.

35.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 36 - EXECUTION

36.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.
- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at **50-foot (15-m)** maximum intervals in straight runs, and at **25-foot (7.6-m)** maximum intervals in congested areas.

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- F. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

36.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Install labels at **10-foot (3-m)** maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. Emergency Power.
 - 2. Power.
 - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and hand holes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.
 - a. Color shall be factory applied [**or** field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit].
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of **6 inches (150 mm)** from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
 - E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

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3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

- F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panel boards and similar equipment in finished spaces.

- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels
 1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.

- H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 1. Labeling Instructions:
 - a. Indoor Equipment: Adhesive film label with clear protective overlay Unless otherwise indicated, provide a single line of text with **1/2-inch- (13-mm-)** high letters on **1-1/2-inch- (38-mm-)** high label; where two lines of text are required, use labels **2 inches (50 mm)** high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label Stenciled legend **4 inches (100 mm)** high].
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 265100 - INTERIOR LIGHTING

PART 37 - GENERAL

37.1 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.

37.2 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

37.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

37.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 38 - PRODUCTS

38.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.

SECTION 265100 - INTERIOR LIGHTING

- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least [**0.125 inch (3.175 mm)**] minimum unless otherwise indicated.
 - b. UV stabilized.

38.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Comply with UL 935 and with ANSI C82.11.
 - 2. Designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
 - 4. Sound Rating: [Class A] [Class A except Class B for T12/HO and T12/Slim line lamp ballasts].
 - 5. Total Harmonic Distortion Rating: Less than 20 percent.
 - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 7. Operating Frequency: 42 kHz or higher.
 - 8. Lamp Current Crest Factor: 1.7 or less.
 - 9. BF: 0.88 or higher.
 - 10. Power Factor: 0.95 or higher.
- B. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.
 - 1. Ballast Manufacturer Certification: Indicated by label.
- C. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

SECTION 265100 - INTERIOR LIGHTING

38.3 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - 1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Nightlight Connection: Operate one fluorescent lamp continuously.
 - 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

38.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
 - 2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 - 3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

SECTION 265100 - INTERIOR LIGHTING

38.5 EMERGENCY LIGHTING UNITS

- A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.
1. Battery: Sealed, maintenance-free, lead-acid type.
 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

38.6 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.
- B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

38.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, [12 gage (2.68 mm)]
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

SECTION 265100 - INTERIOR LIGHTING

- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 39 - EXECUTION

39.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

39.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 40 - GENERAL

40.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

40.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

40.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and** the unit will be fully operational after the seismic event."

40.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

40.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- B. Field quality-control reports.

40.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

40.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 41 - PRODUCTS

41.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, Retain option in first paragraph below if manufacturer's name and model number are indicated in schedules or plans on Drawings; delete option and insert manufacturer's name and model number if not included on Drawings.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings <Insert manufacturer's name; product name or designation> or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- C. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Single Throw, [240] [600]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [specified] [indicated] fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Six Pole, Single Throw, 208 -V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

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- F. Type HD, Heavy Duty, Double Throw, **208** V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- G. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

41.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements,
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- C. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Single Throw, 208 -V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Six Pole, Single Throw, 208V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Type HD, Heavy Duty, Double Throw, 208V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- G. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

41.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, Basis-of-Design Product: Subject to compliance with requirements, provide product or comparable product by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

41.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.

PART 42 - EXECUTION

42.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

42.2 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

42.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION 262816

SECTION 262416 - PANELBOARDS

PART 43 - GENERAL

43.1 SUMMARY

- A. Section includes distribution panel boards and lighting and appliance branch-circuit panel boards.

43.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panel boards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

43.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panel board and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panel boards and over current protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual over current protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of over current protective device included in panel boards.

43.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: Submit certification that panel boards, over current protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Field quality-control reports.
- C. Panel board schedules for installation in panel boards.

SECTION 262416 - PANELBOARDS

43.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

43.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

43.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 44 - PRODUCTS

44.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panel boards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Directory Card: Inside panel board door, mounted in transparent card holder.
- C. Incoming Mains Location: Top
- D. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.

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3. Ground Lugs and Bus Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Sub feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panel boards with one or more main service disconnecting and over current protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panel board Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream over current protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.
- I. Panel board Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

44.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 3. [Siemens Energy & Automation, Inc.](#)
- B. Panel boards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Over current Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Over current Protective Devices: For Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Over current Protective Devices: Fused switches.

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44.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 3. [Siemens Energy & Automation, Inc.](#)
- B. Panel boards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Over current Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Column-Type Panel boards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

44.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. [Eaton Electrical Inc.; Cutler-Hammer Business Unit.](#)
 2. [General Electric Company; GE Consumer & Industrial - Electrical Distribution.](#)
 3. [Siemens Energy & Automation, Inc.](#)
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.

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4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handles in off position.
 - e. Handle Clamp: Loose attachment, for holding circuit-breaker handles in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."

44.5 ACCESSORY COMPONENTS AND FEATURES

- A. Portable Test Set: For testing functions of solid-state trip devices without removing from panel board. Include relay and meter test plugs suitable for testing panel board meters and switchboard class relays.

PART 45 - EXECUTION

45.1 INSTALLATION

- A. Receive, inspect, handle, store and install panel boards and accessories according to NECA 407.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of trim [**90 inches (2286 mm)**] above finished floor unless otherwise indicated.
- D. Mount panel board cabinet plumb and rigid without distortion of box. Mount recessed panel boards with fronts uniformly flush with wall finish and mating with back box.

SECTION 262416 - PANELBOARDS

- E. Install over current protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four **1-inch (27-GRC)** empty conduits from panel board into accessible ceiling space or space designated to be ceiling space in the future. Stub four **1-inch (27-GRC)** empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

45.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panel board Nameplates: Label each panel board with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panel boards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

45.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panel board bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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- D. Panel boards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panel boards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION 262416