

Specifications for

***Replacement of an Existing CRAC Unit  
and Relocation of CRAC Unit in Lab C,  
Data Center  
Building 515***

June 2012



Brookhaven National Laboratory  
Brookhaven Science Associates  
Facilities & Operations Directorate  
Modernization Project Office  
Upton, NY 11973

**BROOKHAVEN**  
NATIONAL LABORATORY

ESH&Q Risk Level Low (A3-Minor)  
Project Coordinator: Lizardos Engineering Associates, P.C.  
Supervisor: D. Sievers

Specification: 12780  
Project: 01337  
Activity: 01337



## **STATEMENT OF WORK**

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In general, work consists of, but is not limited to, providing all labor, materials, and equipment as shown on drawings and detailed in this specification to upgrade the computer room air conditioning units in Laboratories A, B and C in Bldg. 515.

The sequence in which work is to be performed:

1. Reconfigure the Fire Detection HSSD system, Fire Suppression Inergen system, and Security components.
2. Remove wall between Laboratories A and B & C, indicated doorways, and all associated work on Drawing 12780-A1.
3. Upgrade computer room air conditioning units in Laboratories A, B and C.

### Mechanical Work

1. Relocation of existing air conditioning unit ACU/008 serving data center Laboratory B, along with associated chilled water piping, heating hot water piping, electrical (refer to Electrical Drawings) and controls.
2. Demolition and removal of existing air conditioning unit AC/5 serving data center Laboratory C, associated drycooler and pump package, glycol piping, drain and cold water piping, electrical (refer to Electrical Drawings) and controls.
3. Furnish and install new chilled and heating hot water piping connections from/to relocated air conditioning unit ACU/008. Contractor shall connect new piping to existing under raised floor.
4. Install new BNL furnished downflow Liebert unit, drycooler, pump package to dunnage on roof as indicated on the Drawings and Schedules (see 12780-M3, 12780-S1). Furnish and install new glycol piping from/to existing drycooler/pump package, 40% propylene glycol charge, associated cold water and drain piping from/to unit as indicated on Drawings.
5. Balancing, startup and testing of all systems.

### Electrical Work

Scope of physical work located in Building 515, Network Labs Data Center for modification of Electrical Distribution System itemized below:

1. Demolition Work is as follows. Electrical Contractor shall provide services & equipment to perform demolition on the following equipment & systems, which includes disposal & removal of waste materials,
2. Relocate the electrical fire alarm, Inergen and security components from the Lab C to Lab A doorway to new double doorway,
3. Demolition fire alarm, Inergen and security components on existing wall at blocked doorway in Lab C,
4. Demolition Power, Control & Data Wiring on existing Liebert DX Unit (515-AC-5) located in Lab-C and terminate all power wiring for reuse,
5. Demolition Power, Control & Data Wiring on existing Liebert CHW unit (515F1-ACU-008) in Lab-C and terminate all power wiring for reuse,
6. Demolition Power & Control Wiring on existing Roof-Top Dry Cooler and terminate all power wiring for reuse,

7. Demolition and remove Power, Control & Data wiring on existing Outdoor Dry Cooler, Ground Level and dispose of all Power, Control & Data wiring,
8. New work is as follows. Electrical Contractor shall provide all wire, cable, conduit, conduit supports, electrical, data & fire alarm terminations, to perform the following work,
9. Relocated Liebert Chilled Water (CHW) unit (515F1-ACU-008) in Network Lab Data Center, including reconnect to existing Power, provide Control & Data wiring, inter-tie w/ ALC Environmental Control Panel, connect Leak Detection Units and coordinate w/ BNL ITD Group to connect data to BNL LAN Network,
10. New Liebert Direct Cooling (DX) Glycol Unit (515-AC-5) in Network Lab Data Center, including reconnect to existing Power, provide Control & Data wiring, inter-tie w/ ALC Environmental Control Panel, connect Leak Detection Units and coordinate w/ BNL ITD Group to connect data to BNL LAN Network,
11. New Liebert Dry Cooler (DC) Unit (515-DC-1) on B515 Roof-Top, including including reconnect to existing Power, provide Control & Data wiring, inter-tie w/ ALC Environmental Control Panel, connect Leak Detection Units and roof penetrations to site of the existing RTU,
12. Fire Alarm & Detection, plus Inergen Gas Suppression System is as follows. Electrical Contractor, w/ Fire Alarm Subcontractor, shall provide the following upgrades, expansions & additions to the existing Fire Alarm & Detection and Inergen Gas Suppression Systems,
  - a. Relocate HSSD sensor pick-ups from existing Lab-A onto the existing fire detection zone for Lab-C,
  - b. Connect Liebert cooling equipment smoke detectors to existing Fire Alarm Control Panel (FACP),
  - c. Provide Liebert cooling equipment shutdown circuits from Fire Alarm Control Panel (FACP), including shutdown relays,
13. Inergen Gas Suppression Systems:
  - a. Expand Main Gas Line from under existing Lab-C into the area under existing Lab-A,
  - b. Provide Gas Line from expanded main and add discharge heads through the ceiling into the former Lab-A area,
14. Commissioning & As-Built activities are as follows. Electrical Contractor shall provide services & field support to Start-up and Commission the following Equipment & Systems:
  - a. Liebert Chilled Water (CHW) unit (515F1-ACU-008) in Network Labs Data Center,
  - b. Liebert Direct Cooling (DX) Glycol Unit (515-AC-5) in Network Labs Data Center,
  - c. Liebert Dry Cooler (DC) Unit (515-DC-1) on B515 Roof-Top,
  - d. Fire Alarm & Detection, plus equipment shutdown circuits,
  - e. Inergen Gas Suppression System,
  - f. ALC Environmental Control System,
15. Electrical Contractor shall provide red-line mark-ups of the as-built systems onto the construction drawings for incorporation into the permanent project documentation records.

Time is of the Essence for this project. See Supplementary Conditions, Clause SC-1.

## ***DRAWING INDEX***

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<b>Number</b>	<b>Title</b>	<b>Date</b>
12780-T1	Title Sheet	06/01/2012
12780-A1	Demo & New Floor Plan, Door Schedules & Details	06/01/2012
12780-S1	General Notes, Part Roof Framing Plan, Sections	06/01/2012
12780-M1	Mechanical Legends, Symbols, Notes and Details	06/01/2012
12780-M2	Demolition and New Work Part Plans	06/01/2012
12780-M3	Equipment Schedules and Flow Diagrams	06/01/2012
12780-E1	Cover Sheet w/ Legends and Schedules	06/01/2012
12780-E2	Data Center & Roof-Top Plans, Demolition & New Work	06/01/2012
12780-E3	DX & CHW Control & Block Wiring Diagrams	06/01/2012
12780-E4	DX & CHW Leak Detection & Environmental Wiring Diagrams	06/01/2012
12780-E5	Data Center Cooling Power, One-Line Diagrams	06/01/2012
12780-FP1	Panel, Wiring Details, Bill of Material, Electrical Notes, Riser Diagram, Battery Calculation	06/01/2012
12780-FP2	Partial Plan View, Mounting Details	06/01/2012
12780-FP3	Isometric Drawing, Flow Calc, Mechanical Details	06/01/2012
12780-FP4	HSSD Details	06/01/2012
12780-FP5	Partial Plan View, Piping Isometric & Details, Sampling Point Drill Chart	06/01/2012



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DIVISION 00 – BIDDING AND CONTRACT REQUIREMENTS  
SECTION 000700 – GENERAL CONDITIONS

GC-1. DEFINITIONS

A. As used in these Specifications, the following have the meaning shown opposite each:

1. BNL – Brookhaven Science Associates, operator of Brookhaven National Laboratory, and its authorized representatives of various Divisions and Departments.
2. FOD – BNL's Facilities & Operations Directorate.
3. MPO – BNL's Modernization Project Office and its authorized representative.
4. BNL Site – Land occupied by Brookhaven National Laboratory, Brookhaven Township, Suffolk County, New York.
5. Site – Immediate area of BNL Site assigned to Contractor for performance of work.
6. Work – Includes but is not limited to all labor, materials, tools, and equipment required and reasonably inferred by Contract to complete all construction.
7. Contractor – Person or entity identified in Lump Sum Contract and responsible for completion of all work.
8. Subcontractor – Person or entity directly contracting with Contractor including one who furnishes material worked to a special design according to Drawings and Specifications, but not including one who merely furnishes materials not so worked.

B. Words such as provide, furnish, install, and include, mean work by Contractor. Words such as approved, directed, and inspected, mean MPO's approval, direction and inspection.

C. In the interest of brevity, words such as "Contractor shall," have been omitted from some sections of the Specifications.

GC-2. SCALE OF DRAWINGS

A. Drawings are generally to scale, but Contractor shall follow indicated dimensions. Request clarification if discrepancies are noted. Scaling of drawings shall be at Contractor's own risk.

GC-3. REFERENCE DRAWINGS

A. Drawings of existing building and site are available for reference at MPO office.

GC-4. MANUFACTURERS' SPECIFICATIONS

- A. Conform to specified manufacturer's published specifications and installation instructions unless otherwise specified or indicated.
- B. Federal agencies, to the extent practicable, are required to amend procurement practices so as to minimize the purchase of products manufactured with ozone depleting substances. The Contractor shall, therefore, provide materials that use low or non-ozone depleting substances during their manufacture and/or installation. Materials that do not comply shall be identified in the contractors submittal for approval.
- C. Federal agencies, to the extent practicable, also are required to amend procurement practices so as to utilize, to the maximum extent, construction materials that have been produced with the use of recovered (recycled) materials. For the purposes of this project, where applicable, technical sections that may include building insulations, blast furnace slag containing cement and concrete, carpet, floor tiles, restroom partitions, signage, patio blocks and traffic barricades have been prepared in compliance with Federal Regulation 40 CFR Part 247.
- D. Should this Project be designed to be a high-performance, sustainable facility to receive LEED certification, the criteria will be designated in a separate specification Section 01352.

GC-5. VOLATILE ORGANIC COMPOUNDS (VOC'S)

- A. Volatile Organic Compounds (VOC's) and their emissions are controlled under the New York Codes, Rules and Regulations of the State of New York. Architectural surface coatings must comply with 6NYCRR Part 205, latest edition. Coating lines must comply with 6NYCRR Part 228, latest edition.
  - 1. For the purpose of the BNL location, Nassau, Suffolk, Westchester and Rockland Counties fall under the compliance rules of the New York City metropolitan area.
  - 2. All coatings and coated products to be used in the work, shall comply with the appropriate rules and regulations.

GC-6. PRICE-ANDERSON ACT

- A. Radiological protection is controlled under the requirements of Title 10, Code of Federal Regulations, Part 835, "Occupational Radiation Protection" (10 CFR Part 835).
- B. The provisions of this CFR apply to any activity carried out pursuant to this contract by the Contractor, its subcontractors, suppliers and employees, that has the potential to result in the exposure of an individual to radiation or radioactive material.
- C. The Contractor shall comply, in full, with all applicable requirements of this CFR and shall implement, document, report on, and maintain the required work documents, as necessary to ensure its full compliance.

GC-7. BIOPREFERRED PROGRAM

- A. Clause FAR 52.223.2 – Affirmative Procurement of Biobased Products Under Service and Construction Contracts applies to the work performed under this Contract. In the performance of this Contract, the Contractor shall make maximum use of biobased products that are United States Department of Agriculture (USDA)-designated items. These items can be found on the USDA Web site <http://www.biopREFERRED.gov/DesignationItemList.aspx>.

GC-8. WORK PERMITS

- A. The work of this Contract is controlled by the requirements of BNL Standards-Based Management System; “Work Planning and Control for Experiments and Operations,” latest edition.
- B. A Work Permit, prepared by BNL and signed by the Contractor, shall be posted or on hand at the project site. By signing the Work Permit, the Contractor indicates that they understand the hazards of the job and the permits required.
- C. A Tool Box Meeting shall be held by the Contractor to discuss any requirements noted on the Work Permit with all Contractor and Subcontractor personnel assigned to the Work. A Tool Box Meeting Log shall be kept on the Job Site and be available for auditing by BNL.

GC-9. NOTICE TO PROCEED

- A. The Contractor shall not knowingly, without formal notice from MPO, prematurely commence operations on the BNL Site. The Notice to Proceed will not be issued by MPO prior to receipt, by Contracts and Procurement, of all required bonds and insurance documents, and prior to receipt, and approval by MPO, of the required Safety Plan.
- B. The Notice to Proceed will be issued, in accordance with Clause A above, along with a BNL Integrated Safety Management (ISM) Flowdown Form. This form shall be completed by every Subcontractor to be used on this Project and returned to MPO, by the Contractor, as part of the requirements of the Supplementary Conditions Section “Shop Drawings, Manufacturers Data, and Samples,” Clause R, “Required Submittals.”
- C. Work may proceed, however, in the preparation and submittal of required submissions and the ordering of materials and equipment that do not require prior approval by MPO.

GC-10. WORK HOURS

- A. Perform all work on weekdays, excluding BNL holidays, between 8:00 a.m. and 5:00 p.m., unless otherwise specified or approved. BNL holiday list available upon request.
- B. Notify MPO 24 hours in advance to request approval to work outside of the above working hours. Advise MPO of all planned activities and submit a list of all contractor

and subcontractor employees who are expected on-site during the off-hour period. All employees working during off-hours must possess a valid BNL contractor employee photo identification badge (see GC-12).

- C. If off-hours work request is approved, MPO will notify BNL Police Headquarters and the Main Gate of the days and hours that work is planned. Failure to notify MPO will be cause for BNL Police to deny access to the job-site.

GC-11. CONSTRUCTION NOTIFICATION

- A. MPO must be notified and made aware of all construction work-in-progress.
- B. When construction has not been previously scheduled, notify MPO Construction Services each day before 9:00 a.m. of planned activities.
- C. MPO will provide telephone extension numbers.

GC-12. IDENTIFICATION OF EMPLOYEES

- A. All Contractor and Subcontractor employees must attend the Contractor/Vendor Orientation Training Course (see GC-13), and be approved by BNL in order to work on the BNL site. A contractor employee photo identification badge will then be issued in order to have access to the site.
- B. U.S. citizens must bring proof of citizenship, photo ID and proof of Social Security number. Acceptable citizenship proof is a passport, birth certificate, naturalization papers, voting eligibility, or similar documentation. Drivers' license, military ID cards, union cards, and Social Security cards are insufficient by themselves as proof of citizenship. Proof of Social Security number includes Social Security card, pay stub, W-2 form or medical insurance card. Handwritten documents are not acceptable. Upon arrival at the BNL Main Gate, they will be sent to the Visitors Trailer to receive a temporary pass, which allows them access to the site to attend CVO training.
- C. All Non-U.S. citizen workers, including Legal Permanent Residents, requiring access to BNL shall complete a BNL Form 473 located on the BNL home page, [www.bnl.gov](http://www.bnl.gov), Guest Registration link. Each worker shall provide the requested personal information and information concerning their company, forwarding the completed form to their designated BNL Project Manager. Non-U.S. citizens shall provide documentation showing eligibility to be in the United States. This includes a valid passport and visa. Other documentation, to include but not limited to, a permanent resident card, passport entry "process form 1-551", INS documents 1-94, 1-20, DS-2019, or 1-539 part 3 and proof of Social Security, may be necessary to establish legal status and work on the BNL site. Failure to provide proper documentation will result in access being denied until the required documents are provided. Foreign National Contractor employees must submit all required documents 30 days in advance of the required access date as access approvals may take up to 30 days. All Foreign National Contractor employees are

responsible to ensure they remain in legal INS status. BNL ID badges will expire on the expiration date of their current legal status or one year after issuance, whichever comes first. At that point they must reapply with updated documentation to continue eligibility to work at BNL.

- D. The Contractor shall assure that all Contractor and Subcontractor employees promptly obtain a current BNL contractor employee photo identification badge. Badges shall be obtained in the Badging Office on the Ground Floor of the Research Support Center, Bldg. 400, Monday through Thursday, 8:30 a.m. to 4:00 p.m., and Friday, 8:30 a.m. to 1:00 p.m. In order to keep badging times to a minimum, the Contractor should limit sending all of his employees at the same time. New contract workers will only be issued contractor ID badges (and granted access to the site) after completion of required safety training as well as presentation and approval of citizenship documents, BNL form 473 for foreign nationals, and proof of Social Security Number.
- E. Contractor and Subcontractor employees must wear the badge so as to be visible at all times while on-site.
- F. Contractor employee identification badges will be valid for the anticipated duration that the employee expects to require access to the Site as indicated on the C/VOT application. This period will be a maximum of one (1) year and will then require renewal, upon expiration, at the Badging Office, Bldg. 400. Badges will be provided at no cost to the Contractor. Immediately upon release of employees or project completion, Contractor's Superintendent shall return badges to the Badging Office. (BNL will retain badges for re-issue for one year.)
- G. Contractor employees shall report lost identification badges immediately to the Badging Office, Bldg. 400.

GC-13. CONTRACTOR TRAINING REQUIREMENTS

- A. All Contractor and Subcontractor employees are required to attend BNL's Contractor/Vendor Orientation Training on their first day on site.
- B. Contractor/Vendor Orientation Training is a one and one-half (1-1/2) hour overview of BNL and OSHA safety requirements. The orientation is offered 8:30 a.m. weekdays in Building 938. Upon completion of the orientation, a card will be issued that must be signed by Construction Inspection, Bldg. 650T. The Contractors' employee (U.S. citizens as well as foreign nationals) information must then be entered in the BNL Guest Information System (GIS). To facilitate this process, the following personnel are trained to enter data in GIS: Donna Pfeiffer in Building 129, and Claudia Hatton, Cindy Klemm and Denise Bingham-Miesell in Building 134C. The employee must then return to the Badging Office, Bldg. 400, to obtain the employee identification badge. This safety orientation will be valid for a period of one year. Satisfactory completion will be indicated by issue of employee identification badge.

- C. Contractor and Subcontractor employees who have not attended the Safety Orientation will be directed to stop work until they have done so.
- D. All Contractor and Subcontractor employees who may be required to “Work On or Near” electrical circuits within the BNL electrical distribution system are required to complete BNL’s Electrical Safety I training course. This course is available on the Web at <http://training.bnl.gov/course/electsaf1> , and is valid training for one (1) year.
- E. In addition to completing the course, each organization’s electrical work Foreman/ Supervisors must discuss NFPA 70E requirements and specific hazard and risk information with their staff. This job briefing should discuss specific electrical work procedures, protective equipment requirements and departmental contacts at the local application level. BNL can provide a document that can be used as guidance for this discussion. This job level discussion can be informal but a record of this briefing shall be documented.
- F. Contractor shall provide a list of workers that he authorizes to “Work On or Near” and perform LOTO. Contractor and Subcontractor employees who may be required to “Work On or Near” electrical circuits and who have not completed the Web-based BNL Electrical Safety 1 training and NFPA 70E briefing will not be allowed to perform such work until they have done so.
- G. All Contractor and Subcontractor employees who may be required to “Work On or Near” electrical circuits must complete an approved NFPA 70E training seminar. Contractor can provide equivalent “in house” NFPA 70E training to his/her employees in lieu of taking “outside” training from an authorized company. Contractor’s program shall follow the guidelines of NFPA 70E and thoroughly demonstrate that all employees have been properly trained in all facets associated with NFPA 70E. If the Contractor decides to provide his/her own NFPA 70E training, Contractor’s program shall be submitted to BNL for approval. All Contractor and Subcontractor employees that “Work On or Near” electrical circuits shall have taken and passed a CPR training program that has been approved by BNL.

GC-14. COORDINATION

- A. Arrange and coordinate work, be responsible for acts and omissions of all parties involved in the work, be responsible for satisfactory performance of all work, ensure that each trade is fully informed of full extent of work required, and coordinate installation of all equipment and shop fabricated material, including that supplied by BNL. BNL assumes no responsibility for contractual relations between Contractor and other parties.

GC-15. MEN AND MATERIALS

- A. Do not utilize men or materials which would cause work stoppage on BNL Site.
- B. Radiation Generating Devices are of special concern. The following industrial equipment, known to contain radiological sources or able to generate radiation, if brought to the BNL

Site, require the Contractor to notify the Project Manager, in advance, and require a Radiological Work Permit to be approved prior to their use on site. RWPs require Health Physics review.

1. Radiography Equipment
2. Moisture Density Gauges
3. Soil Density Gauges
4. X-Ray Equipment

GC-16. SUBCONTRACTOR REVIEW

- A. BNL reserves the right to review, to approve or disapprove proposed Subcontractors based upon past safety and performance quality. No later than two (2) weeks after signed Contract, submit directly to MPO, a complete list of proposed Subcontractors for review.
- B. Subcontractors must meet the current published OSHA DART Rate and Recordable Incidence Rates for construction in their trades. Subcontractors shall also have an insurance Experience Modification Rating equal to or less than one (1).

GC-17. PRE-CONSTRUCTION MEETING

- A. MPO will set up a Pre-Construction Meeting, at which time the ES&H issues, Safety Awareness issues, Submittal procedures, and Site Organization procedures will be addressed. The Contractor's Superintendants, Supervisors, and Foreman are required to attend the Pre-Construction Meeting.

GC-18. CONSTRUCTION SCHEDULE

- A. Within three (3) weeks after signed Contract, submit, directly to MPO, a detailed work schedule which must fall within number of weeks specified.
- B. When work falls behind schedule due to Contractor's fault or negligence, increase all labor and overtime to assure completion within schedule.
- C. BNL will utilize all available contractual remedies to enforce schedule compliance. Should the Contractor encounter delays caused by BNL, it is the Contractor's responsibility to promptly notify the contracting officer and to request an extension of the contract compliance date.

GC-19. JOB MEETINGS

- A. Job meetings will be held at the job site at least monthly unless otherwise designated by MPO.
- B. The Contractor and his field superintendent, and the subcontractors or vendors whose presence is necessary, shall attend job meetings.

- C. Decisions, instructions and interpretations agreed upon at such meetings will be recorded in a "Memorandum of Meeting" prepared by MPO and furnished to the Contractor and each attendee for necessary action.

GC-20. SUBSTITUTIONS

- A. Unless otherwise specified, substitutions may be made for items specified when substitutions are approved equals. Submit substitutions for approval in accordance with heading "SHOP DRAWINGS, MANUFACTURERS DATA, AND SAMPLES" in Supplementary Conditions.
- B. When proposing a substitution, submit:
  - 1. Shop Drawings providing complete descriptive and technical data. Submit samples and additional information when directed.
  - 2. Statement of effect on all other work in Contract.
- C. MPO reserves right to request drawings indicating all required revisions to Contract Drawings prior to giving approval.
- D. If a substitution is approved, be responsible for all resulting changes in work and for all systems, equipment and material, functioning as originally intended.

GC-21. CONTRACTOR'S MATERIALS REMOVALS

- A. Obtain property pass through MPO for removal of Contractor's materials and equipment from BNL Site. Schedule removals during specified work hours.

GC-22. TRANSPORTATION

- A. In transporting materials and equipment, use designated roads and railroad on BNL Site. Obtain information concerning these facilities from, and coordinate all transport operations with, MPO. When necessary to maintain work schedule, ship all materials, including Subcontractors' items, from point of origin to BNL Site by direct means equal to, or better than, express service.
- B. In transporting radioactive materials and waste, or hazardous waste, a DOE-MCAP approved transporter must perform the transportation. The MPO Waste Management Representative will coordinate all shipments of radioactive materials and waste, or hazardous waste.
- C. Shipments requiring a manifest (radioactive or hazardous) shall be prepared by a qualified broker. The broker shall sign as the shipper of record for radioactive shipments, with a qualified BNL Waste Management Representative approving the document. A Hazardous Waste Manifest shall be prepared by a qualified broker and signed by a BNL Waste Management Representative.

GC-23. TRAFFIC WAYS

- A. Schedule, confine, and perform work, as directed, so as not to interfere with BNL traffic on existing roads, walks, parking and other paved areas. Park all vehicles in designated parking areas. Load and unload vehicles where directed. Comply with all BNL traffic regulations. Violations will be backcharged from the Contract amount.

GC-24. CODES AND STANDARDS

- A. Meet requirements of BNL Standards-Based Management System (<https://sbms.bnl.gov>); ES&H Standards and other applicable SBMS standards, and all other codes and standards specified. In cases of conflict, the standard providing the greater protection shall govern.
- B. BNL is an ISO 14001 certified laboratory. It shall be the duty and the responsibility of the Contractor and his subs to comply with the BNL standards and procedures in the area of environmental control, hazardous waste generation, spill prevention, and all other standards specified herein.
- C. Copies are available for reference at MPO.

GC-25. FIRE PROTECTION AND DETECTION SYSTEMS

- A. Do not modify, disconnect and, in any way, impair systems without approval.
- B. Notify MPO forty-eight (48) hours in advance of all work on fire protection systems.

GC-26. OPEN FLAME OPERATIONS

- A. It shall be the duty and responsibility of the Contractor performing any cutting or welding to comply with the provisions of BNL Standards-Based Management System; ES&H Standards, and the National Fire Protection Association's National Fire Codes pertaining to such work.

The Contractor shall read and be familiar with the provisions of these standards and codes. The Contractor shall be responsible for all damages resulting from failure to so comply.

- B. Notify MPO forty-eight (48) hours in advance of cutting, welding, or similar open flame operations.
- C. Provide any required fire watch and take all required precautions where directed.
- D. MPO will make arrangements for a Cutting/Welding Permit. NO WORK shall proceed prior to the issuance of the written Cutting/Welding Permit nor shall work continue after expiration date of permit.

GC-27. PROTECTION OF PROPERTY

- A. Contractor shall be responsible for the security of property within the work site.
- B. Protect, with whatever means and methods required, all new and existing property from damage by and as a result of work in this Contract as approved, including disappearance. Refer to BSA LLC, General Terms and Conditions for Construction and Labor Hour Agreements, Article titled: Contractor's Responsibilities.
- C. Repair, refinish, replace and otherwise correct all damage, and replace all missing materials, as directed and approved by MPO.

GC-28. TEMPORARY SERVICES

- A. All requests by the Contractor for temporary services i.e. electric power, for their own use or for use by any subcontractor, shall be made only through their designated MPO contact.
- B. All methods, materials, and scheduling of temporary services shall be as directed and approved.
  - 1. BNL will furnish, without charge, sources of water and electric power and will perform initial tie-in and removal of same. MPO will, upon request, indicate locations.
  - 2. Contractor shall supply, install, maintain, and remove all equipment and required devices for temporary water, power, and lighting systems from point of initial tie-in as necessary to perform the work.

GC-29. SERVICE INTERRUPTIONS

- A. Do not interrupt service until directed. Notify MPO two (2) weeks in advance of all proposed service interruptions unless otherwise specified or directed.
- B. Keep all interruptions to a minimum. Complete all possible prior work and prefabrication, and have all labor and materials on Site, as approved, prior to interruption.

GC-30. COORDINATION WITH BNL ACTIVITIES

- A. Coordinate and schedule all work with all BNL activities and operations through MPO.

GC-31. CUTTING AND PATCHING

- A. Cut, drill, alter, remove, and replace all existing construction as required for performance of work. Patch and finish all changed and damaged work to match existing construction as approved by BNL.

GC-32. WORK BY TRADES

- A. Work of a trade is not necessarily limited to the Drawing or Specification page describing work to be done by that trade.

GC-33. SALVAGE

- A. Salvage is that material and equipment, as defined in the Specifications, to be removed by the Contractor from the Project facility, but is to remain the property of BNL.
- B. Remove all specified salvageable material and equipment and pass it through the vehicle radiation monitor. Place, where directed by, and turn over to, MPO, on the BNL Site.
- C. Remove all salvageable material and equipment, as specified, and place on BNL Site where directed.
- D. Remove all non-salvageable material and equipment and legally dispose of same off the BNL Site.
- E. All removed salvageable material and equipment, as defined in the Specifications, shall remain property of BNL.
- F. All removed salvageable and non-salvageable materials and equipment shall pass through the vehicle radiation monitor prior to disposal on the BNL Site or exiting the BNL Site.

GC-34. WORK AS BUILT

- A. MPO will provide a complete set of prints of the Contract Drawings. Mark up accurately, showing all changes, in a neat, legible manner. Final payment will not be approved prior to receipt of approved marked up prints.

GC-35. CONSTRUCTION WASTE MANAGEMENT

- A. Waste and demolition materials shall be segregated into disposal categories:
  - 1. Radioactive waste is any refuse, solid or liquid, that must be managed for its radioactive content.
  - 2. Hazardous waste is any refuse, solid or liquid, that is a by-product of processes/ activities that can pose a hazard to health or environment that must be managed for its hazardous nature (usually listed by EPA).
  - 3. Mixed waste is any refuse that contains both Low-Level Radioactive Waste (LLRW) as well as hazardous waste.
  - 4. Non-hazardous waste is any refuse, other than construction debris, that is considered industrial or special in nature (oil, anti-freeze, etc.). The BNL Standards-Based Management System (SBMS) contains the full descriptions.

5. Universal waste is any battery containing hazardous constituents such as mercury/lithium/lead/nickel cadmium, certain pesticides, as well as mercury-containing thermostats and fluorescent lamps and tubes.
  6. Construction rubbish and debris is any refuse as a result of the normal construction or earth clearing activity such as packing and shipping materials, discarded lumber and wood materials, metals, insulation, gypboard, piping, electrical scrap, tree branches, roots, and sweepings.
- B. Radioactive waste and mixed waste disposal will be coordinated by the MPO Waste Management Representative, Gary Olsen, (631) 344-8580.
  - C. Hazardous waste and mixed waste shall be disposed of by the Contractor at the BNL Waste Management Facility, or at an approved off-site facility coordinated by the MPO Waste Management Representative.
  - D. Universal waste shall be disposed of by the Contractor at the BNL Waste Management Facility, or at an approved off-site facility coordinated by the MPO Waste Management Representative.
  - E. Non-hazardous waste shall be disposed of by the Contractor at the BNL Waste Management Facility, or at an off-site disposal facility approved by BNL.
  - F. Construction rubbish and debris shall be disposed per GC-36.

GC-36. SITE CLEANING AND DISPOSAL OF CONSTRUCTION DEBRIS

- A. Keep Site clear of debris and rubbish at all times. Burning of debris and rubbish will not be permitted.
- B. Place all construction debris and rubbish in appropriate containers and legally dispose of same periodically off the BNL Site.
- C. At job completion, promptly remove tools and equipment, and clean premises thoroughly, as approved by BNL.
- D. All removed construction debris, excess clearing, excavation and/or grading material, rubbish, and equipment, removed from the Site, shall pass through the Vehicle Radiation Monitor on East Princeton Avenue, prior to being disposed off the BNL Site.

END OF SECTION 000700

DIVISION 00 – BIDDING AND CONTRACT REQUIREMENTS  
SECTION 000800 – SUPPLEMENTARY CONDITIONS

SC-1. CRITICAL MILESTONES

- A. This project is one where critical milestones are required to be met. The contract completion date shall be adhered to, as well as any established as critical. Failure to be "substantially complete" by the completion date established in the signed contract will be considered by BNL as being non-responsive and could lead to the barring of the Contractor from bidding future projects at BNL for a period of one (1) year.
- B. Substantial Completion is the stage in the progress of the Work when the Work or a designated portion thereof is sufficiently complete, as determined by MPO in accordance with the Contract Documents, so as to be able to be occupied or utilized for its intended use.
- C. Critical dates that must be met are as follows:
  - 1. Project Completion: 9/30/2012

SC-2. SHOP DRAWINGS, MANUFACTURERS DATA, AND SAMPLES

- A. The term "shop drawings and data" includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, similar materials and samples furnished by Contractor to explain and show in detail, specific portions of work required by Contract.
- B. Shop drawings and data for construction shall be submitted with such promptness as to cause no delay in the work. Allow sufficient time for checking, correcting, resubmitting and rechecking. Submittals to BNL by Contractor, subcontractor, or any low tier subcontractor, pursuant to a construction contract, shall show in detail (i) the proposed fabrication and assembly of structural elements and (ii) the installation (i.e., layout, form, fit, setting, and attachment details) of materials or equipment. BNL may duplicate, use, and disclose in any manner and for any purpose shop drawings and data delivered under this Contract.
- C. These contract conditions shall be included in all subcontracts hereunder at any tier.
- D. Before submitting any data for approval, the Contractor shall coordinate all such drawings and data, and check them for accuracy, completeness, and compliance with Contract requirements. The Contractor shall see that all work contiguous with and having bearing on the work indicated on drawings is accurately and distinctly illustrated and that work shown is in conformity with contract requirements.
- E. The Contractor shall indicate his approval on all submittals as evidence of the above coordination and review. Shop drawings and data submitted to BNL without evidence of Contractor's approval, may be returned for resubmission.

- F. Shop drawings shall be numbered consecutively and shall represent:
  - 1. All working and erection dimensions.
  - 2. Arrangement and sectional views.
  - 3. Necessary details, including information for making connections to other work.
  - 4. Kinds of materials and finishes.
- G. Shop drawings shall be dated, and shall contain:
  - 1. Name and Number of project.
  - 2. Description of required equipment, materials, and classification item numbers.
  - 3. Locations at which materials or equipment are to be installed in the work.
  - 4. Identification of drawings and specification sections to which they apply.
- H. BNL's technical liaison will indicate its review action on shop drawings and data and, if rejected as submitted, shall indicate its reasons therefor. No work shall be done on an item or system, including fabrication, prior to MPO taking no exception. Taking no exception by BNL shall not relieve Contractor from responsibility for any errors or omissions in such drawings and data, nor from responsibility for complying with requirements of this Contract, except with respect to variations described and approved in accordance with (I) below.
- I. If shop drawings and data show variations from Contract requirements, Contractor shall describe such variations in writing separate from drawings and data at the time of submission. If BNL approves any such variation(s), it shall issue an appropriate Contract modification, except that, if variation is minor and does not involve a change in price or in time of performance, a modification need not be issued.
- J. Submission of data for approval shall be accompanied by letter of transmittal, in duplicate, containing the name of the project, Contractor's name, number of drawings, titles and other pertinent data.
- K. Submit Shop Drawings on Ozalid copies of original Contractor's Drawings. Submit five (5) sets of Ozalid prints for each submission until approved.
- L. Submit opaque manufacturer's cuts and data sheets clearly marking all applicable data. Submit five (5) copies for each submission until approved.
- M. Submit samples, tagged and labeled and with a 3" x 4" space for approval stamp. Submit two (2) samples for each submission.

- N. The General Conditions portion of the Contractors monthly payment requisitions may be reduced if required Shop Drawings, Manufacturers Data, Samples and any other required submissions are not received, or until they are received in a timely manner.
- O. Except for required submissions specified below, submit Shop Drawings, Manufacturers Data, and Samples only for items where a substitution is requested. Refer to GC-20, Substitutions.
  - 1. Note: Substitutions in protective device manufacturer AND make OR model shall affect the existing Arc Flash Hazard Analysis. Substitutions in protective devices shall require the successful bidder to perform, or to pay for, the revised analysis. Refer to Section 260573 – Electrical Short Circuit/ Protective Device Coordination/ Arc Flash Study.
  - 2. Approval of the proposed substitution must be received prior to installation. Submitting protective device substitutions that are unsuccessfully analyzed shall be at the risk of the successful, contractor, subcontractor and/ or vendor.
  - 3. Any protective device analyzed per Section 260573 that allows an arc flash hazard greater than a Category 2 (> 8.0 cal/ cm<sup>2</sup>) shall be rejected for substitution without prior review, justification and approval.

P. Address all submissions to:

Brookhaven National Laboratory  
 Donald Sievers, Manager  
 Building 134-C  
 Upton, New York 11973

Q. Mark all submission transmittals as follows:

JOB TITLE: Lab C Data Center – Relocation and Replacement of CRAC Units  
 JOB NO. 12780, BLDG. NO. 515

R. Required Submissions:

Item	Shop Dwg.	Mfrs. Data	Samples	Other Data
* 1. Schedule of Values				X
* 2. Unit Prices				X
* 3. List of Subcontractors with Completed ISM Flowdown Forms				X
4. Environment, Health and Safety Plan				X
5. Occupational Medicine Program				X
6. Rigging Plan				X

Item	Shop Dwg.	Mfrs. Data	Samples	Other Data
7. Recycled Materials Reports				X
8. Certification of Specification Compliance				X
9. Preventative Maintenance Program Data				X
10. Operation and Maintenance Data				X
11. Piping Layout	X			
12. Piping Specialties	X	X		
13. Piping Hangers		X		
14. Control System	X	X		
15. Conduit & Raceway		X		
16. Conduit Hangers, Supports & Clamps		X		
17. Wire & Cable: Power, Control & Data		X		
18. Fuses & Circuit Breakers		X		
19. Disconnect & Safety Switches		X		
20. Roof-top Penetration Materials & Methods	X	X		

S. MPO reserves right to request additional data.

T. Critical Items:

1. Submit items marked with an asterisk within two (2) weeks after signed Contract.
2. No later than two (2) weeks after receiving approval, submit copies of purchase orders and vouchers showing final purchase agreement and promised delivery date.

SC-3. BNL SUPPLIED ITEMS

A. Items supplied by BNL:

1. Computer Room Air Conditioning Unit (AC/5)
2. Drycooler with Compression Tank (DC/1)
3. Pump Package (P/1A and P/1B)

B. Shop Drawings and Manufacturer's Data will be available at MPO.

C. Check all items in presence of MPO Construction Representative to insure they are complete with all parts and appurtenances, and free from damage. Move items from point of storage on BNL Site and completely install and connect at Site. Handle all items with care.

SC-4. TEMPORARY WORK

- A. All methods, materials, and schedules for installation, operation, maintenance, and removal of all temporary work shall be approved. Upon removal, restore all property to original condition as approved.
- B. Telephone: BNL will not provide telephones. Contact F&O Business Operations Office within five (5) working days after notice to proceed and arrange for a temporary telephone to be installed.
- C. Field Office: BNL will not provide building office space. Within five (5) working days after notice to proceed, provide, where directed, an approved Field Office with lighting. Provide heat, when temperature drops below 60°F.
- D. Toilet Facilities: BNL will not provide toilet facilities. Provide, where directed, and properly maintain, portable toilet facilities, as approved, from start to finish of operations.
- E. Fire Extinguishers: One (1) portable tank type fire extinguisher containing fifteen pounds of liquid carbon dioxide, complete with hanger, seat type valve, 3 feet of hose and non-shatterable discharge hose, complete with brackets for wall mounting; as manufactured by Walter Kiddie & Co., Model 15KS, or equal.
- F. First Aid Kit: One (1) industrial first aid kit as manufactured by Acme Products, Kit Number 25, or equal, located where directed by MPO.
- G. Closures: Install temporary, weathertight closures over exterior openings immediately after openings are created.
- H. Partitions: Provide, where indicated on Drawings, temporary, dust-tight partitions, complete with all doors, constructed of noncombustible materials with all joints and edges taped.
- I. Storage Facilities: BNL will not provide storage space. Provide, where directed, an approved storage facility.
- J. Fences: Erect four (4) foot high lath and wire temporary fencing, where indicated on Drawings, before start of other work.
- K. Existing Roofing: Protect existing roofing with plywood or other approved material. Confine workmen and material to protected area.
- L. Existing Flooring: Protect existing flooring with plywood or other approved material. Confine workmen and material to protected area.

M. Ventilation:

1. Provide ventilation in accordance with codes specified and as approved.
2. Conform to standards of the American Conference of Governmental Industrial Hygienists Threshold Limit Values and Occupational Safety and Health Administration Standards for permissible exposure limits.

N. Showers:

1. Provide a shower trailer in accordance with codes specified and as approved. Locate where directed by MPO.

O. Heating:

1. Provide heating in accordance with codes specified and as approved by BNL.
2. Maintain proper temperatures for storage and installation of all materials as recommended by material manufacturers' published instructions and as directed by BNL.
3. Provide systems approved for unattended operation. Conform to requirements of NFPA 31, 89M, 211, 54, and OSHA Part 1926.154. All components of temporary systems shall be UL, FM, and AGA approved.
4. Maintain proper ventilation for health and safety of personnel.
5. Use of resistance heating to provide temporary heat will not be permitted.

SC-5. PAINTING

- A. Prepare and paint existing surfaces marred during construction and new surfaces with one (1) prime coat and two (2) finish coats matching surrounding areas. Comply with latest revisions of OSHA 29 CFR 1926, BNL Standards-Based Management System; ES&H Standards, 6NYCRR Parts 205 & 228, and UL standards and regulations.

SC-6. SAFETY REQUIREMENTS

- A. All Contractor and Subcontractor employees are required to attend BNL's Contractor/Vendor Orientation Training (see GC-13).
- B. MPO will arrange and ESH&Q Division will provide additional safety instructions, as required. All personnel shall conform to special requirements for wearing TLD's, personal protective equipment, protective clothing, respirators, and other safety measures as required. TLD's, only, will be provided by BNL at no charge, unless otherwise specified.
- C. Refer to Section 000900 for Site and Construction Safety requirements.

SC-7. INDUSTRIAL HYGIENE MONITORING

- A. Refer to Section 000900 for Industrial Hygiene Monitoring requirements.

SC-8. LEED CERTIFICATION

- A. This project is to be LEED certified. Refer to Section 018113 – Sustainable Design (LEED) Requirements, for type, required submittals, credits, options and other specifics that will allow this project to be certified.

SC-9. PROCEDURES WITHIN COMPUTER AREA

- A. The computer area is Bldg. 515, Network Labs A, B, C, including space below raised floor system.
- B. Workmen shall be supervised by an approved Contractor's or Subcontractor's representative at all times and shall not enter areas other than where work is required.
- C. Minimize infiltration and spreading of dust, dirt, fumes and other foreign matter as approved. Prefabricate, premix, and otherwise prepare dust and dirt producing materials outside of building where directed.
- D. When a dust producing operation in the computer area cannot be avoided, remove all dust and dirt as it is created with an approved heavy-duty commercial vacuum cleaner. Under floor areas normally have smoke detection fire alarm service. Notify MPO 48 hours in advance of dust producing operations to minimize the chance of false alarms.
- E. Keep computer area clear of all rubbish. Place debris in approved covered containers and empty outside of building, where directed, at least once a day.
- F. Use extreme care at all times to protect all computer equipment. Do not place tools, materials, and other items on or against equipment.
- G. Limit the total number of floor panels removed at one time, as directed. Barricade resulting floor openings.
- H. Immediately remove from computer area, all tools, equipment and materials not in use. All work setups, such as ladders and floor openings, which obstruct operational passages to computer equipment shall not be left overnight unless specifically approved.
- I. Smoking is not permitted in computer area.
- J. Any workman not conforming to BNL procedures will be directed to leave the building. BNL shall not be responsible for resulting expense.
- K. There may be several Contractors working in the computer area doing work that is not included in this Contract. Coordinate and schedule all work in this Contract with MPO and cooperate with other Contractors to insure uninterrupted computer operation, an orderly work procedure, and a minimum number of workmen in the area at one time.

SC-10. SPECIAL SERVICE INTERRUPTIONS

- A. Refer to heading "SERVICE INTERRUPTIONS" in General Conditions.
- B. Service interruptions may occur only when permitted during scheduled shutdowns.
- C. Scheduled shutdowns normally occur during normal working hours.
- D. Notify MPO two (2) weeks in advance of all proposed service interruption unless otherwise specified or directed.
- E. All materials, prefabricated where directed, and labor must be on Site before a shutdown will be permitted.
- F. Increase labor force, use overtime or both, as directed, to insure completion of work in specified time. Include all overtime costs required to complete installation.
- G. Work requiring a power shutdown, must be completely installed, tested, and ready for use in a period not to exceed time specified by MPO.

SC-11. PENETRATIONS

- A. Seal all penetrations through fire rated systems with an approved fire and/or smoke stop material, Hilti North America Fire Stopping Systems, or equal as approved by MPO, capable of maintaining the level of fire protection of the wall, partition, floor or ceiling penetrated.
  - 1. Systems selected shall be appropriate for the joint and/or penetration involved, such as floor to floor, wall to wall, floor to wall, head of wall, and whether there is movement or no movement capability.

SC-12. CONSTRUCTION SAFETY

- A. Refer to Section 000900 for Site and Construction Safety requirements.

SC-13. CRANES, TRUCKS, MATERIAL HANDLING, AND LIFTING EQUIPMENT

- A. Contractor shall notify MPO 48 hours prior to any earthwork and/or rigging operations. All cranes, boom trucks, and lifting equipment must be approved by MPO prior to use. No equipment operations will be allowed until approval of equipment has been granted. Contact the MPO Hoist and Rigging Inspector, (631) 344-5456, for equipment inspections.
- B. All heavy equipment, including cranes and earth-working equipment must be in compliance with OSHA, ANSI, and DOT requirements, must be in good repair, and is subject to inspection by BNL. Equipment found to be leaking oil or other fluids will not be permitted to operate at BNL.

- C. BNL has several areas throughout the complex where overhead clearance is a concern. Contractor shall disclose overall dimensions of any heavy equipment prior to being brought on BNL site. Contractor and BNL shall walkdown the entire route/path that heavy equipment will use to ensure there are no interferences with overhead lines or other height restricted areas. Any modifications to the agreed upon route/path shall be approved by BNL prior to moving heavy equipment.

SC-14. SCHEDULE OF VALUES

- A. Successful bidder shall submit no later than 2 weeks after contract signing the following Schedule of Values breakdown. Separate the Construction Safety costs from the cost figure for General and Special Conditions, and list separately:
  - 1. General and Special Conditions
  - 2. Bond
  - 3. Occupational Medicine Program
  - 4. Site and Construction Safety
- B. Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule and Applications for Payment. Applications for Payment cannot be processed without an approved Schedule of Values.
- C. Use BNL Form F 2685 and Tabulation Sheet F 2686, or the standard AIA Application for Payment, as the forms for payment, in accordance with BSA LLC, General Terms and Conditions for Construction and Labor Hour Agreements, Article titled: Payment.

SC-15. SPILLS OF HAZARDOUS MATERIALS

- A. If, during construction activities, a release, discharge, or spill of petroleum products or chemicals occurs, the Contractor shall:
  - 1. Immediately notify Safeguards and Security at ext. 2222 (or 911) from Site telephones or 631-344-2222 from cell phones or Direct Connect 173\*37738\*66 on a Nextel, and MPO, of the release, discharge, or spill.
  - 2. Immediately, per SBMS, initiate cleanup and disposal operations by a BNL approved hazardous waste management contractor, complete the operations, and be responsible for monitoring and/or sampling in the event of a spill, to the satisfaction of BNL.
- B. The disposal of contaminated material will be coordinated by MPO through the Environmental Waste Management Services Division, with appropriate documentation and disposition forms.

SC-16. RECORD DOCUMENT SUBMITTALS

- A. Do not use the set of Contract Drawings issued by MPO (see GC-34) for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for MPO's reference during normal working hours.
- B. Maintain a clean, undamaged set of black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
  - 1. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work.
  - 2. Mark new information that is important to BNL but was not shown on Contract Drawings or Shop Drawings.
  - 3. Particular attention shall be given to recording of all underground utilities as well as the fire protection, fire alarm and fire detection system operations and maintenance manuals and record documents.
  - 4. Note related change-order numbers where applicable.
  - 5. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.
- C. Refer to Specification Sections for requirements of miscellaneous record keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to MPO for the permanent project records.

SC-17. OPERATION AND MAINTENANCE DATA

- A. To aid the continued instruction of operating and maintenance personnel, and to provide a positive source of information regarding the products incorporated into the Work, furnish and deliver the data described in this Section and in pertinent other Sections of these Specifications.
- B. Submit two (2) copies of data, bound in 8½" x 11" manuals, in 3-ring binders with section separators, complying with the requirements in the Shop Drawing section herein.

C. Operating and Maintenance Instructions:

1. Where Instruction Manuals are required to be submitted under other Sections of these Specifications, prepare in accordance with the provisions of this Section. Clearly identify the contents of each Manual on the front cover.
2. Contents: Include at least the following:
  - a. Neatly typewritten index near the front of the Manual, giving immediate information as to location within the Manual of all emergency information regarding the installation.
  - b. Complete instructions regarding operation and maintenance of all equipment involved including lubrication, disassembly, and reassembly.
  - c. Complete nomenclature of all parts of all equipment.
  - d. Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
  - e. Copy of all guarantees and warranties issued.
  - f. Manufacturers' bulletins, cuts, and descriptive data, where pertinent, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
  - g. Such other data as required in pertinent Sections of these Specifications.
3. Indoctrination and Training:
  - a. Arrange for the installer of equipment and systems that require maintenance to meet with BNL F&O personnel to provide instruction in proper operation and maintenance.
  - b. The review should include, but not be limited to, walk through(s), description of the system, sequence of operations, operations and maintenance manuals, spare parts, tools, lubricants, control sequences, preventative maintenance sequences, hazards, and startup and shutdowns.
4. Revisions:
  - a. Following the indoctrination and instruction of operation and maintenance personnel, review all proposed revisions of the Manual with MPO, and make the revisions in the Manual and resubmit.

SC-18. PREVENTATIVE MAINTENANCE PROGRAM

- A. A program of scheduling preventative and routine maintenance covering all operating equipment shall be prepared by the General Contractor, Vendors, and Subcontractors, as specified in these Supplementary Conditions.
- B. The preparation, submittal, and approval of this program on the attached data sheets, as well as the Operation and Maintenance Data Manuals, is prerequisite to Final Acceptance of the work and resultant Final Payment.
- C. Each Respective Trade Contractor, Vendor, and Subcontractor shall furnish to the General Contractor for compilation, the pertinent data shown on the attached form applicable to each piece of operating equipment.

ATTACHMENT - 2 Sheets - PMPD 1 & 2

SC-19. CERTIFICATION

- A. Certification of compliance with specification performance standards and manufacturers' specifications and directions shall be furnished for any portion of this work for which specific performance requirements and/or manufacturers' specifications are listed.
- B. It shall be the responsibility of the General Contractor to secure two (2) copies of each certification when required and transmit same to BNL.
- C. Sample Certification Form (2 pages) is attached as an exhibit at the close of the Supplementary Conditions. Each item requiring certification shall be so noted and affidavits shall be filed singly to cover each specified material, installation, application, and the like.
- D. CERTIFICATION SHALL ACCOMPANY EACH SUBMITTAL.
- E. Packaged Equipment:
  - 1. Where packaged (factory assembled) mechanical and electrical equipment is furnished, a certificate shall be included with the submission of shop drawings or catalog data stating that the equipment complies with OSHA, National Electrical Codes, and applicable Underwriter's Laboratories Standards in respect to motor protection, grounding, and protection against hazards, and is approved by all Regulatory Agencies.

PREVENTATIVE MAINTENANCE PROGRAM OPERATING EQUIPMENT DATA

1. Equipment Name
2. Manufacturer
3. Model No.
4. Serial No.
5. Contractor
6. Specialty Contractor
7. Vendor
8. Job Name
9. Job Number
10. Agency from whom parts may be obtained:
11. Agency from whom service may be obtained:
12. Service Agreement:    Yes    No    Expires -
13. a) Guarantee:        Yes    No    Expires -  
    b) Warrantee:        Yes    No    Expires -
14. Equipment Location:    Building        Floor  
                                    Room No.        Area Des.
15. Area Served:            Building        Floor  
                                    Room No.        Area Des.
16. Furnished in accordance with:  
      Contract Drawing No.  
      Specification Paragraph

Date of Issuance: \_\_\_\_\_

Submitted By: \_\_\_\_\_

Equipment Name: \_\_\_\_\_

PMPD-1

PREVENTATIVE MAINTENANCE PROGRAM OPERATING EQUIPMENT DATA (cont'd)

17. List Shop Drawings, Equipment Cuts, Catalogs, or the other drawings which show this equipment.
18. Indicate spare parts lists, maintenance and instruction manuals, or other data furnished.
19. Indicate all services connected to this equipment - water, drain, steam, return, gas, vacuum, chilled water, electric, etc. Give sizes of connections, amount used, pressure, etc.
20. Type of refrigerant (if any)
21. Capacity of equipment
22. Electrical Characteristics:    Voltage            Amp            Phase
23. Electrical Circuit Data Panel Designation  
    Panel Location                      Circuit Number  
    Fuse Size                              Fuse Type
24. Location and data of any auxiliaries
25. Other Data

Date of Issuance: \_\_\_\_\_

Submitted By: \_\_\_\_\_

Equipment Name: \_\_\_\_\_

PMPD-2

CERTIFICATION OF SPECIFICATION COMPLIANCE

I/WE, the MANUFACTURER/SUPPLIER and INSTALLER of \_\_\_\_\_

as specified in Section Number \_\_\_\_\_ of the Contract Documents prepared by Brookhaven National Laboratory, Upton, New York 11973 for:

(Project Title) \_\_\_\_\_

(Building) \_\_\_\_\_ (J/N) \_\_\_\_\_

(Contract Number) \_\_\_\_\_

do (does) herein certify that all materials furnished for said project do fully comply with all specification requirements as stated within the Contract Documents and further certifies that installation of this work has been performed in strict accordance with recognized standards of the industry governing such work, and all applicable Codes, Regulations, and Standards.

CONTRACTOR: \_\_\_\_\_

CERTIFICATION BY: \_\_\_\_\_ TITLE: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CERTIFICATION DATED: \_\_\_\_\_

Distribution:

Original and One Copy to:

Brookhaven National Laboratory  
Donald Sievers, Manager  
Building 134-C  
Upton, New York 11973

CSC-1

CERTIFICATION OF SPECIFICATION COMPLIANCE

CORPORATE ACKNOWLEDGEMENT

On the \_\_\_\_\_ day of \_\_\_\_\_, before me came \_\_\_\_\_  
to me known and who by me being duly sworn did depose and say that he resides at \_\_\_\_\_  
\_\_\_\_\_ that he is the officer of the said corporation executing  
the foregoing instrument that he knows the seal of said corporation, that the seal affixed to said  
instrument is such corporate seal, that it was so affixed by order of the Board of Directors of said  
corporation and that he signed his name thereto by like order.

\_\_\_\_\_  
Notary Public

INDIVIDUAL ACKNOWLEDGEMENT

State of \_\_\_\_\_  
County of \_\_\_\_\_

On the \_\_\_\_\_ day of \_\_\_\_\_, before me came \_\_\_\_\_  
to me known and who by me being duly sworn did depose and say that he resides at \_\_\_\_\_  
\_\_\_\_\_ that he is the individual who executed the foregoing instrument.

\_\_\_\_\_  
Notary Public

PARTNERSHIP ACKNOWLEDGEMENT

State of \_\_\_\_\_  
County of \_\_\_\_\_

On the \_\_\_\_\_ day of \_\_\_\_\_, before me came \_\_\_\_\_  
to me known and who by me being duly sworn did depose and say that he resides at \_\_\_\_\_  
\_\_\_\_\_  
that he is a partner in the firm of \_\_\_\_\_  
doing business under the name of \_\_\_\_\_  
and that he executed the foregoing instrument on behalf of said partnership.

\_\_\_\_\_  
Notary Public

CSC-2

END OF SECTION 000800

DIVISION 00 – BIDDING AND CONTRACT REQUIREMENTS  
SECTION 000900 – SITE AND CONSTRUCTION SAFETY

SCS-1. GENERAL

- A. The Contractor is solely responsible for Construction Safety for the duration of this Contract.
- B. All Contractor's operations shall be in accordance with all applicable safety statutes, requirements and standards, including, but not limited to, the Federal Occupational Safety and Health Administration (OSHA), this document, and applicable sections of the Department of Energy's 10 CFR 851 Worker Safety and Health.
- C. BNL will not tolerate non-adherence to safety requirements under this Contract. Failure to comply will result in BNL's direction to stop work in accordance with BSA LLC, General Terms and Conditions for Construction and Labor Hour Agreements, Article titled: Compliance with 10 CFR 851 and BSA's Worker Safety and Health Program. Non-compliance could also mean the barring of the violating individuals from the BNL Site. Repeated safety violations may also result in a permanent Work Stoppage under the same Article.
- D. A verbal or written Stop Work Order may be imposed by BNL for specific work activities when site conditions are created or exist that pose unacceptable risks or imminent danger. In addition, actions perceived by BNL to be in flagrant disregard of established safety and environmental requirements will be cause for Stop Work actions to be taken. Some examples of justification to take this action, include, but are not limited to the following:
  - 1. Workers who have not attended the BNL-required CVO Orientation Safety Seminar prior to work on BNL property.
  - 2. Failure to follow Contractor's HASP requirements.
  - 3. No BNL-accepted Contractor Safety Representative or Alternate on the work site.
  - 4. Failure to develop or implement the required Phase Hazard Analysis (PHA) plans.
  - 5. No BNL-accepted Contractor's PHA reviewed by all parties involved with such work prior to commencing activities.
- E. BNL reserves the right to refuse access to the Project Site, or require immediate removal from the Project Site, any individual violating or alleged to have violated established site safety or Security regulations.
- F. All debris, or other material or substances that constitutes a hazard, in any form, liquid or solid, shall be cleaned off floors and other walking/working surfaces daily, (indoors or outdoors), or as often as necessary as conditions change/develop.

SCS-2. HEALTH AND SAFETY PLAN (HASP)

- A. The Contractor shall operate the construction site under this contract in accordance with a HASP that has been accepted by BNL.
- B. The Contractor shall prepare and submit a detailed Construction HASP within two (2) weeks of the Contract signing and before the commencement of any physical work on site. The HASP Outline/Template is available on the BNL Construction Safety Subject Area web page, a copy of the Template can also be requested through the BNL Contract Administrator. It is the Contractor's sole responsibility to fully develop an acceptable HASP for submittal to BNL.
- C. The Contractor shall make any revisions and corrections that are noted upon review of the HASP by BNL, and, when accepted, resubmit three (3) printed copies and one (1) electronic copy of the HASP in PDF format to the BNL Technical Representative for distribution.
- D. The HASP shall be revised as necessary to reflect changing hazard conditions.
- E. While an acceptable HASP is a contractual requirement and BNL undertakes to review the same for compliance, BNL is not obligated to accept such program, and neither the initial review nor any subsequent acceptance of the HASP by BNL shall mean that any omission or error contained in the HASP is waived by BNL or shall relieve the contractor of its obligations to conduct the project in an entirely safe manner and in accordance with all applicable safety statutes, requirements and standards.

SCS-3. HASP DOCUMENT ORGANIZATION / REQUIREMENTS

- A. The HASP shall be organized as per the BNL HASP Outline/Template, which provides the minimum requirements for the HASP. The Outline/Template is available on the BNL Construction Safety Subject Area web page, a copy of the Template can also be requested through the BNL Contract Administrator.
- B. Cover page shall include name of Contractor, name of Project, Contract number, revision number, date of revision(s), name and signature of Contractor Safety Representative approving the HASP.
- C. Table of contents listing all Sections and Exhibits.
- D. A brief description of the Project.
- E. Organization chart of Contractor and Subcontractor personnel responsible for implementing the HASP and their duties and responsibilities. The chart shall show the reporting relationship and integration of the Safety Representative and Alternate with all personnel, including top level managers; responsible for implementing the Health and Safety Plan, (HASP), Program. The chart will also show reporting relations of Competent Persons as defined in this section.

- F. The HASP shall include but not be limited to the following information and requirements as applicable to the project:
1. Compliance Letters
    - a. The contractor shall submit a letter or certificate of compliance indicating that the Contractor is aware of, and has reviewed, and will comply with, the safety regulations of the OSHA Standards (29 CFR 1910 & 1926), Standard for Electrical Safety in the Workplace (NFPA 70E), DOE Worker Safety & Health Program (10 CFR 851), F&O Directorate’s ES&H Procedures, BNL Standards-Based Management System (SBMS), and all other federal, state and local environmental, safety and health requirements applicable to the scope of work. (Contact the Contract Administer for access to or copies of applicable F&O and SBMS documents for this contract.) The letter shall be signed by an Officer of the Contractor’s company that shall include signatures of all Subcontractors, (continuously updated as they are retained by the Contractor).
    - b. A copy of one of the following:
      - 1) A copy of the company record of past injury, accident, fire and property damage experience, including motor vehicle, for the previous two (2) years, Experience Modification Rate (EMR) from Insurance Broker for previous (2) years, and Environmental Citations/Violations received for the last five years, if any, or
      - 2) Contractor’s OSHA 300 Logs for the current year and past three years, EMR from Insurance Broker for previous (2) years, and a list of OSHA and Environmental Citations/Violations received for the last three years, if any.
  2. Statement of Accident Prevention Program: Include a thorough description of the Contractor’s safety program including, but not limited to, the following as it applies to this Project:
    - a. Personal Protective Equipment (PPE): BNL has PPE requirements for work on the Project. Mandatory items shall be worn at all times as determined through the HASP. These PPE requirements include, but are not limited to:
      - 1) ANSI Compliant Z87.1 – Eye Protection (Mandatory): Grinding, chipping or other similar particle producing operations shall also require a face shield.
      - 2) ANSI Compliant Z89.1 1997 – Head Protection (Mandatory): SEI certified hard hats meeting the requirements for Type I Class E protection shall be properly worn and maintained (i.e., no bump caps or cowboy type hard hats).

- 3) ANSI/ISEA 107-2004, Class 2 Compliant High Visibility Reflective Apparel or Safety Vests (Mandatory): All Contractor employees shall wear flame retardant safety vests that have 360-degree reflective visibility; the front of the vest may be fitted with a transparent plastic pocket, flush mounted, to accommodate the BNL photo ID. The Contractor and all Subcontractors shall utilize safety vests with a label on the front and back identifying them as a “Contractor”.
    - a) A specific variance may be granted for not wearing Hi-Vis reflective vests that involves hot work activities i.e. welding, grinding, brazing etc, This variance must be evaluated and authorized, in writing, by BNL. Vests can be obtained from and are manufactured by:
      - (1) The Industries for the Blind of New York State, 296 Washington Avenue Extension, Albany, New York 2203-5316, Tel. (800) 421-9010, Fax (518) 456-3587.
  - 4) ANSI Z41-1991 Compliant Foot Protection (Mandatory): Shoes shall be durable and in good condition without breaks or splits, be at least six inches high, be equipped with a safety toe, and be completely laced or buckled. The shoes shall have defined heels that are no more than one inch high, (sneakers/gym shoes are prohibited). The sole of the footwear shall provide good traction under slippery conditions.
  - 5) Minimal Acceptable Clothing for Construction Work (Mandatory): Long pants, short-sleeved shirts, (4-inch sleeve minimum).
  - 6) Other PPE as required by Contractor’s scope of work, HASP, OSHA, DOE, and BNL.
- b. Contractor Safety Representative
- 1) The Contractor shall assign an individual employed by the Contractor as Safety Representative, and one (1) Alternate. The Contractor Safety Representative and Alternate will be responsible for safety on the job site whenever work is being conducted. Representative or Alternate shall be immediately available and present on the Construction Site whenever construction activities are being performed, otherwise work will not be conducted. These individuals shall be named in the HASP.
  - 2) The Contractor shall submit to BNL for acceptance the documentation that describes the qualifications of the proposed candidates for Safety Representative and Alternate for the awarded scope of work. Prior to acceptance, BNL may interview the candidate for Safety Representative or Alternate. The submitted documentation shall include for a 3-year

period, a description of the duties, responsibilities, accomplishments and safety record of preceding assignments from which the candidate has gained effective safety engineering experience. The Contractor shall not change the accepted Safety Representative or Alternate without receiving BNL's acceptance of the replacement. The Safety Representative and Alternate shall be subject to BNL's continuing acceptance.

- 3) A Multi-Discipline Contractor Safety Representative and Alternate shall:
  - a) have completed the "30-Hour OSHA Compliance for the Construction Industry" Outreach construction safety course;
  - b) have a working knowledge of the 29 CFR 1926 construction safety standards and 29 CFR 1910 General Industry standards as referenced by the construction safety standards
  - c) have a working knowledge of the requirements of 10 CFR 851 as they relate to construction safety; and
  - d) demonstrate the ability to effectively supervise and assure the safety of the type of work for which they will be responsible.
- 4) A Single-Discipline Contractor Safety Representative and Alternate shall:
  - a) have completed the "10-Hour OSHA" Construction Outreach course, and
  - b) demonstrate their ability to effectively supervise the type of work for which they will be responsible.
- 5) The Contractor Safety Representative shall maintain a daily site Safety Log for all project site safety matters. All safety-related activities including safety deficiencies and corrective actions taken shall be included in the Log. The Log shall be updated and signed daily reflecting safety issues by the designated Safety Representative. This Log shall be maintained on site and be available for BNL's review. It must also accompany the Safety Representative to Project progress meetings for discussion. Whenever the Safety Representative is not present, the responsibilities of maintaining the safety Log shall be that of the assigned Safety Alternate.

c. Competent Person(s)

- 1) Specific identification of "Competent Person(s)" is per OSHA. The Competent Person(s) qualifications include, but are not limited to, formal Construction Safety Awareness courses taken, applicable to the nature of this Project, and where applicable, the method of accomplishment in a

specific plan, i.e. fall protection, excavation, etc. Competent Person must have had formal, documented training, have knowledge of existing standards, and have authority to take actions deemed necessary.

- a) A “Competent Person” certification is not achieved by successfully completing a 10- or 30-hour Construction Outreach Safety training course. It is through specialized courses of instruction for that particular field or topic.
  - b) A “Competent Person” shall have the authority to stop the work if an unsafe condition develops or an unsafe act is occurring.
- 2) Competent Person(s) shall be designated in the HASP.
  - 3) Competent Person(s) shall be designated by the Contractor’s Safety Representative to oversee safety matters in an individual group performing work at individual work locations. They may be Subcontractor personnel and have other Project responsibilities in addition to their safety function. They shall be familiar with the work being performed, shall have appropriate OSHA-related training, be familiar with the hazards to be encountered at the particular Work Site, and shall be capable of being designated as the OSHA-defined “Competent Person”.
  - 4) An interview may be required with BNL to establish their competency and to secure the BNL’s acceptance/concurrence prior to their assignment as a Competent Person.
- d. Inspections: A written program to provide for the frequent (daily), written inspections and reporting of job site conditions relating to safety. These documents shall be available for inspection by BNL upon request.
- e. Walking and Working Surfaces
- 1) A written program describing the design, maintenance, protection and inspection of walking and working surfaces in compliance with the fall protection requirements of 29CFR1926 Subpart M.
  - 2) All workers on a working/walking surface 6 feet or more above a lower level shall be protected from falling by a guardrail system, a safety net system, or personal fall arrest system. This 6 feet requirement also applies to Steel Erection. The other requirements of 29CFR 1926 Subpart R apply to Steel Erection.
  - 3) Where a guardrail system is employed, and a controlled access zone has been established for leading edge work, the control line may be used in lieu of a guardrail system along the edge that parallels the leading edge

as described in the written and accepted site-specific fall protection program. The program shall include the designation of the “Competent Person”. The Contractor’s “Competent Person” shall have been formally trained in ANSI fall protection standards and safety, and have authority to take actions deemed necessary. See Section on “Competent Person(s)” in this section.

f. Contractor/Subcontractor Responsibilities

- 1) The Contractor shall include, and shall require the compliance with, all the applicable safety requirements of this contract in all contracts with all tiers of Subcontractors. The Contractor is totally responsible for the safety performance and compliance of subcontractors of any tier.
- 2) Prior to the start of work, a pre-construction meeting shall be scheduled by the Contractor with his subcontractors to review specific safety requirements of the project, including the HASP. The meeting will also include the following:
  - a) That BNL will not tolerate non-adherence to safety and environmental requirements under this Contract, including the HASP. Failure to comply will result in BNL’s direction to stop work in accordance with the Article titled: Compliance with 10 CFR 851 and BSA’s Worker Safety and Health Program. Non-compliance could also mean the barring of the violating individuals from the BNL Site. Repeated safety violations may also result in a permanent Work Stoppage under the same Article.
  - b) A verbal or written Stop Work Order may be imposed by BNL for specific work activities when site conditions are created or exist that pose unacceptable risks or imminent danger.
  - c) BNL reserves the right to refuse access to the Project Site, or require immediate removal from the Project Site, any individual violating or alleged to have violated established site safety, environmental, or Security regulations.
  - d) All debris, or other material or substances that constitutes a hazard, in any form, liquid or solid, shall be cleaned off floors and other walking/working surfaces daily, (indoors or outdoors), or as often as necessary as conditions change/develop.

3. Safety Training and Communication
  - a. A written program describing the training employees in the recognition and avoidance of unsafe conditions and in the safety regulations applicable to this Project.
  - b. The conducting of informal “tool box” safety and health training sessions at least weekly for all employees on the worksite. Depending on the size and nature of the project, this may be accomplished in single or multiple sessions and may address different topics for different work crews. Documentation of all “tool box” training sessions shall be prepared by the Contractor and annotated with the date, time, and names of all employees in attendance.
  - c. Provisions through meetings, established contacts, documents or other means, for the mutual exchange of information with Contractor and Subcontractor personnel on:
    - 1) Changes in scope of work
    - 2) Recognized hazards
    - 3) Identified inspection deficiencies
    - 4) Future phases of work
    - 5) Potential problem areas
    - 6) Coordination of crafts/trades
  - d. A written program to ensure that all employees and Subcontractors have been properly trained for the hazards anticipated on this project as specified in the Phase Hazard Analysis. Severe or repetitive safety violations shall be cause for permanent removal from the job site.
  - e. A written program to establish and implement a drug and alcohol-free workplace program.
    - 1) A single violation of this program shall result in the offending individual being removed from the job-site and recommendation for participation in an approved drug abuse assistance or rehabilitation program, and/or reporting to the civil authorities for criminal prosecution. BNL’s Contracting Officer shall be notified in writing within 10 days after receiving notice of an employee's or subcontractor employee’s conviction under a criminal drug statute for a violation occurring in the workplace. Notification shall include the position title of the employee and the appropriate personnel action to be taken within 30 days under the requirements of this program.

- 2) The program shall include ongoing mandatory documented drug-free awareness training, intervention procedures, and program enforcement.
  - 3) The program shall include pre-hiring and random and post accident drug and alcohol testing.
  - 4) The program shall identify the individual responsible for implementing this program.
4. Hazard Communication
- a. A written hazard communication program to inform employees and all sub-contractor employees of known chemical hazards that may exist in the workplace in compliance with OSHA 29 CFR 1910 Subpart Z. This program shall apply to chemicals known to be present in the workplace in such a manner that employees may be exposed under normal conditions, non-routine tasks, or foreseeable emergencies.
  - b. The program shall address labels and other forms of warning, Material Safety Data Sheets (MSDS) and employee information and training, a listing of hazardous chemicals known to be present in the workplace, methods for informing employees of hazards of non-routine tasks, and methods for informing employees and subcontractor employees of hazards they may be exposed to while working on the Project.
5. Emergencies: Fire, Medical, Environmental and Accidents
- a. A written program for response to emergencies, including emergency notification. The program shall address injury reporting, first aid, notification of BNL emergency and project personnel, and accident and injury investigation. The program shall also address fire protection and prevention, including hot work permits, fire watches, and fire extinguishers, in conformance with 29 CFR 1926 Subparts F and J. The Contractor shall identify and post indoor and outdoor assembly area locations and evacuation routes from the Project Site.
  - b. The Contractor shall have a program to protect the environment, to include spill prevention and response. The contractor is responsible to immediately notify BNL project/safety personnel of all injuries, and to conduct a thorough and timely accident investigation, determine the cause(s), and implement corrective and preventive measures. The Laboratory reserves the right to monitor all such investigations and causal analysis processes for all recordable injuries, and further reserves the right to conduct its own investigations.

6. Excavations

- a. A written program is required describing the design, maintenance, protection and inspection of excavations in compliance with 29 CFR 1926 Subpart P. The program shall include the designation of the “Competent Person”. The Contractor’s Competent Person shall have been formally trained in OSHA excavation standards and safety, and have authority to take actions deemed necessary. See Section on “Competent Person(s)” in this section.
- b. The Contractor shall submit to BNL for acceptance the documentation that describes the qualifications of the proposed candidate(s) for Competent Person. The program shall ensure all personnel engaged in work within excavations are trained on current project-specific excavation hazards prior to start of each shift.
- c. The soil at BNL is classified as Class C soil, and the excavation safety program shall comply with the requirements for that soil classification.

7. Concrete and Masonry Penetrations

- a. The Contractor shall ensure safe penetration into or through any existing concrete or masonry surface.
- b. BNL SBMS and F&O Directorate’s Policies and Procedures shall be followed, including the completion of appropriate Penetration Permits and the provision and use of utility locating/detecting equipment. The Contractor shall provide trained “Authorized Employees” and shall submit, for MPO review and approval, the name and type of the utility locating/detecting equipment to be used, as well as the names of the trained personnel who will perform the locating task with this equipment and who will execute the penetration work.
- c. Non-aggressive penetrations cannot be executed without first using utility locating/detecting equipment and obtaining approval by MPO.
- d. Aggressive penetrations cannot be executed without first using utility locating/detecting equipment followed by the completion and approval of a MPO Aggressive Penetration Permit.

8. Electrical Safety

- a. A program is required certifying the safe operating condition, and assuring the proper maintenance of, permanent and/or temporary light, power and electrical equipment, including protective devices (GFCI) for portable electric tools, in conformance with 29 CFR 1926 Subpart K.

- b. Working on or near energized electrical circuits will only be allowed when all methods available to perform the work in a de-energized state have been evaluated and determined to be infeasible. Working on or near energized conductors is subject to the restrictions and provisions of the Standard for Electrical Safety in the Workplace (NFPA 70E), and MPO Procedure DF-ESH-102 Electrical Safety.
- c. All Contractor and Subcontractor employees who work on or near energized parts as defined in NFPA 70E shall complete the BNL Electrical Safety 1 Training Course. The course is available on the Web at <http://training.bnl.gov/course/electsaf1>, and is valid for one (1) year. In addition to completing this course, each organization's Electrical Work Supervisor must discuss the "Standard for Electrical Safety in the Workplace" (NFPA 70E) requirements and specific hazard(s) and risk information with their staff. This job briefing shall discuss specific electrical work procedures, protective equipment requirements, and departmental contacts at the local application level. This job level discussion can be informal; however, a record of this briefing shall be documented. The Contractor shall ensure that all employees and subcontractor employees who may be required to "Work On or Near" electrical circuits within the BNL AC Distribution System and all associated equipment are trained and authorized employees. A "trained and authorized employee" is deemed to be an individual who has been qualified in the skills and knowledge related to the service, maintenance, construction and/or operation of electrical equipment and installations, and has received safety training on the hazards involved, including the wearing of the appropriate PPE.
- d. The Contractor shall provide documentation which clearly indicates the qualifications and training of all employees performing such work.
- e. All Contractor and Subcontractor employees that "Work On or Near" electrical circuits shall have taken and passed a CPR training program that has been accepted by BNL.
- f. The Contractor will arrange for the issuance of a "Working On or Near" Permit as required by DF-ESH-102 Electrical Safety. The Contractor shall give BNL a minimum of 48 hours notice of any requirement to "Work On or Near" to allow time for the BNL permitting process. "Working On or Near" operations that only involve testing, diagnostic work, and/or service tasks on equipment for voltages less than 600 Volts AC-to-ground may be covered by a Testing, Troubleshooting, and Voltage measuring Electrical Energized Permit, which may also cover the entire project period up to a maximum of one year. Operations involving "Working On or Near" for voltages greater than 50 Volts AC-to-ground may require a specific "Working On or Near" Permit for each

work situation required. Work may only proceed when the “Working On or Near” Permit is completed and all parties performing the work have been informed of the hazards involved and the PPE to be worn. An authorized Supervisor from the Contractor who is performing the work and a BNL-designated Manager must sign the permit before any work can be performed.

9. Mobile Equipment Program

- a. A program is required certifying the safe operating condition of, and assuring the proper maintenance of, earth-moving equipment, cranes, vehicles and other such heavy equipment, including an environmental protection spill prevention plan, in conformance with 29CFR 1926 Subparts N and O.
- b. A Rigging Plan shall be submitted in conformance with 29 CFR 1926.251 and the BNL Construction Safety Subject Area as a part of the HASP and in accordance with the conditions noted in the Supplementary Conditions clause, “SHOP DRAWINGS, MANUFACTURERS DATA, AND SAMPLES” whenever this equipment is to be used on Site. Incremental submission of the Rigging Plan is acceptable, but in no case shall be submitted less than four (4) working days prior to any scheduled lift. Acceptance of the Rigging Plan by BNL is required prior to the commencement of any lift.

10. Fall Protection

- a. A written program certifying that all temporary staging, platforms, scaffolding, planking, bracing, scaffold towers and walkway work are to be designed, erected, used, maintained, and dismantled in accordance with OSHA 29 CFR 1926 Subpart L, and BNL SBMS.
- b. The Contractor’s Competent Person shall have been formally trained in scaffold standards and safety, and shall assure that all personnel engaged in the erection and/or dismantling of scaffolding meet the definition of a “Competent Person”. See Section on “Competent Person(s)” in this section.
- c. Scaffolds shall be physically tagged as to their condition and verified by the “Competent Person” on a daily basis, when they are being used. The scaffold tagging system shall include:
  - 1) Green Tag: To be placed on all scaffolds at all access points by the designated competent person indicating that the completed scaffold complies with all regulatory requirements.
  - 2) Yellow Tag: To be placed on all scaffolds at all access points by the designated competent person indicating that the scaffolds are structurally sound, but an accessory such as a handrail cannot be installed due to the location of the scaffold, or the nature of the work to be

performed. Other forms of fall protection are required on all yellow-tagged scaffolds.

- 3) Red Tag: To be placed on scaffolds by the designated competent person on scaffolds that are damaged, defective, being constructed or dismantled indicating that no access is permitted by personnel not authorized to erect, dismantle or make repairs to scaffolds and in a visible location, preferably at the access points.
- d. The Contractor's scaffold "Competent Person" shall also assure that all personnel working on or from the scaffolds have been trained in the proper procedures and precautions while using the scaffolding. Tool Box training at the Site is acceptable.

#### 11. Lockout/Tagout Program

- a. A Lock-Out/Tag-Out program shall comply with OSHA 29 CFR 1926.417 and 29 CFR 1910.147, and BNL's LOTO Subject Area.
- b. Lock-Out/Tag-Out is the required method of control when performing service, maintenance, or construction around any machinery where personnel could be injured by startup of the equipment or release of stored energy. Sources of energy shall include, but not limited to, mechanical (kinetic/potential), electrical, electromagnetic, chemical, thermal, hydraulic, and pneumatic.
- c. Contractor shall provide his own locks in compliance with the BNL LOTO Subject Area, lockout devices, and red tags for Lock-Out/Tag-Out of energy sources(s). A logbook shall also be maintained and kept in a designated area assigned by BNL.

#### 12. Hot Work (Welding/Cutting & Open Flame Operations)

- a. Proper cutting/welding permits shall be obtained from the BNL Construction Inspector. The contractor will participate in the review for the permit and comply with all requirements on the permit. Cease operations if permit conditions cannot be met.
- b. Requirements of the SBMS Fire Safety Subject Area shall be observed.
- c. Hot Work Permits are required for:
  - 1) Welding and allied processes;
  - 2) Heat treating by use of open flame;
  - 3) Grinding;

- 4) Thawing pipe by open flame or resistance from electrical current flowing through the pipe;
- 5) Powder-driven anchors;
- 6) Hot riveting;
- 7) Thermite welding;
- 8) Brazing, braze welding, silver solder and soldering;
- 9) Similar applications producing or using a spark, flame, or heat.

13. Confined Space Entry

- a. When Confined Space Entry is required, the Contractor shall have a written Confined Space Entry Program which complies with OSHA 29 CFR 1910.146 and BNL Confined Space Subject Area (<https://sbms.BNL.gov>).
  - 1) The program shall require the “Competent Person” (as defined by OSHA) to:
    - a) Establish procedures and practices for safe entry.
    - b) Have air monitors to check concentration of oxygen, explosive/flammable gases and the specific contaminants of concern (e.g. hydrogen sulfide in sewer utility holes).
    - c) Test and monitor conditions to identify and evaluate hazards.
    - d) Prevent unauthorized entry.
    - e) Station an attendant outside permit spaces during entry.
    - f) Post procedures to summon rescuers and prevent unauthorized personnel from attempting rescue.
    - g) Develop a system for preparing, issuing, using, and canceling entry permits.
  - 2) Permits are required to include an identification of the confined space, its hazards, a list of authorized entrants, the purpose of their entry, and the date and duration of their permits; the current attendants and entry supervisor; and both the results of tests performed and any measures necessary to isolate the permit space and eliminate or control the hazards. The permit must also describe the acceptable entry conditions, emergency equipment and the means to summon rescue and emergency services.

- 3) Authorized entrants into confined spaces must be effectively trained to be aware of any hazards they may face and be able to recognize signs and symptoms of exposure. They must also be familiar with any emergency equipment in the confined space.

14. Respiratory Protection & Exposure Monitoring

- a. All work on this Project with regard to, and of, the conditions listed must be done within the occupational exposure limits for Industrial Hygiene hazards set in OSHA 29 CFR 1926, 29 CFR 1910, and ACGIH *Threshold Limit Values*® (see BSA LLC, General Terms and Conditions for Construction and Labor Hour Agreements, Article titled: Compliance with 10 CFR 851 and BSA's Worker Safety and Health Program). Compliance with the OSHA Permissible Exposure Limits and American Conference of Governmental Industrial Hygienists (ACGIH) *Threshold Limit Values*® shall be determined by representative personnel exposure monitoring and dosimetry conducted by the Contractor and his Industrial Hygienist. Monitoring shall be continuously performed during the total duration of the hazardous condition. The details of the project's exposure monitoring equipment, methods, and monitoring strategy shall be included in the Contractor's Environmental, Health and Safety Plan. Conditions that require industrial hygiene monitoring include, but are not limited to:
  - 1) Asbestos
  - 2) Beryllium
  - 3) Working with Chemicals, Adhesives, or Lead
  - 4) Release of Silica (grinding, drilling, core boring, jackhammering of concrete, masonry, mortar, etc.)
  - 5) Confined Spaces
  - 6) Heat Stress
  - 7) Carcinogens
  - 8) Noise and Hearing Conditions
  - 9) RF/Microwave/Non-Ionizing Radiation
  - 10) Static Magnetic Fields
- b. The Contractor is required to provide qualified monitoring and hazard assessment personnel (per DOE G440.1-3 *Occupational Exposure Assessment*) to conduct all Industrial Hygiene monitoring.

- c. The Contractor is required to conduct monitoring with calibrated equipment using NIOSH or OSHA approved methods, and to have analysis conducted by an American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing certified laboratory or by National Institute of Standards and Technology (NIST) traceable calibrated direct reading instrumentation. All instrumentation used for surveys shall have been calibrated in compliance with the manufacturer's specification prior to use in the field.
  - d. Copies of all equipment calibration, field sampling sheets, laboratory analysis reports, and hazard assessment evaluation reports are to be provided to MPO, in accordance with the Shop Drawings, Manufacturers Data, and Samples Section above.
15. Phase Hazard Analysis Program
- a. The Phase Hazard Analysis (PHA) shall provide BNL with a defined plan of action for identified hazards and comprehensive prevention methods for exposures to workers, the BNL populous/public, and property. The PHA shall identify the specific tasks to be completed, including access, egress, set-up and breakdown, under all expected or created environmental conditions. It shall include the method of work for completing these tasks, associated work hazards, and the corresponding equipment and methods that will be used to prevent loss to persons or property for all contracted work, including that of Subcontractors.
  - b. Subcontractors may develop their own PHA's and forward them to the General Contractor for their written approval, who will then forward the PHA's to BNL for acceptance.
  - c. The PHA shall be used as the basis for Contract coordination items and safety planning discussions in the Construction Management process.
  - d. BNL requires a minimum of 5 working days to review the Contractor's submitted PHA's.
  - e. Work shall not proceed on a task until the PHA has been accepted in writing by BNL.
  - f. Assistance in developing effective PHA's is available from the BNL Construction Safety Engineering Staff.
  - g. All workers shall comprehend the scope of work and safety instructions required to perform the job. All workers employed by the Contractor and all Sub-Contractors shall acknowledge, in writing, that they have read and understood the HASP and all subsequently accepted modifications and PHAs. If workers cannot read or speak English or are hearing impaired, an

interpreter shall be provided by the Contractor to ensure that the scope of work, information regarding hazards associated with the work-site, and safety requirements are relayed to them in a manner in which they can understand. The interpreter shall sign that he has explained the plan, and shall be at the work-site whenever these workers are on the job. The accepted HASP and all subsequently accepted modifications and PHAs shall be available at the job site to all Contractor and Sub-Contractor employees for review.

16. Sources of Radiation

- a. Lasers brought onto the BNL site must be reviewed by the BNL Laser Safety Officer. Only lasers which are Class 2, 3A, or 3R, will be permitted on the construction site.
- b. Only qualified and trained employees will be assigned to install, adjust, and operate laser equipment. Proof of qualification of the laser equipment operator will be available and in possession of the operator at all times. (Name of Contractor) will have the training documentation on file or it will be readily available.
- c. Areas in which lasers are used will be posted with standard laser warning placards.
- d. Only those devices labeled as Class 2 or 3a, or 3r (no greater than 5 milliwatts) will be used.
- e. Areas in which lasers are used will be posted with standard laser warning placards. These can be obtained from the BNL Laser Safety Officer.
- f. Beam shutters or caps will be utilized, or the laser turned off, when laser transmission is not actually required. When the laser is left unattended for a substantial period of time, such as during lunch hour, overnight, or at change of shifts, the laser will be turned off. Consideration to best mitigate laser beam transmissions to passing motorists will be evaluated.
- g. When it is raining or snowing, or when there is dust or fog in the air, the operation of laser systems will be prohibited where practicable; in any event, employees will be kept out of range of the area of the source and target during such weather conditions.
- h. Laser unit in operation should be set up above the heads of the employees, when possible.

17. Occupational Medicine Program

- a. A written program describing the comprehensive occupational medicine services provided to each of the Contractor employees and subcontractor employees who: work at BNL for 30 or more days in a 12 month period; or work for any length of time at BNL and are required by statute to be enrolled in a medical or exposure monitoring program. The services shall be provided by an occupational medicine provider (“OMP”) that:
  - 1) Plans and implements the occupational medicine services
  - 2) Is under the direction of a physician licensed in the state of New York.
  - 3) Is staffed by health care professionals with valid New York State licenses in their respective professions.
- b. These services shall be fully compliant with all provisions of Section 8 (“Occupational Medicine”) of Appendix A of the Federal Regulation 10 CFR 851.
- c. The contractor shall provide a written acknowledgement signed by the OMP that the medical surveillance and medical certification to be provided will be in compliance with OSHA, DOE or other statutory or contractual requirements, and will be fully compliant with the provisions of Section 8 (Occupational Medicine) of Appendix A of the Federal Regulation 10 CFR 851.

END OF SECTION 000900

DIVISION 02 – EXISTING CONDITIONS

SECTION 024119 – SELECTIVE STRUCTURE DEMOLITION

A. General:

1. Furnish all labor, materials and equipment necessary to provide selective demolition of selected portions of buildings or structures, selected site elements, and removal of construction indicated, including disconnection, capping and removal of affected utilities, salvage of existing items to be reused or recycled, and legal disposal of non-salvageable materials off the BNL Site.
2. All removed salvageable and non-salvageable materials and equipment shall pass through the vehicle radiation monitor prior to disposal on the BNL Site or exiting from the BNL Site for legal disposal.

B. Codes and Standards:

1. OSHA 29 CFR 1926
2. NESHAPS 40 CFR 61 Subpart M
3. BNL Standards-Based Management System; ES&H Standards (SBMS)
4. NFPA 241 Construction, Alteration and Demolition Operations
5. Suffolk County Sanitary Code 10
6. Rules and Regulations of the State of New York, Part 56 of Title 12.

C. Summary:

1. This Section requires removal and legal disposal, off the BNL Site, of the following:
  - a. Hazardous materials are not expected to be encountered in the Work. Notify MPO immediately if suspect materials are encountered.
  - b. Selective Demolition Work:
    - 1) Removal of interior partitions as indicated on drawings.
    - 2) Removal of doors and frames indicated "remove."
    - 3) Removal of existing windows in wall openings indicated to be blocked off.

D. Submittals:

1. General: Submit the following in accordance with the “Shop Drawings, Manufacturers Data, and Samples” Section of the Supplementary Conditions.
  - a. Proposed schedule of operations, including coordination for shutoff, capping, and continuation of utility services as required.
    - 1) Provide a detailed sequence of selective demolition and removal work to ensure uninterrupted progress of BNL's on-site operations.
    - 2) Coordinate with BNL's continuing occupation of those adjacent portions of the facility.
    - 3) Statement of Refrigerant Recovery.

E. Job Conditions:

1. Occupancy:
  - a. BNL will occupy portions of the building immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of BNL's normal operations.
  - b. Provide minimum of 72 hours advance notice to MPO of demolition activities that will affect BNL's normal operations.
2. Condition of Structures:
  - a. BNL assumes no responsibility for actual condition of structures to be demolished.
  - b. Conditions existing at time of inspection for bidding purposes will be maintained by BNL insofar as practicable. However, variations within structure may occur by BNL's removal and salvage operations prior to start of demolition work.
3. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed.
  - a. Storage or sale of removed items on site will not be permitted.
4. Protections: Provide temporary barricades and other forms of protection to protect BNL's personnel and general public from injury due to selective demolition work.
  - a. Provide protective measures as required to provide free and safe passage of BNL's personnel and general public to occupied portions of building.
  - b. Erect temporary covered passageways as required by authorities having jurisdiction.

- c. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
  - d. Protect from damage existing finish work that is to remain in place and becomes exposed during demolition operations.
  - e. Protect floors with suitable coverings when necessary.
  - f. Construct temporary insulated dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
  - g. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
  - h. Remove protections at completion of work.
5. Damages: Promptly repair damages caused to adjacent facilities by demolition work.
  6. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
    - a. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from MPO. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
  7. Flame Cutting: Do not use cutting torches for removal until work area is cleared of flammable materials. At concealed spaces, such as interior of ducts and pipe spaces, verify condition of hidden space before starting flame-cutting operations. Maintain portable fire suppression devices during flame-cutting operations. Comply with General Conditions.
  8. Utility Services: Maintain existing utilities indicated to stay in service and protect against damage during demolition operations.
    - a. Per NFPA 241.8-6, Utilities, electric service shall be reduced to a minimum and identified to leave no uncertainty as to which circuits are energized.
    - b. Comply with the Construction Safety clauses of the Supplementary Conditions, for Lock-Out/Tag Out procedure for electrical circuit interruptions.
    - c. Do not interrupt utilities serving occupied or used facilities, except when authorized, in writing, by MPO. Provide temporary services during interruptions to existing utilities, as acceptable to MPO.
    - d. Maintain fire protection services during selective demolition operations.

9. Environmental Controls: Use water sprinkling, temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.

a. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

F. Products:

1. Performance Requirements:

a. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

b. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

c. LEED Requirements for Building Reuse:

1) Credit MR 1.1 and Credit MR 1.2: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.

2) Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.

3) Credit MR 1.2 and Credit MR 1.3: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.

G. Execution:

1. Preparation:

a. General: Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.

1) Cease operations and notify MPO immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.

- 2) Provide protections as specified in Clause E above.
    - a) Where selective demolition occurs immediately adjacent to occupied portions of the building, construct dust-proof partitions of minimum 4-inch studs, 5/8-inch drywall (joints taped) on occupied side, 1/2-inch fire-retardant plywood on demolition side. Fill partition cavity with sound-deadening insulation.
    - b) Provide weatherproof closures for exterior openings resulting from demolition work.
  - 3) Locate, identify, stub off, and disconnect utility services that are not indicated to remain.
    - a) Provide bypass connections as necessary to maintain continuity of service to occupied areas of building. Provide minimum of 72 hours advance notice to MPO if shutdown of service is necessary during changeover.
  - 4) Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.
2. Demolition:
- a. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
    - 1) Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools. Work shall not proceed until utilities have been made safe.
    - 2) Locate demolition equipment throughout structure and remove materials to avoid imposing excessive loads on supporting walls, floors, or framing.
    - 3) Provide services for effective air and water pollution controls as required by BNL.
    - 4) Demolish foundation walls to a depth of not less than 12 inches below existing ground surface. Demolish and remove below-grade wood or metal construction. Break up below-grade concrete slabs.
    - 5) For interior slabs on grade, use removal methods that will not crack or structurally disturb adjacent slabs or partitions. Use power saw where possible. See G.2.a.1) for safing of utilities.

- 6) Completely fill below-grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel, or sand, free of trash and debris, stones over 6 inches in diameter, roots, or other organic matter.
  - b. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to MPO in written, accurate detail. Pending receipt of directive from MPO, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.
3. Disposal of Demolished Materials:
    - a. Remove from building site, debris, rubbish, and other materials resulting from demolition operations. Transport and legally dispose off BNL site.
      - 1) If hazardous materials are encountered during demolition operations, notify MPO immediately. Contractor must comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
      - 2) Burning of removed materials is not permitted on project site.
  4. Cleanup and Repair:
    - a. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections and leave interior areas broom clean.
      - 1) Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION 024119

DIVISION 22 – PLUMBING

SECTION 224200 – DOMESTIC COLD WATER SYSTEM

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. All work shall meet requirements of NSPC.
- B. This Section covers all domestic hot and cold water piping within the building line.
- C. Install Epco dielectric couplings at connections to hot water heaters.

1.2 RELATED SPECIFICATION SECTIONS

- A. The following sections of these specifications are to be referenced in order to provide a complete and functioning system of the piping system described in this section:
  - 1. Section 231000 "GENERAL PIPING"
  - 2. Section 231100 "PIPE HANGERS AND SUPPORTS"
  - 3. Section 231300 "IDENTIFICATION OF PIPING SYSTEMS"
  - 4. Section 232100 "PIPE AND EQUIPMENT INSULATION"
  - 5. Section 224230 "DISINFECTION OF POTABLE WATER SYSTEMS"

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

- A. Pipe (CW):
  - 1. 2" and Under: Type L hard-drawn copper tubing, conforming to ASTM-B88 and ANSI-H23.1.
- B. Fittings:
  - 1. 2" and Under: Wrought copper solder joint, conforming to ASTM-B75 and ANSI-B16.22.
    - a. 125 lb. class cast iron flanged fittings, conforming to ASTM-A126 Class B and ANSI-B16.1, may be used in lieu of carbon steel butt welding fittings for pipe sizes 2-1/2" thru 12".
- C. Unions:
  - 1. Copper Tubing: Nibco Figure 633, wrought copper, solder ends, conforming to ANSI-B16.22.

D. Flanges:

1. Copper Tubing: 150 lb. class cast brass, conforming to ASTM-145-4B and ANSI-B16.24.

2.2 VALVES

A. Shutoff, Vent, Drain, and Blowdown Valves:

1. 2" and Under: Nibco Figure T-595 screwed ends or Figure S-595 solder ends; Powell Star Figure 4201T-SE screwed ends or Figure 4201T-TE solder ends; or Conbraco "Apollo" Figure 82 Series 100 screwed ends or Figure 82 Series 200 solder ends; 150 lb. class, reinforced TFE seats and seals, 3 piece, bronze body ball valve. No substitutes permitted.

B. Check Valves:

1. 2" and Under: Crane Figure 36 screwed ends, or Figure 1340 solder ends, 200 lb. class, bronze body, "Y" pattern, regrinding type swing check.

2.3 MISCELLANEOUS EQUIPMENT

A. Strainers:

1. 2" and Under: Sarco Type BT, 250 lb. class, bronze body, screwed ends.

PART 3 – EXECUTION

3.1 JOINTS

- A. Joints shall be 94/6 soldered, screwed, butt welded, and flanged.

END OF SECTION 224200

DIVISION 22 – PLUMBING

SECTION 224230 – DISINFECTION OF POTABLE WATER SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Disinfection shall meet requirements of AWWA-C651 "Disinfecting Water Mains."
- B. Perform disinfection in the presence of PE.

PART 2 – PRODUCTS

PART 3 – EXECUTION

3.1 DISINFECTION

- A. Disinfect all new domestic hot and cold water systems as follows:
  - 1. Flushing: Run clean water through entire system of sufficient quantity and velocity to flush out all foreign matter.
  - 2. Disinfecting: Inject chlorine into system either as a gas or solution allowing enough water through to mix with the chlorine to carry it down the main to prevent back up of concentrated mixtures. When proper residual of 50 ppm has been obtained, as proved by tests taken at designated outlets, secure all outlets and allow solution to remain in system for 24 hours.

3.2 TESTING

- A. After solution has remained in system for 24 hours take samples at test points, and deliver samples to an approved laboratory for bacteriological analysis.
  - 1. Analysis shall determine if samples meet with AWWA and USPHS potability standards.
  - 2. Submit test results to PE no later than two (2) weeks from date of delivery of samples to the laboratory.
- B. If tests do not meet with the above standards, repeat flushing and disinfecting procedures.
- C. Acceptance: After PE has accepted the system, flush and refill system as directed.

END OF SECTION 224230

DIVISION 23 – HVAC

SECTION 230100 – GENERAL MECHANICAL REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The General Conditions and Supplementary Conditions of these specifications apply to this section. Consult them in detail for applicable instructions.
- B. This Section, "230100", governs all requirements as applicable to the mechanical work specified in other Sections of Divisions 21, 22 and 23.

1.2 REFERENCE STANDARDS

- A. The documents of the Societies and Associations listed below that are in effect on the date the Contract is let out, form a part of this Specification. Specific references to various sections of these documents are made throughout the text of this Specification and do not infer that only they are to be adhered to.

1.	AABC	Associated Air Balance Council
2.	ADC	Air Diffusion Council
3.	AMCA	Air Movement and Control Association Inc.
4.	ANSI	American National Standards Institute
5.	API	American Petroleum Institute
6.	ARI	Air Conditioning and Refrigeration Institute
7.	ASA	Acoustical Society of America
8.	ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers.
9.	ASME	American Society of Mechanical Engineers
10.	ASNT	American Society for Non-Destructive Testing
11.	ASPE	American Society of Plumbing Engineers
12.	ASTM	American Society for Testing and Materials
13.	AWS	American Welding Society
14.	AWWA	American Water Works Association
15.	CFR	Code of Federal regulations
16.	CGA	Compressed Gas Association
17.	CTI	Cooling Tower Institute
18.	EPA	Environmental Protection Agency
19.	FM	Factory Mutual System
20.	IEEE	Institute of Electrical and Electronic Engineers
21.	MSHA	Mine Safety and Health Administration
22.	MSS	Manufacturer's Standardization Society
23.	NEBB	National Environmental Balancing Bureau

24.	NSPC	National Standard Plumbing Code
25.	NEMA	National Electric Manufacturers Association
26.	NIOSH	National Institute for Occupational Safety and Health
27.	NFPA	National Fire Protection Association
28.	NVLAP	National Voluntary Laboratory Accreditation Program
29.	NYCRR	New York Codes, Rules and Regulations
30.	OSHA	Occupational Safety and Health Administration
31.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
32.	UL	Underwriters Laboratories Inc.
33.	USPHS	United States Public Health Service

### 1.3 GENERAL SCOPE

- A. Provide materials, tools, labor, and equipment necessary to furnish, deliver, erect, install, connect, test, and adjust mechanical systems and related work

### 1.4 DRAWINGS, SPECIFICATIONS AND SHOP DRAWINGS

- A. Turn over to each Subcontractor a full set of Drawings and Specifications, and to individual Subcontractors concerned one set of Shop Drawings. Drawings, Specifications, and Shop Drawings of BNL provided equipment are available at PE.

### 1.5 BNL PROVIDED EQUIPMENT

- A. Install BNL provided equipment listed in Supplementary Conditions, as indicated on Drawings, and in strict accordance with manufacturer's installation instructions available at PE.
- B. Provide necessary connecting ductwork, piping, supports, and appurtenances necessary to make equipment operational and functional.

### 1.6 SHUTDOWNS

- A. See "SERVICE INTERRUPTIONS" in General Conditions.
- B. Piping Systems (Except Sprinkler): PE will shut off, drain, and refill piping systems as required for removal, extension, and connection of existing and new systems.
- C. Ductwork Systems: PE will de-energize fans serving ductwork to be removed and extended.

### 1.7 STEEL SHAPES AND RODS

- A. Steel shapes and rods used as stiffeners, reinforcing, and hangers in ductwork and piping systems shall be carbon steel conforming to ASTM-A36, unless otherwise indicated.

1.8 WELDING

- A. Welding shall be done by competent welders in accordance with AWS D10.9, AR-3 "Code for ARC and Gas Welding in Building Construction."
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- C. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

1.9 GALVANIZED METAL REPAIR AT WELDMENTS

- A. Repair damaged hot-dip galvanizing at weldments applying Z.R.C. cold galvanizing compound aerosol spray in several passes to ensure all bare metal is protected. Prior to applying compound, thoroughly wire brush weldments to remove slag residue and weld spatter, and clean surfaces with Z.R.C. metal conditioner.

1.10 RIGGING

- A. All equipment rigging shall be performed by a qualified rigger in the presence of PE.
- B. Prior to rigging, submit a rigging plan for approval.
- C. Exercise extreme caution in all operations and make good at own expense, as approved, any damage incurred to BNL property.

1.11 WORK "ON OR NEAR" ELECTRIC CIRCUITS

- A. All Contractor and/or Subcontractor employees required to perform work "on or near" electric circuits shall complete the appropriate NFPA 70E training as outlined in the "Contractor Training Requirements" section of the General Conditions (GC-12). No work is to commence unless the said employees meet the training requirements of Section GC-12. In addition, the mechanical Contractor(s) shall institute a "Lockout/Tagout" (LOTO) Program as outlined in the "Construction Safety" section of the Supplementary Conditions (SC-22).

END OF SECTION 230100

DIVISION 23 – HVAC

SECTION 231000 – GENERAL PIPING

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Exercise extreme care to prevent foreign matter and moisture from entering piping systems and mechanical components during installation.
- B. Pipe shall be new, free from flaws and laminations of any kind, straight and of the longest commercially available lengths. Do not use waste and short lengths for making up pipe runs. Each length of pipe shall be marked with name or brand of manufacturer, kind of pipe, and specification type.
- C. Size pipe as indicated on drawings. Increase and reduce pipe sizes at equipment connections only.
- D. Where dimensions are not shown, piping layout is fitting to fitting.

1.2 GENERAL EXECUTION

- A. Install piping square and true with walls and partitions, in wall chases, pipe shafts, recesses, and above hung ceilings, in such a manner not to interfere with operation of existing valves, established head room, aisle clearances, removal of equipment, electrical fixtures, and access doors.
- B. Install piping free of sags or bends and with ample space between piping to permit proper insulation application.
- C. At connections of dissimilar piping material, i.e., copper-to-steel pipe, install Epco dielectric couplings, gasketed copper-to-steel companion flanges, or bronze bodied valves.
- D. Provide all pipe strainers with blowdown valves.
- E. Install shut-off valves at main in all branch lines.
- F. All piping and tubing offsets and directional changes shall be made with fittings. Bending of pipe and tubing is not permitted.
- G. Provide unions and companion flanges to facilitate removal and servicing of equipment and related accessories.

## PART 2 – GENERAL MATERIAL

### 2.1 MISCELLANEOUS FITTINGS AND SPECIALITIES

- A. Nipples: Close nipples are not permitted. Nipples 4" long and smaller shall be Schedule 80.
- B. Elbows: Elbows shall be long radius type, unless otherwise indicated.
- C. Pipe Sleeves: Penetrations shall have Schedule 40 galvanized steel pipe sleeves of at least 1" larger diameter than outside diameter of pipe or pipe insulation passing through sleeve. Annular space between sleeve and pipe or insulation shall be fitted and tightly caulked with mineral or glass wool.
  - 1. Wall sleeves shall be flush with wall.
  - 2. Floor sleeves shall project 3/4" above finished floor.
  - 3. Roof sleeves shall project 8" above roof. For pitch pocket and flashing details see Drawings.
- D. Escutcheons: For steel and insulated piping escutcheons shall be rough cast iron, for bare copper tubing, escutcheons shall be polished cast brass.
  - 1. Wall escutcheons shall be split low type.
  - 2. Floor escutcheons shall be split high type.

## PART 3 – EXECUTION

### 3.1 PIPE JOINTS

- A. 94/6 Soldered: Cut tube ends square with a wheel cutter designed for copper tube work. Use a sizing tool to correct all tube distortions. Remove burrs from inside and outside of cut edge, and clean joining surfaces with steel wool or sand cloth until all discoloration is removed, and metal is smooth and bright. Apply a thin, uniform, and complete coating of J. W. Harris Stay-Clean soldering flux to cleaned surfaces of tube and fitting. After tube has been inserted into fitting, revolve tube or fitting to spread flux evenly. Apply heat from a single-flame or multi-flame circular torch to fitting. Test heat by touching fitting with J. W. Harris Stay-Brite 8, 94/6 Tin-Silver solder. When fitting reaches solder flow temperature, remove heat, and apply solder to edge of fitting. Feed solder at one or two points along joint, do not feed solder around full circumference of joint. When a ring of solder appears around full circumference of tube at fitting, joint is complete. Let solder cool to plastic state, and remove excess solder with a cloth or brush, leaving a fillet of solder in chamfer at end of fitting.

- B. Screwed: Cut pipe square, and ream after threading to a diameter slightly larger than I.D. of pipe. Cut thread full depth of die.
1. 2" and under: Make up joints with Hercules Chemical Co. Teflon tape dope. Starting with entry thread, wrap tape tightly in a clockwise direction, as viewed from pipe end, overlapping each wrap 1/4" until entire thread is covered.
  2. 2-1/2" and over: Make up joints with Permatex pipe dope. Do not use pipe dope on plastic pipe threads, use tape dope as specified above.
- C. Solvent Cemented: Cut pipe square, and remove burrs on inside and outside of cut edge. Chamfer end of pipe, and clean joining surfaces of pipe and fitting with PVC primer. Apply a uniform and complete coating of Schedule 80 PVC solvent cement to entire fitting socket, including shoulder at socket bottom, and pipe O.D. to be inserted in fitting including cut end of pipe. Join pipe and fitting immediately by rotating fitting or pipe 1/2 turn while pipe is seated into full depth of fitting socket. Hold pipe and fitting together until cement takes hold. Primer and cement shall be as recommended by pipe manufacturer, and conform to ASTM-D2564.
- D. Flanged:
1. Gaskets: Ring-type, 150 lb. class
    - a. For All Systems, Except Steam and Condensate: 1/16" thick Teflon gasket material.
  2. Bolts:
    - a. All except HPS and HPC: Steel, square headed machine, or full threaded stud bolts, conforming to ASTM-A307 Grade B and ANSI-B1.1 coarse thread series Class 2A fit.
  3. Nuts:
    - a. All except HPS and HPC: Heavy duty, hexagon, conforming to ASTM-A307 and ANSI-B18.2, tapped in accordance with ANSI-B1.1 coarse threaded series Class 2B fit.
- E. Butt Welded: Single Vee-Groove weld butt joint performed by competent welders in accordance with AWS Code, and code for Pressure Piping ANSI-B31.1 Clean all surfaces to be welded of oxide, protective coating, dirt, grease, and other foreign matter by mechanical means. Cleaning shall extend back from top of bevel on outside, and from face of flange on inside of joint 1/4". Use standard weight groove-type welding rings with knock-off spacer pins Tube Turns Figure 960 for field welding of pipe 2-1/2" in diameter and over.
- F. Piping within Data Center ceiling and raised floor shall be either soldered or screwed. Welding in the ceiling and raised floor is not permitted.

END OF SECTION 231000

DIVISION 23 – HVAC

SECTION 231100 – PIPE HANGERS AND SUPPORTS

PART 1 – GENERAL

1.1 GENERAL INSTALLATION

- A. Pipe hangers and supports, i.e. beam clamps, rods, inserts, clevises, anchors, guides, and accessories shall be black steel and conform to ANSI-B31.1, unless otherwise indicated.
- B. For additional instructions concerning hangers and supports of sprinkler piping see Section 219150, PART 3 - EXECUTION.
- C. Support piping from structural members, concrete slabs, walls, and columns. Do not hang piping from other piping, conduits, equipment, and ducts.
- D. Install supports and hangers so they will not be disengaged by movement of the supporting pipe, or interfere with equipment, access doors, and valves.
- E. Support riser piping independently of the connected horizontal piping.
- F. Do not drill, tap, or notch structural steel members for fastening of pipe hangers and supports.

PART 2 – PRODUCTS

2.1 STRUCTURAL ATTACHMENTS

- A. Structural Steel: Figure Numbers are Anvil International, Inc. (formerly ITT Grinnell).

<b>Pipe Size (in.)</b>	<b>C-Clamps (Figure)</b>	<b>Beam Clamps (Figure)</b>	<b>Side Beam Clamps (Figure)</b>
½ thru 2	87 w/89	134	14
2½ thru 5	N.A.	134	14
6 & 8	N.A.	228	14
10	N.A.	228	N.A.
12	N.A.	228	N.A.

N.A. = Not Applicable

- B. Existing Concrete Slabs: Phillips Model R self-tapping rod hanger concrete fastener.
- C. New Concrete Work: Anvil International, Inc. Figure 152 malleable iron screw concrete insert.
- D. Columns and Walls: Anvil International, Inc. carbon steel welded bracket, Figure 195 for maximum load up to 1500 pounds, and Figure 199 for maximum load up to 3000 pounds.

- E. Floor Penetrations:
  - 1. Steel Piping: Anvil International, Inc. Figure 261 black carbon steel riser clamp.
  - 2. Copper Tubing: Anvil International, Inc. Figure CT121 copper finished carbon steel riser clamp with plastic coating.
- F. Wood Beams: Anvil International, Inc. Figure 202 black malleable iron side beam bracket for lag screw fastening to beam.

## 2.2 PIPE SUPPORTS

- A. Single Pipe Supports:
  - 1. Clevises: Provide with three (3) nuts to lock clevis to hanger rod.
    - a. Bare Steel Piping: Anvil International, Inc. Figure 260 adjustable clevis.
    - b. Insulated Steel Piping:
      - 1) Anvil International, Inc. Figure 300 adjustable clevis for insulated pipes, where pipe temperature is not more than 15 degrees F above or below ambient temperature.
      - 2) Anvil International, Inc. Figure 260 adjustable clevis, where pipe temperature is between 16 and 100 degrees F above ambient temperature
      - 3) Anvil International, Inc. Figure 181 adjustable steel yoke pipe roll for insulated pipes, where pipe temperature is more than 100 degrees F above ambient temperature, or pipe is subject to expansion or contraction.
    - c. Bare Copper Tubing:
      - 1) 4" and Under: Anvil International, Inc. Figure CT65 copper plated carbon steel adjustable clevis.
      - 2) 4" and Over: Anvil International, Inc. Figure 260 carbon steel adjustable clevis.
    - d. Bare and Insulated PVC and Plastic Piping, and Insulated Copper Tubing: Anvil International, Inc. Figure 260 adjustable clevis with pipe shields Figure 167.
    - e. Cast Iron Pipe: Anvil International, Inc. Figure 590 black carbon steel adjustable clevis hanger.
  - 2. Hangers Rods: Anvil International, Inc. Figure 146 continuous thread, or Figure 140 threaded ends, carbon steel with black finish. Maximum load carried by hanger rods shall be as follows:

Nominal Rod Diameter (in.)	Pipe Size (in.)	Maximum Concentrated Load (pounds @650 degrees)
3/8	1/2 thru 2	610
1/2	2½ thru 8	1130
5/8	10	1810
3/4	12	2710

B. Multiple Pipe Supports: Use angle and tubular trapeze hangers to support overhead piping in groups. Spacing of hangers shall be for smallest diameter pipe in group.

1. Angle Trapeze Hangers: Black carbon steel, with rod holes a minimum of one (1) inch from ends.

Angle Length (in.)	Rod Hole Center to Center (in.)	Angle Size (in.)	Hanger Rod Size (in.)	Maximum Concentrated Load (pounds)
10	8	1½ x 1½ x 1/4	3/8	900
12	10	2 x 2 x 1/4	1/2	1500
18	16	3 x 3 x 1/4	1/2	2500
24	22	4 x 3 x 3/8 (L.L.V.)	5/8	3000
30	28	5 x 3 x 3/8 (L.L.V.)	3/4	4500
36	34	6 x 4 x 3/8 (L.L.V.)	3/4	5000

(L.L.V.) Long Leg Vertical

2. Tubular Trapeze Hangers: Anvil International, Inc. Figure 46 black carbon steel.

Length (in.)	Size (in. x in. x in. x #/ft)	Hanger Rod Size (in.)	Maximum Concentrated Load (pounds)
36	1/4 x 4 x 4 x 12.00	7/8	5100
48	1/4 x 6 x 4 x 15.42	1	6000
60	1/4 x 8 x 4 x 18.00	1-1/8	8000

### 2.3 PIPE SHIELDS AND SADDLES

A. Provide where insulated pipe and insulated tubing is resting on supports and trapezes.

1. Insulated Copper Tubing: Anvil International, Inc. Figure 167 galvanized carbon steel 180 degrees circumference insulation protection shields.

2. Insulated Steel Pipe:

- a. Anvil International, Inc. carbon steel pipe covering protection saddle.
- b. Anvil International, Inc. Figure 167 may be used in lieu of protection saddle only in conjunction with Anvil International, Inc. Figure 260 clevis hanger.

PART 3 – EXECUTION

3.1 SPACING OF HANGERS SUPPORTING HORIZONTAL PIPING AND TUBING

A. Threaded and Welded Steel Piping, and Uninsulated Soldered Copper Tubing:

Pipe Size (in.)	Maximum Span (ft.)	Pipe Size (in.)	Maximum Span (ft.)
1/2	5	4	12
3/4	6	5	16
1	6	6	17
1¼	7	8	19
1½	8	10	22
2	9	12	23
2½	10	14	25
3	10		

- B. Insulated Copper Tubing with Pipe Shields: Maximum span is limited to ten (10) feet.
- C. Provide additional hangers and supports at offsets, at end of branches, at concentrated loads, i.e., valves, strainers, flanges, and as required to provide a properly supported system.

3.2 SUBMITTALS

- A. Submit marked-up piping drawings showing hanger locations, model numbers, types, sizes, and typical support arrangements and details.

END OF SECTION 231100

DIVISION 23 – HVAC

SECTION 231200 – PIPING SPECIALITIES

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

PART 2 – PRODUCTS

2.1 VACUUM BREAKERS AND AIR VENTS

- A. Vacuum Breakers: Hoffman Specialty Model 62, 3/4" screwed connection, 150 lb. class, with 1/4" to 4" Hg. vacuum adjustment.
- B. Automatic Air Vents: Spirax Sarco Model AE30A [AE30C] automatic air vent with dezincification resistant copper alloy body, EPDM valve head, check valve [and lockshield valve].
- C. Air Eliminators: Watson McDaniel Model AV813W or Spirax Sarco Model 13WS. Cast iron body and cover, stainless steel internals, Viton seat for elevated temperatures and tight shut-off.

END OF SECTION 231200

DIVISION 23 – HVAC

SECTION 231300 – IDENTIFICATION OF PIPING SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. All piping system identification shall meet requirements of ANSI-A13.1 "Scheme for the Identification of Piping Systems," and ANSI-Z535.1 "Safety Color Code for Marking Physical Hazards."
- B. Buried piping is not covered by this Section.
- C. Provide piping content identification legends and directional flow arrows on all systems installed under this Contract. Where flow is multidirectional, use double headed arrows.
- D. Provide systems having temperatures above 120°F or pressures more than 40 psig with legends indicating those temperatures and pressures.
- E. Electric and steam traced insulated piping shall have a legend identifying the tracing.

PART 2 – MATERIAL

2.1 LEGENDS AND FLOW ARROWS

- A. Legends and Flow Arrows: Seton Name Plate Corp., Setmark System Type SNA for 5" and under diameter piping and covering, and Type STR for 6" and over diameter piping and covering. Minimum color field lengths, letter heights, field and letter colors, and legends shall be as follows:
- B. Color Field Lengths and Letter Heights

<b>Nominal Diameter of Piping or Covering</b>	<b>Minimum Length of Color Field</b>	<b>Letter Heights</b>
1-1/4" and Under	8"	1/2"
1-1/2" thru 2"	8"	3/4"
2-1/2" thru 6"	12"	1-1/4"
8" thru 10"	24"	2-1/2"
10" and Over	32"	3-1/2"

C. Field and Letter Colors

System Legends	Field Colors	Letter Colors
Chilled Water Supply	Green	White
Chilled Water Return	Green	White
Domestic Cold Water	Green	White
Hot Water Heating Supply	Yellow	Black
Glycol Supply	Green	White
Glycol Return	Green	White
Drain	Green	White

2.2 VALVE TAGS

- A. Seton Name Plate Corp. Style 300-BL, 2" diameter tags on all valves installed. Include on tag respective legend as indicated below, and number as shown on Chart.
  - 1. CW for cold water valves.
  - 2. DR for drain valves.
  - 3. CHWS for chilled water supply valves, as required for respective system.
  - 4. CHWR for chilled water return valves, as required for respective system.
  - 5. GLS for glycol supply valves, as required for respective system.
  - 6. GLR for glycol return valves, as required for respective system.
  - 7. HHWS & HHWR for heating hot water.

2.3 VALVE CHARTS

- A. Provide and mount as directed, in a suitably glazed frame, a typewritten chart giving valve number, whether valve is N.O. or N.C., location, and function of each valve installed.

PART 3 – EXECUTION

3.1 LEGENDS

- A. Install legends close to valves, and where pipes change direction, branch, and pass through walls, floors, and roofs. Legend intervals shall not be greater than 25 feet on straight pipe runs. Legends and flow arrows shall be visible to a person standing on the floor.

3.2 TAGS

- A. Secure tags to valve handles with Seton Name Plate Corp. Catalog 820 brass "S" hooks. Drill lever handle of ball valves to attach "S" hook.

END OF SECTION 231300

DIVISION 23 – HVAC

SECTION 232100 – PIPE AND EQUIPMENT INSULATION

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. This Section covers all piping and equipment insulation not buried, inside and outside the building.
- B. Composite insulation, jacket, and adhesive shall be UL labeled and listed, have a flame spread of 25 or less, a smoke developed rating of 50 or less, and meet requirements of ASTM-E84 and NFPA 255. High density and expanded plastics will not be accepted regardless of fire retardant additives or manufacturer's claims.
- C. Asbestos or asbestos-containing insulation materials will not be accepted.
- D. To the maximum extent, pipe and equipment insulation shall be supplied from manufacturers that produce these products with the use of recoverable (recycled) materials as required by Federal Regulation 40 CFR 247.
- E. Do not insulate piping until systems, including electric tracing, have been tested, and accepted.
- F. Insulation shall be continuous thru wall, ceiling, floor, and roof openings and sleeves.
- G. Apply insulation in strict accordance with manufacturer's installation instructions.

1.2 APPLICATION

- A. Insulate all piping systems and equipment listed below in accordance with the table in Section 3.1
  - 1. Hot Water Heating supply and return piping.
  - 2. Domestic Cold Water piping.
  - 3. Chilled Water supply and return piping (CHWS&R).
  - 4. Glycol supply and return piping (GLS&R).
  - 5. Drain piping.
- B. Cold Equipment (below ambient temperature): Insulate the following cold equipment:
  - 1. Glycol pumps.

PART 2 – PRODUCTS

2.1 PIPE INSULATION

- A. Johns-Manville Micro-Lok® Fiberglass Pipe Insulation, AP-T Plus jacket, one piece heavy density fiberglass applied to pipe with all seams and end joints butted tightly. Use self-sealing laps to seal longitudinal seams. Use Johns-Manville 3" wide butt strips with self-sealing adhesive to seal butt joints. Provide outward clinching staples on 2" centers on laps and two (2) staples per butt strip when ambient air around insulation will be below 15°F or above 130°F.

2.2 FITTING, VALVE, AND FLANGE INSULATION

- A. 3" and Under: Johns-Manville Microlite 1 lb./cu. ft. density fiberglass blanket insulation. Wrap insulation firmly around fitting compressed to thickness of adjoining insulation, secure with 20 gauge galvanized annealed steel wire, and apply a smooth coat of Johns-Manville Insulkote® Weather Protective Coating.
- B. 4" and Over: Secure segments of molded pipe insulation to fitting with 20 gauge galvanized annealed steel wire, and coat with Johns-Manville 375 Insulating and Finishing Cement to thickness of adjoining pipe insulation.
- C. Johns-Manville Zeston® 2000 PVC, pre-molded insulated fitting covers and jacketing, may be used in lieu of, or in combination with, insulation methods described above.

PART 3 – EXECUTION

3.1 PIPE INSULATION THICKNESSES

Systems	1-1/2" Pipe & Under	2" to 4" Pipe	5" to 6" Pipe	8" Pipe & Over
Hot Water Heating Supply and Return	1½"	2"	3"	3½"
Chilled Water Supply and Return	1½"	1½"	1½"	1½"
Glycol Supply and Return	1½"	1½"	1½"	1½"
Domestic Cold Water	1	1	1	1

3.2 ALL FITTINGS, VALVES, AND FLANGES

- A. Apply a layer of 10 x 20 mesh glass cloth, lapped 2" on itself and adjoining insulation. Embed glass cloth between two (2) 1/16" thick coats of Epolux sealer, as indicated below:
  1. For hot water systems use Epolux Cadalag 336 or Cadalon 510 sealer.
  2. For domestic cold water, drain, glycol and chilled water systems use Epolux Cadolar 670 sealer.

- B. Protective Jacketed Insulation: Apply .016" thick Childers Aluminum Roll Jacketing over all exposed interior pipe risers from floor level to eight (8) feet above floor.
- C. Glycol Pump Package Insulation:
  - 1. Encase pump package with removable enclosure furnished by drycooler manufacturer lined with two inch thick fiberglass board.
    - a. Fill voids between insulation and pump housing with Armaflex sheet insulation.
    - b. For fluids below 65°F. vapor seal closure joints of metal casing.

END OF SECTION 232100

DIVISION 23 – HVAC

SECTION 232217 – HOT WATER HEATING SYSTEM

PART 1 – GENERAL

1.1 GENERAL INFORMATION

- A. This Section covers all hot water heating piping within the building.

1.2 RELATED SPECIFICATION SECTIONS

- A. The following sections of these specifications are to be referenced in order to provide a complete and functioning system of the piping system described in this section:
  - 1. Section 231000 "GENERAL PIPING"
  - 2. Section 231100 "PIPE HANGERS AND SUPPORTS"
  - 3. Section 231300 "IDENTIFICATION OF PIPING SYSTEMS"
  - 4. Section 232100 "PIPE AND EQUIPMENT INSULATION"

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

- A. Pipe (HHWS and HHWR):
  - 1. Schedule 40 black steel, conforming to ASTM-A53.
  - 2. Type L hard drawn copper tubing, conforming to ASTM-B88 and ANSI-H23.1 may be used in lieu of Schedule 40 black steel for pipe sizes 2" and under.
- B. Fittings:
  - 1. 2" and Under: Standard 150 lb. class malleable iron screwed, conforming to ANSI-B16.3 or wrought copper solder joint, conforming to ASTM-B75 and ANSI-B16.22.
- C. Unions:
  - 1. Copper Tubing: Nibco Figure 633, wrought copper, solder ends, conforming to ANSI-B16.22.
  - 2. Steel Pipe: Grinnell Figure 463, 150 lb. class, bronze-to-iron ground joint, conforming to ANSI-B2.1.

## D. Flanges

1. Welded and Threaded Steel Pipe: 150 lb. class carbon steel, conforming to ASTM-A105 and ANSI-B16.5. Figure numbers are Tube Turn's.
  - a. Welding Neck Flanges: Figure 30.
  - b. Slip-On Flanges: Figure 50.
  - c. Threaded Flanges: Figure 60.
  - d. Blind Flanges: Figure 70.
- E. Elbolets and Thredolets: Bonney Forge, carbon steel, 3000 lb. class, conforming to ASTM-A105 Grade II.
- F. Weldolets: Bonney Forge, carbon steel, extra strong class butt welding end connection, conforming to ASTM-A105 Grade II.

## 2.2 VALVES

## A. Shutoff, Vent, Drain, and Blowdown Valves:

1. 2" and Under: Nibco Figure T-595-Y screwed ends or Figure S-595-Y solder ends; or Powell Star Figure 4201T-SE screwed ends or Figure 4201T-TE solder ends; or Worcester Figure 411TSE screwed ends or Figure 411TTE solder ends; 150 lb. class, ball valve. No substitutes permitted.

## B. Calibrated Balancing Valves: Tour &amp; Andersson Model STAD-NPT threads.

## C. Check Valves:

1. 2" and Under: Crane Figure 36 screwed ends or Figure 1342 solder ends, 200 lb. class, bronze body, "Y" pattern, regrinding type swing check.

## D. Relief Valves: Consolidated Figure 1478, 300 lb. class, bronze body, seat and disc, ASME tested and stamped, and National Board Certified. For inlet and outlet connections, discharge rate, and set pressure, see Drawings.

## 2.3 STRAINERS

## A. Strainers:

1. 2" and Under: Sarco Type BT, 250 lb. class, bronze body, screwed ends.
2. Screens: Stainless steel suitable for water duty.

2.4 THERMOMETERS AND GAUGES

- A. Pipe Line Thermometers: Weksler Type AA5L-9, adjustable angle type, 2 degree division 9" scale, 30 to 240°F range, with lagging extension type well Catalog T6M3D2E.
- B. Pressure Gauges: Weksler Type AA14C, 1/4" bottom connection, 4½" Dia. white dial, 0 to 100 psig range, 10 psi figure intervals, with Type A10 tee handle cock.

2.5 MISCELLANEOUS EQUIPMENT

- A. Flexible Connectors: Flexonics Model PCB, bronze pump connectors.

PART 3 – EXECUTION

3.1 JOINTS

- A. Joints shall be 94/6 soldered, screwed, butt welded, and flanged.

END OF SECTION 232217

DIVISION 23 – HVAC

SECTION 235300 – GLYCOL SYSTEM

PART 1 – GENERAL

1.1 GENERAL INFORMATION

1.2 RELATED SPECIFICATION SECTIONS

- A. The following sections of these specifications are to be referenced in order to provide a complete and functioning system of the piping system described in this section:
1. Section 231000 "GENERAL PIPING"
  2. Section 231100 "PIPE HANGERS AND SUPPORTS"
  3. Section 231300 "IDENTIFICATION OF PIPING SYSTEMS"
  4. Section 232100 "PIPE AND EQUIPMENT INSULATION"

PART 2 – PRODUCTS

2.1 FLUID

- A. Dow Chemical, Dowfrost inhibited, propylene glycol solution with the following properties:
1. Boiling Point: 310°F.
  2. Freezing Point: -60°F.
  3. Relatively clear, water-white appearance.
  4. pH: 9.0 to 10.0.
  5. Specific Heat at 50°F: .913 BTU/lb./ °F.
  6. Specific Gravity at 50°F: 1.034.
  7. Viscosity: 4.51 centipoise at 50°F.

2.2 PIPE AND FITTINGS

- A. Above Ground Piping (GLS and GLR):
1. Pipe: Type L hard drawn copper tubing, conforming to ASTM-B88 and ANSI-H23.1.
  2. Fittings: Wrought copper solder joint, conforming to ASTM-B75 and ANSI-B16.22.
- B. Unions: Nibco Figure 633, wrought copper solder type, conforming to ANSI-B16.22.

- C. Flanges: 150 lb. class, cast brass, conforming to ASTM-145-4B and ANSI-B16.24. Figure numbers are Mueller's.
  - 1. Companion Flanges: Figure F-900.
  - 2. Blind Flanges: Figure F-903.

## 2.3 VALVES

- A. Shutoff, Blowdown, Drain, and Vent Valves:
  - 1. 2-1/2" and Under: Nibco Figure S-595-Y, or Powell Star Figure 4201T-TE, or Worcester Figure 411TTE, 150 lb. class, solder ends, ball valve. No substitutes permitted.
  - 2. 3" and Over: Bray Figure 31, 175 lb. class, bubble-tight butterfly valve, cast iron body with four (4) drilled and tapped lugs, aluminum-bronze disc, 416 stainless steel stem, replaceable resilient seat Type EPDM, with Bray Figure 01 lever lock handle and 90° notched plate.
    - a. Use stud bolts thru tapped lugs to facilitate removal of downstream piping. Valves to be rated for 150 psi dead end service.
    - b. Do not use supplemental flange gaskets.
- B. Calibrated Balancing Valves: Tour & Andersson Model STAF-SG ANSI.
- C. Check Valves:
  - 1. 2-1/2" and Under: Crane Figure 1342, 200 lb. class, solder ends, bronze body and swing check disc.
  - 2. 3" and Over: Crane Figure 373, 125 lb. class, flanged ends, bronze trimmed, swing check.
  - 3. Pump Discharge 2" and Under: Mueller Steam Specialty Silent Check Figure 103M-AP, 250 lb. class, iron body with bronze trim.
  - 4. Pump Discharge 2-1/2" and Over: Williams-Hager Silent Check Figure 636, or APCO Series 600 Silent Check Valve, 125 lb. class, flanged ends, semi-steel globe body with bronze trim.
- D. Relief Valves: Lunkenheimer Figure 202, bronze body, ASME certified and stamped, and factory set as indicated on Drawings.

## 2.4 STRAINERS

- A. 2" and Under: Sarco Type BT, 250 lb. class, bronze body, solder ends with 20 mesh, .033" opening stainless steel screen.
- B. 2-1/2" and Over: Sarco Type AF-250, 250 lb. class, cast iron body, flanged ends.

## 2.5 THERMOMETERS AND GAUGES

- A. Tank Thermometers: Weksler Instrument Type AA5Q-9, adjustable angle type, 2 degree division 9" scale, 30 to 300°F range, with lagging extension type well Catalog T6T3D2E.
- B. Pipe Line Thermometers: Weksler Instrument Type AA5L-9, adjustable angle type, 1 degree division, 9" scale, 0° to 120°F range, with lagging extension type well Catalog T6M3D2E.
- C. Pressure Gauges: Weksler Royal Gauge Type AA14Y, phosphor bronze bourdon tube material, 4½" Dia. white dial, 0 to 100 psig dial range with 10 psi figure intervals, 1/4" diameter bottom connection, with lever handle cock Type A12.

## 2.6 MISCELLANEOUS EQUIPMENT

- A. Flexible Connectors: Flexonics Model PCB, bronze pump connectors.
- B. Flexible Hose: Goodyear Ortac 500, or Goodyear Redwing Multipurpose, suitable for propylene glycol solution, and working pressure of 200 psig at 350°F. Use Ideal Clamp Co. Series 68, stainless steel, worm drive gear clamps to connect hose to piping.

## PART 3 – EXECUTION

### 3.1 JOINTS

- A. Above Ground Piping: Joints shall be Stay Brite 8 9/16 soldered and flanged.

### 3.2 GLYCOL SYSTEM

- A. Fill chilled glycol system with 40% PG and 60% distilled water.

END OF SECTION 235300

DIVISION 23 – HVAC

SECTION 235400 – CHILLED WATER SYSTEMS

PART 1 – GENERAL

1.1 GENERAL INFORMATION

- A. This Section covers all chilled water piping within the building.

1.2 RELATED SPECIFICATION SECTIONS

- A. The following sections of these specifications are to be referenced in order to provide a complete and functioning system of the piping system described in this section:
  - 1. Section 231000 "GENERAL PIPING"
  - 2. Section 231100 "PIPE HANGERS AND SUPPORTS"
  - 3. Section 231300 "IDENTIFICATION OF PIPING SYSTEMS"
  - 4. Section 232100 "PIPE AND EQUIPMENT INSULATION"

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

- A. Pipe (CHWS & R):
  - 1. 2-1/2" and Under: Type L hard-drawn copper tubing, conforming to ASTM-B88 and ANSI-H23.1.
  - 2. 3" and Over: Schedule 40 black steel, conforming to ASTM-A53. Note: 2" and over (Basement only): Schedule 40 black steel, conforming to ASTM-A53.
  - 3. Type L hard drawn copper tubing, conforming to ASTM-B88 and ANSI-H23.1 may be used in lieu of Schedule 40 black steel for pipe sizes 3 inch and over.
- B. Fittings:
  - 1. 2-1/2" and Under: Wrought copper solder joint, conforming to ASTM-B75 and ANSI-B16.22.
  - 2. 3" and Over:
    - a. 3" and Over: Malleable iron full-flow type, conforming to ASTM-A47 Grade 32150 painted with alkyd enamel.
    - b. 125 lb. class cast iron flanged fittings, conforming to ASTM-A126 Class B and ANSI-B16.1, may be used in lieu of carbon steel butt welding fittings for pipe sizes 2-1/2" thru 12".
    - c. Piping within Data Center raised floor shall be either soldered copper or screwed steel. Welding in the raised floor is not permitted.

## C. Unions:

1. Copper Tubing: Nibco Figure 633, wrought copper, solder ends, conforming to ANSI-B16.22.
2. Steel Pipe: Grinnell Figure 463, 150 lb. class, bronze-to-iron ground joint conforming to ANSI-B2.1.

## D. Flanges:

1. Welded and Threaded Steel Pipe: 150 lb. class carbon steel, conforming to ASTM-A105 and ANSI-B16.5. Figure numbers are Tube Turn's.
  - a. Welding Neck Flanges: Figure 30.
  - b. Slip-On Flanges: Figure 50.
  - c. Threaded Flanges: Figure 60.
  - d. Blind Flanges: Figure 70.

E. Elbolets and Thredolets: Bonney Forge, carbon steel, 3,000 lb. class, conforming to ASTM-A105 Grade II.

F. Weldolets: Bonney Forge, carbon steel, extra strong class butt welding connection conforming to ASTM-A105 Grade II.

## 2.2 VALVES

## A. Shutoff, Vent, Drain, and Blowdown Valves:

1. 2-1/2" and Under: Nibco Figure T-595-Y screwed ends or Figure S-595-Y solder ends; Powell Star Figure 4201T-SE screwed ends or Figure 4201T-TE solder ends; or Conbraco "Apollo" Figure 82 Series 100 screwed ends or Figure 82 Series 200 solder ends; 150 lb. class, reinforced TFE seats and seals, 3 piece, bronze body ball valve. No substitutes permitted.
2. 3" thru 12": Bray, Figure 31, 175 lb. class, bubble-tight butterfly valve, cast iron body with four (4), eight (8), or twelve (12) drilled and tapped lugs, ductile iron disc Nylon 11 covered to a thickness of 15 mil, 416 stainless steel stem, replaceable resilient seat Type EPDM (Food Grade).
  - a. Use stud bolts thru tapped lugs to facilitate removal of downstream piping. Valve to be rated for 150 psi dead end service.
  - b. Do not use supplemental flange gaskets.
  - c. 3" thru 6" Valves: Provide with Bray Figure 01 lever lock handle, and 90 notched plate.

- d. 8" thru 12" Valves: Provide with Bray Figure 04 enclosed handwheel worm gear operator, waterproofed, completely sealed and grease packed, with valve position indicator on face of gear box.

B. Check Valves:

1. 2" and Under: Crane Figure 36 screwed ends or Figure 1342 solder ends, 200 lb. class, bronze body, "Y" pattern, regrinding type swing check.
2. 2-1/2" and Over: Crane Figure 373, 125 lb. class, flanged ends, bronze trimmed, swing check.
3. Pump Discharge 2" and Under: Muessco Silent Check Figure 203-AP, 250 lb. class, screwed ends, iron body with bronze trim.

C. Calibrated Balance Valves (Circuit Setters) – CVB-1

1. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of different pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT O-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems and to protect balance valves during shipment.
2. Shop drawing for valves shall include flow characteristic chart to indicated size and flow requirement.
3. Provide a portable differential pressure gauge for use with balancing.
4. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves as manufactured by Tour-Anderssen.

## 2.3 STRAINERS

- A. 2" and Under: Sarco Type BT, 250 lb. class, bronze body, screwed ends.
- B. 2-1/2" and Over: Sarco Type AF-250, 250 lb. class, cast iron body, flanged ends.
- C. Screens: Stainless steel suitable for water duty.

2.4 THERMOMETERS AND GAUGES

- A. Tank Thermometers: Weksler Type AA5Q-9, adjustable angle type, 2 degree division 9" scale, 0° to 160°F range, with lagging extension type well Catalog T6T3D2E.
- B. Pipe Line Thermometers: Weksler Type AA5L-9, adjustable angle type, 2 degree division 9" scale, 0° to 160°F range, with lagging extension type well Catalog T6M3D2E.
- C. Pressure Gauges: Weksler Type AA14C, 1/4" bottom connection, 4½" Dia. white dial, 0 to 100 psig range, 10 psi figure intervals, with Type A10 tee handle cock.

PART 3 – EXECUTION

3.1 JOINTS

- A. Copper Pipe: Joints shall be 94/6 soldered.
- B. Steel Pipe: Joints shall be screwed, butt welded, and flanged. Joints in the Data Center raised floor shall be either soldered or screwed.

END OF SECTION 235400

DIVISION 23 – MECHANICAL  
SECTION 237110 – COMPUTER ROOM UNITS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials and equipment necessary for the receipt, erection, installation, piping connections, power and control wiring, commissioning, start-up and testing, and warranty service for the following BNL furnished equipment:
  - 1. Computer room air conditioning unit, CRAC AC #5 with floor stand.
  - 2. Drycooler with compression tank (DC/1).
  - 3. Pump package (P/1A and P/1B).
- B. All work shall be in accordance with the Drawings and as specified herein.

1.2 GUARANTEE AND WARRANTY SERVICE

- A. Contractor shall include in his bid the cost of providing guarantee and warranty service for the CRAC units as though the Contractor had purchased the unit.

PART 2 – PRODUCTS

2.1 SUMMARY

- A. These specifications describe requirements for a mission critical cooling system. The system shall be designed to control temperature and humidity conditions in the rooms containing electronic equipment.
- B. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room.

2.2 DESIGN REQUIREMENTS

- A. The mission critical cooling system shall be a Liebert self-contained factory assembled unit with down-flow air delivery. The system shall have a total cooling capacity of 229,900 BTU/HR, with a sensible cooling capacity of 189,000 BTU/HR based on an entering air temperature of 75°F dry bulb and 62.5°F wet bulb, 50% RH. The unit shall be supplied with 460volt 3ph 60Hz electrical service, 67.4 full load Amps (FLA), 80.8 wire sizing Amps, and 90 MFCB. The unit shall be capable of delivering 10,400 CFM of air at 0.2 inches w.c. external static pressure with 10 HP fan. Net capacities shall include losses due to fan motor heat. Model shall be DS077KU as manufactured by Liebert.

### 2.3 FRAME CONSTRUCTION

- A. The frame shall be MIG welded, formed sheet metal. It shall be protected against corrosion using the autophoretic coating process. The frame shall be capable of being separated into three parts in the field to accommodate rigging through small spaces.
- B. Downflow Air Supply: The supply air shall exit from the bottom of the unit with the air scrolled towards the front of the unit.
- C. Downflow Air Return: The return air shall enter the unit from the top.
- D. Exterior Panels: The exterior panels shall be insulated with a minimum 1 in., 1.5 lb. density fiber insulation. The main front panel shall have captive ¼ turn fasteners. The main unit color shall be Z0420 IBM Charcoal.

### 2.4 FILTERS, DOWNFLOW UNIT

- A. The filter chamber shall be located within the cabinet, and filters shall be removable from the top of the unit. Filters shall be arranged in a V-bank configuration to minimize air pressure drop.
- B. Filters shall be deep pleated 4 inch filters with an ASHRAE 52.2 MERV 8 rating (45% ASHRAE 52.2).
- C. One (1) extra set of filters shall be furnished per system.

### 2.5 FAN SECTION

- A. The blower section shall be designed for 10,400 CFM at an external static pressure of 0.2 in. wg with 10 HP fan. The fans shall be the centrifugal type, double width, double inlet and shall be dynamically balanced as a completed assembly. The shaft shall be heavy duty steel with self-aligning, permanently sealed, pillow block bearings with a minimum L3 life of 200,000 hours. The fans shall draw air through the A-frame coil to ensure even air distribution and maximum coil performance. A static regain duct shall be factory-installed to the bottom of the blower.
- B. Motor: The fan motor shall be 10 HP at 1750 RPM @ 60 Hz., mounted to an automatic, spring-tensioning base. The motor shall be removable from the front of the cabinet. The fan motor shall be open drip-proof, premium efficiency, inverter duty and shall meet NEMA Premium standard. Motor efficiency shall be a minimum of 91 percent.
- C. Drive Package: The motor sheave and fan pulley shall be double-width fixed pitch. Two belts, sized for 200 percent of the fan motor horsepower, shall be provided with the drive package. An auto-tension system shall provide constant tension on the belts. Belts, shaft, blower bearings, sheave and pulley shall be warranted for five years.

## 2.6 HUMIDIFIER

- A. A humidifier shall be factory-installed inside the unit. Bypass air slots shall be included to enable moisture to be absorbed into the air stream. The humidifier capacity shall be 22 lb./hr. The humidifier shall be removable from the front of the cabinet.
- B. The humidifier shall be of the infrared type consisting of high intensity quartz lamps mounted above and out of the water supply. The humidifier pan shall be stainless steel and arranged to be removable without disconnecting high voltage electrical connections. The complete humidifier section shall be pre-piped, ready for field connection to water supply. The humidifier shall be equipped with an automatic water supply system and shall have an adjustable water-overfeed to prevent mineral precipitation. A high-water detector shall shut down the humidifier to prevent overflowing. A factory-provided air-gap shall prevent backflow of the humidifier supply water.

## 2.7 REHEAT

- A. The environmental control unit shall include a factory-installed reheat coil to control temperature during dehumidification.
- B. The electric reheat coils shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches, and shall be 25kW controlled in three stages. The reheat elements shall be removable from the front of the cabinet.

## 2.8 DUAL REFRIGERATION SYSTEM

- A. Each unit shall include two (2) independent refrigeration circuits and shall include hot gas mufflers, liquid line filter driers, refrigerant sight glass with moisture indicator, externally equalized expansion valves, and liquid line solenoid valves. Compressors shall be located outside the airstream and shall be removable and serviceable from the front of the unit.
- B. Semi-Hermetic Compressor With Four-Step Unloaders Control: The compressor shall be semi-hermetic with a suction gas-cooled motor, vibration isolators, thermal overloads, oil sight glass, automatic reset high pressure switch with control lockout after three failures, pump-down low pressure transducer, suction line strainer, service valves, reversible oil pumps for forced feed lubrication, a maximum operating speed of 1750 RPM. The system shall include cylinder unloaders on the semi-hermetic compressors. The unloaders shall be activated by solenoid valves which are controlled from the microprocessor control. In response to the return air temperature, the microprocessor control shall activate the unloader solenoids and the liquid line solenoids such that four stages of refrigeration cooling are obtained. The stages shall be:
  - 1. One compressor, partially loaded.
  - 2. Two compressors partially loaded.

3. One compressor partially loaded, one compressor fully loaded.
4. Two compressors fully loaded.

On a call for dehumidification, the microprocessor control shall insure that at least one compressor is on full for proper humidity control.

- C. Crankcase Heaters: The compressors shall include crankcase heaters, powered from the indoor unit electric panel.
- D. Evaporator Coil: The evaporator coil shall be A-frame design with offset orientation, three rows deep. It shall be constructed of rifled copper tubes and aluminum fins and have a maximum face velocity of 500 ft. per minute at 10,400 CFM. A stainless steel condensate drain pan shall be furnished.
- E. R-407C Refrigerant: The system shall be designed for use with R-407C refrigerant, which meets the EPA Clean Air Act for phase-out of HCFC refrigerants.

## 2.9 LIEBERT iCOM™ MICROPROCESSOR CONTROL

- A. The Liebert iCOM unit control with large graphic display shall include all of the features as the Liebert iCOM with small graphic display, except that it includes a larger graphical display and shall include the additional features of: “System View”, Spare Parts List, Unit Diary. The Liebert iCOM control processor shall be microprocessor based with a 320x240 dot matrix graphic front monitor display panel and control keys for user inputs mounted in an ergonomic, aesthetically pleasing housing.
  1. System View - Status Overview: “System View” shall display a summary of operation for the total number of operating units within a Unit-to-Unit (U2U) configuration.
  2. Spare Parts List: Menu shall include a list of critical spare parts, their quantity and part numbers.
  3. Unit Diary: Menu shall include a free field area within the unit memory where unit history may be stored for reference.
- B. The Liebert iCOM unit control shall be factory-set for Intelligent Control which uses “fuzzy logic” and “expert systems” methods. Proportional and Tunable PID shall also be user selectable options. Internal unit component control shall include the following:
  1. Compressor Short Cycle Control: Prevents compressor short cycling and needless compressor wear.
  2. System Auto Restart: The auto restart feature will automatically restart the system after a power failure. Time delay is programmable.
  3. Sequential Load Activation: On initial startup or restart after power failure, each operational load is sequenced with a minimum of one second delay to minimize total inrush current.

4. Econo-O-Coil Flush Cycles: Econ-O-Coils are periodically flushed to prevent a buildup of contaminants.
  5. Predictive Humidity Control: Calculates the moisture content in the room and prevents unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature.
- C. The Liebert iCOM control shall be compatible with Liebert remote monitoring and control devices. Unit shall be furnished with BMS interface via Modbus IP, Jbus, BACNet, Profibus and SNMP.
- D. The Liebert iCOM control processor shall be microprocessor based with a 128x64 dot matrix graphic front monitor display and control keys for user inputs mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the unit panels are open or closed. The controls shall be menu driven. The display shall be organized into three main sections: User Menus, Service Menus and Advanced Menus. The system shall display user menus for: active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in % of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes within the service menus. Service menus shall include: setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode. A password shall be required to access the advanced menus which include the factory settings and password menus.
- E. The User Menus shall be defined as follows
1. Active Alarms: Unit memory shall hold the 200 most recent alarms with time and date stamp for each alarm.
  2. Event Log: Unit memory shall hold the 400 most recent events with ID number, time and date stamp for each event.
  3. Graphic Data View: Eight graphic records shall be available: return air temperature, return air humidity, supply air temperature, outdoor temperature and four custom graphs.
  4. Unit View: Status Overview: Simple or Graphical “Unit View” summary displays shall include temperature and humidity values, active functions (and percent of operation) and any alarms of the host unit.
  5. Total Run Hours: Menu shall display accumulative component operating hours for major components including compressors, Econ-O-Coil (FC), fan motor, humidifier and reheat.

6. Various Sensors: Menu shall allow setup and display of optional custom sensors. The control shall include four customer accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC if desired. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.
  7. Display Setup: Customer shall pre-select the desired grouping of display languages at the time of the order from the following choices:
    - a. Group 1: English,
    - b. Service Contacts: Menu shall allow display of local service contact name and phone number.
- F. The Service Menus shall be defined as follows:
1. Setpoints: Menu shall allow setpoints within the following ranges:
    - a. Temperature Setpoint 65-85°F (18-29°C)\*
    - b. Temperature Sensitivity +1-10°F (0.6-5.6°C)
    - c. Humidity Setpoint 20-80% RH\*
    - d. Humidity Sensitivity 1-30% RH
    - e. High Temperature Alarm 35-90°F (2-32°C)
    - f. Low Temperature Alarm 35-90°F (2-32°C)
    - g. High Humidity Alarm 15-85% RH
    - h. Low Humidity Alarm 15-85% RH

\* The microprocessor may be set within these ranges; however, the unit may not be able to control to extreme combinations of temperature and humidity.
  2. Standby Settings/Lead-Lag: Menu shall allow planned rotation or emergency rotation of operating and standby units.
  3. Timers/Sleep Mode: Menu shall allow various customer settings for turning on/off unit.
  4. Alarm Setup: Menu shall allow customer settings for alarm notification (audible/local/remote). The following alarms shall be available:
    - a. High Temperature
    - b. Low Temperature

- c. High Humidity
  - d. Low Humidity
  - e. Compressor Overload
  - f. Main Fan Overload
  - g. Humidifier Problem
  - h. High Lead Pressure
  - i. Change Filter
  - j. Fan Failure
  - k. Low Suction Pressure
  - l. Unit Off
5. Audible Alarm: The audible alarm shall annunciate any alarm that is enabled by the operator.
  6. Common Alarm: A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.
  7. Remote Monitoring: All alarms shall be communicated to the Liebert monitoring system with the following information: Date and time of occurrence, unit number and present temperature and humidity.
  8. Sensor Calibration: Menu shall allow unit sensors to be calibrated with external sensors.
  9. Maintenance/Wellness Settings: Menu shall allow reporting of potential component problems before they occur.
  10. Options Setup: Menu shall provide operation settings for the installed components.
  11. System/Network Setup: Menu shall allow Unit-to-Unit (U2U) communication and setup for teamwork modes of operation (up to 32 units).
  12. Teamwork Modes of Operation: Saves energy by preventing operation of units in opposite modes multiple units.
  13. Auxiliary Boards: Menu shall allow setup of optional expansion boards.
  14. Diagnostics/Service Mode: The Liebert iCOM control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front display. Control outputs shall be able to be turned on or off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.

G. Advanced Menus

1. Factory Settings: Configuration settings shall be factory-set based on the pre-defined component operation.
2. Change Passwords: Menu shall allow new passwords to be set or changed.

H. Control

1. The control system shall allow programming of the following room conditions:
  - a. Temperature Setpoint: 65-85°F (18-29°C)
  - b. Temperature Sensitivity:  $\pm 1^\circ$  to 9.9°F (0.6 to 5.6°C) in 0.1°F (0.1°C) increments
2. All setpoints shall be adjustable from the individual unit front monitor panel. Temperature and humidity sensors shall be capable of being calibrated using the front monitor panel controls to coordinate with other temperature and humidity sensors in the room.
3. In addition, the system shall provide the following internal controls:
  - a. System Auto-Restart: For startup after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6-second increments) time delay. Programming can be performed either at the unit or from the central site monitoring system.
  - b. Sequential Load Activation: During startup or after a power failure, the Liebert iCOM control shall sequence operational load activation to minimize inrush current. Systems allowing multiple loads to start simultaneously are unacceptable.
  - c. Front Monitor Display Panel: The Liebert iCOM control shall provide a front monitor LCD, backlit display panel with 4 rows of 20 characters with adjustable contrast. This display (along with nine front-mounted control keys) shall be the only operator interface required to obtain all available system information such as room conditions, operational status, alarms, control and alarm setpoints and all user selections including alarm delays, sensor calibration, DIP switch selections and diagnostics. All indicators shall be in language form. No symbols or codes shall be acceptable.
  - d. Alarms: The Liebert iCOM control shall activate an audible and visual alarm in event of any of the following conditions:
    - 1) High Temperature
    - 2) Low Temperature
    - 3) High Humidity

- 4) Low Humidity
- 5) Main Fan Overload
- 6) Change Filters
- 7) Loss of Air Flow
- 8) Loss of Power
- 9) Custom Alarm (#1 to #4)
- 10) Compressor Overload

Custom alarms are four customer accessible alarm inputs to be indicated on the front panel. Custom alarms can be identified with prepared (programmed) labels for the following frequently used inputs:

- 1) Leak Under Floor
- 2) Smoke Detected
- 3) Loss of Water Flow
- 4) Standby Unit On

User customized text can be entered for two of the four custom alarms.

Each alarm (unit and custom) can be separately enabled or disabled, selected to activate the common alarm, and programmed for a time delay of 0 to 255 seconds.

- e. Audible Alarm: The audible alarm shall annunciate any alarm that is enabled by the operator.
- f. Common Alarm: A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.
- g. Remote Monitoring: All alarms shall be communicated to the Liebert site monitoring system with the following information: date and time of occurrence, unit number and current temperature and humidity.
- h. Diagnostics: The control system and electronic circuitry shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front monitor panel. Control outputs shall be able to be turned On or Off from the front monitor panel without using jumpers or a service terminal.
- i. Data Collection: The control system shall maintain accumulative operating hours of compressors, fan motor and Econ-O-Coil. The 10 most recent alarms shall be retained.
- j. Communication: The Liebert iCOM control shall be compatible with Liebert remote monitoring and control devices.

## 2.10 VARIABLE SPEED DRIVE

- A. The fan motor speed shall be varied from 100% to 60% of rated speed in response to room conditions. This shall be controlled automatically by the Liebert iCOM control. The variable speed drive shall be available with an infrared humidifier.

## 2.11 ADDITIONAL COMPONENTS

- A. The computer room environmental control system shall be equipped with the following accessories:
  1. Disconnect Switch—Locking Type: The manual disconnect switch shall be mounted in the high voltage section of the electrical panel. The switch shall be accessible from the outside of the unit with the door closed to prevent access to the high voltage electric components until switched to the off position.
  2. High Temp Stat: The high temp stat shall immediately shut down the environmental control system when activated. The high temp stat shall be mounted in the electrical panel with the sensing element in the return air.
  3. Condensate Pump, Dual Float: The pump has capacity of 145 GPH (548 l/h) at 20 ft. head (58 kPa). The pump is complete with integral dual float switch, pump, motor assembly, and reservoir. The secondary float shall send a signal to the local alarm and shut down the unit upon high water condition.
  4. Liebert Liqui-tect™ Sensors (Max. of Two Per Unit): Furnish two (2) solid state water sensors under the raised floor, Model LT460-Z45, including 45 feet of leak detection cable, 20 hold down clips and external 24 VAC control transformer.
  5. Floor Stand: The floor stand shall be constructed of a heliarc-welded, tubular steel frame. The floor stand shall have adjustable legs with vibration isolation pads. The floor stand shall be 12 inches high.
  6. Floor Stand Turning Vane: A factory-supplied, field-mounted turning vane shall be provided.
  7. Smoke Sensor and Fire Stat: The smoke sensor and fire stat shall immediately shut down the environmental control system and activate the alarm system when activated. The smoke sensor shall be mounted in the electrical panel with the sensing element in the return air compartment.
  8. Liebert Modbus IP Card: Liebert units shall be provided with an OpenComm NIC card providing a connection to the DDC system using the Modbus IP protocol. All cards shall be furnished by the Unit Manufacturer.
  9. Discharge temperature sensor.

10. Low Voltage Terminal Package: Factory-installed and wired terminals shall be furnished for customer connection to lock out the reheat and humidifier upon contact closure. Two (2) extra N/O common alarm contacts shall be provided. Two (2) extra remote shutdown terminals shall be provided. A separate supply air temperature sensor shall be embedded on the discharge air side.

## 2.12 GLYCOL SYSTEMS

- A. The water-cooled condensers for each circuit shall be cleanable, shell-and-tube, counter flow type. The heads shall be removable to allow for cleaning of the water tubes. Condensers shall be rated for a maximum refrigerant pressure of 400 psi at 100°F.
- B. GLYCOOL Coil: The GLYCOOL (Econ-O-Coil) shall be constructed of copper tubes and aluminum fins. The coil shall be A-frame or V-frame in order to minimize air pressure drop, and shall be nested with the DX coil. The Econ-O-Coil shall be upstream of the DX coil to enable pre-cooling of the air.
- C. GLYCOOL Three-Way Control Valve: The GLYCOOL coil shall be equipped with a fully proportional three-way control valve rated at 150 psi. This motorized control valve shall control the amount of flow to the GLYCOOL (Econ-O-Coil) coil to control room temperature and relative humidity.

## 2.13 DRYCOOLER

- A. The drycooler shall be the low profile, slow speed, multiple direct drive, propeller fan type. The drycooler shall be constructed of aluminum and contain a copper tube aluminum fin coil with an integral electric control panel and disconnect switch. The drycooler shall be designed for 95°F ambient and shall be capable of rejecting the condenser heat of the indoor unit. Drycooler shall be matched to heat rejection capacity of the indoor unit. Drycooler shall be four (4) fan, Model DDO-466, 14.4 full load amps (FLA), 16.3 wire sizing amps (WSA) and 20 OPD.
- B. The dual 5 HP pump package shall include pumps, enclosure, field-mounted flow switch and a separate factory-wired control box (including a lead/lag switch for the pumps). The standby pump shall automatically start upon failure of the lead pump. Each pump shall be rated for 76 GPM at 118 feet at head.

## PART 3 – EXECUTION

### 3.1 INSTALLATION OF PRECISION COOLING UNITS

- A. General: Install precision cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

- B. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.
- C. Piping Connections: Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.
- D. Field Quality Control: Startup mainframe coolant units in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. See Paragraph 3.7 for additional requirements.

### 3.2 RIGGING AND ERECTION

- A. Receive from manufacturer at BNL, transport to building site, and erect unit on floor stand furnished by manufacturer with unit.
- B. Prior to unit erection, install floor stand in location shown on drawings. Modify existing computer room floor tile supports as required to install units.

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings and specialties.

### 3.4 MANUFACTURER RESPONSIBILITIES

- A. Field Installation
  - 1. As the installation of all equipment shall be done by an Installing Contractor, the Manufacturer shall coordinate with the Installing Contractor for work including the following:
    - a. Coordinating assembly, pipe and electrical connections, sizes and locations.
    - b. Certification that equipment is properly installed and operating in accordance with manufacturer's instructions.
- B. Manufacturer shall provide tests, to confirm compliance with this Specification.
  - 1. The entire electrical system shall be functionally checked, including motors, controls, etc., for proper operation.
- C. Manufacturers Field Startup Controls Interface Responsibility
  - 1. The control contractor shall be responsible to field configure at startup each unit for Modbus IP communications. The manufacturer shall field coordinate at startup with BNL BMCS system integrator to assign each card to the Ethernet 14 subnet, including static IP address, gateway IP address, subnet mask address and MAC address of the communication card.

### 3.5 INSTALLATION

- A. Upon completion of the startup procedures, the Manufacturer shall certify in writing that the units and appurtenances are operating properly in accordance with the manufacturer's instructions.

### 3.6 BNL ACCEPTANCE

- A. BNL will accept only complete, workable equipment and systems under the following conditions:
  - 1. After receipt by BNL of all the working drawings in "Approved" status by the Engineer.
  - 2. After completion of all specified equipment cleaning, start-up, field testing and performance runs as specified herein and receipt by BNL of all specified certifications accepted by the Engineer.
  - 3. After receipt by BNL of complete service manuals as specified herein.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  - 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. Report results in writing.
- C. Tests and Inspections
  - 1. After installing the units and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks and tie-down straps.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.

3.8 STARTUP SERVICE

- A. BNL has pre-purchased the services of a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer’s written instructions and do the following:
  - 1. Inspect for visible damage to unit casing.
  - 2. Inspect for visible damage to coils and fans.
  - 3. Inspect internal insulation.
  - 4. Verify that labels are clearly visible.
  - 5. Verify that clearances have been provided for servicing.
  - 6. Verify that controls are connected and operable.
  - 7. Verify that filters are installed.
  - 8. Remove packing from vibration isolators.
  - 9. Verify lubrication on fan and motor bearings.
  - 10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 11. Adjust fan belts to proper alignment and tension.
  - 12. Start unit according to manufacturer’s written instructions.
    - a. Complete startup sheets and attach copy with Contractor’s startup report. Inspect and record performance of interlocks and protective devices; verify sequences.
  - 13. Operate unit for an initial period as recommended or required by manufacturer.
  - 14. Calibrate thermostats.
  - 15. Adjust and inspect high-temperature limits.
  - 16. Coordination with BNL BMCS system integrator for Modbus IP communications to each unit, including field configuration of card for static IP address, gateway IP address, subnet mask address and MAC address of the communication card.

END OF SECTION 237110

DIVISION 23 – HVAC

SECTION 239100 – TESTING OF PIPING SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. This Section covers the testing of all piping systems within the building.
- B. After completion of piping installation, test all systems as directed by, and in the presence of PE.
- C. PE is to be notified 24 hours in advance of any test to be performed.
- D. PE will provide gauges required for tests.
- E. Furnish pumps, instruments, and other equipment, including test medium necessary for conducting prescribed tests.

PART 2 – EXECUTION

2.1 PRIOR TO PRESSURE TESTING

- A. Ascertain piping, appurtenances and equipment are free of all foreign objects such as weld rods, metal shavings, papers, tools, and loose rust.
- B. Blow-thru tube and pipe runs with their respective mediums. Submit blow-thru procedure for prior approval.
- C. Take all necessary measures to prevent distortion of piping and equipment by applying suitable restraining devices.
- D. Exclude all equipment and accessories which will be damaged by being subjected to full test pressure by blanking off or by some other approved means.

2.2 GENERAL PROCEDURES

- A. Raise pressure in piping undergoing test to required test pressure at a rate not exceeding 100 psi per minute.
- B. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.
- C. During test, sharply tap all joints and connections to start any potential leaks that would normally start due to contraction, expansion, and vibration.
- D. Repair leaks, replace defective material and workmanship, and retest until system is tight and free of leaks.
- E. At conclusion of tests, drain and bleed off systems as directed, and reconnect equipment and accessories which were disconnected prior to testing.

2.3 HYDROSTATIC TEST PROCEDURES

- A. Paint potential leak sources with a powdered blue chalk and water solution, and let dry.
- B. Fill system completely with BNL domestic cold water by venting at high points.
- C. Use a small pump to establish test pressure to minimize flood damage.
- D. Conduct pressure tests as detailed in ASME B31.3, NFPA 25, or NFPA 31 and as outlined in these Specifications.
- E. Discoloration of painted-on solution indicates a leak.
- F. Eliminate leaks by tightening, repairing, or replacing components.
- G. Repeat test until there are no leaks.
- H. After completion of test, clean solution off all surfaces.

2.4 PNEUMATIC (GAS) BUBBLE TEST PROCEDURES

- A. For systems requiring nitrogen test, supply nitrogen in cylinders equipped with shutoff valve, pressure reducing valve, cylinder pressure gauge, line pressure gauge, and bleed valve.
- B. Conduct pressure tests as detailed in ASME B31.3, and as outlined in these Specifications.
- C. Brush potential leak sources with American Gas & Chemical Co.'s "Leak-tec" thin film bubble testing solution. If solution bubbles, wipe off pipe, and carefully mark leak area.

PART 3 – TESTS

3.1 CHILLED WATER, GLYCOL, HOT WATER HEATING AND DRAIN COLD WATER SYSTEMS

- A. Test system hydrostatically at 150 percent of the system's maximum anticipated pressure.
- B. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leaks.

END OF SECTION 239100

DIVISION 23 – MECHANICAL  
SECTION 239200 – CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This work shall include, but not be limited to, providing all labor, material and equipment illustrated on the Drawings and specified herein, including:
1. Furnish and install controllers within control panels for operation of Computer Room Air Conditioning (CRAC) units.
  2. Installation and wiring of field-installed leak detection sensors at the CRAC units and drip pan accomplished by electrical contractor.
  3. Contractor shall program all CRAC units, existing (1) and new (1), into “AHU management system” to cycle units on and off based on both temperature and dew point within space to save energy and wear.
  4. Providing all system and applications software and programming necessary for the sequences of operation for CRAC units.
  5. Coordinating the installation of all controls with the installers of the CRAC units.
  6. Startup, testing and commissioning of all controls and associated software. All setpoints, alarms, events and I/O data shall be transmitted and mapped on the BNL ALC Building Automation System, including temperature, humidity, dew point, CRAC unit setpoints, CRAC unit run hours, etc.
  7. Demonstration of proper control operation to BNL.
  8. Training of BNL personnel on operation and maintenance of system.
  9. Providing operations and maintenance manuals for installed equipment.
  10. Providing warrantee service for period specified herein.

1.2 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this Specification and shall be used in conjunction with this Section as part of the contract documents.

- B. The following sections constitute related work:
1. Section 000800 – Supplementary Conditions, Paragraph SC-2 Shop Drawings, Manufacturer's Data and Samples.
  2. Section 230100 – General Mechanical Requirements
  3. Section 231000 – General Piping
  4. Section 239350 – Balancing of Air and Water Systems

### 1.3 DESCRIPTION

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each mechanical system and building floor plan by a point-and-click graphic. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- B. The system shall directly control HVAC equipment as specified in Section 239250 Sequences of Operation.
- C. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends, and alarms specified in Section 239250 Sequences of Operation shall be BACnet objects.

### 1.4 APPROVED CONTROL SYSTEMS

- A. Controls shall be WEBCtrl as manufactured by Automatic Logic Corporation.

### 1.5 QUALITY ASSURANCE

- A. Installer and Manufacturer Qualifications
1. Installer shall have an established working relationship with Control System Manufacturer.
  2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

### 1.6 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these Plans and Specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code (NEC)
2. ASHRAE/ANSI 135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)

#### 1.7 SYSTEM PERFORMANCE

A. Performance Standards: System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 sec.
2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens: Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command: Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 15 sec.
6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
7. Performance: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation: Each workstation on the network shall receive alarms within 5 sec of other workstations.
9. Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Control Stability and Accuracy: Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

**Table 1**  
**Reporting Accuracy**

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO <sub>2</sub> )	±50 ppm

Note 1: 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

**Table 2**  
**Control Stability and Accuracy**

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

## 1.8 SUBMITTALS

- A. Product Requirements: Meet requirements of Shop Drawings, Manufacturer's Data, and Samples. Provide five (5) copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2004 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 3 prints of each drawing on 11" x 17" paper. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide following as a minimum:

1. Direct Digital Control System Hardware
  - a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
  - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
    - 1) Direct digital controllers (controller panels)
    - 2) Transducers and transmitters
    - 3) Sensors (include accuracy data)
    - 4) Actuators (electric)
    - 5) Actuators (pneumatic)
    - 6) Valves
    - 7) Relays and switches
    - 8) Control panels
    - 9) Power supplies
    - 10) Batteries
    - 11) Operator interface equipment
    - 12) Wiring
    - 13) Transformers

- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
  - d. Floor plan schematic diagrams indicating field sensor and controller locations.
  - e. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Controlled Systems
- a. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
  - b. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
  - c. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
  - d. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. Indicate alarmed and trended points.
- B. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
1. Project Record Drawings: As-built versions of submittal shop drawings provided as AutoCAD 2004 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 5 prints of each drawing on 11" x 17" paper.
  2. Testing and Commissioning Reports and Checklists: Completed versions of reports, checklists, and trend logs used to meet requirements of Section 239200.
  3. Operation and Maintenance (O&M) Manual: Printed, electronic, or online help documentation of the following:
    - a. As-built versions of submittal product data.
    - b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

- c. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
  - d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
  - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
  - f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
  - g. Graphic files, programs, and database on magnetic or optical media.
  - h. List of recommended spare parts with part numbers and suppliers.
  - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
  - j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
  - k. Licenses, guarantees, and warranty documents for equipment and systems.
  - l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- C. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least six weeks before first class.

## 1.9 WARRANTY

### A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve software deficiencies at no charge for 24 months after system acceptance. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items.

## 1.10 OWNERSHIP

### A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- #### A.
- Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

### 2.2 COMMUNICATION

- #### A.
- Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ASHRAE/ANSI Standard 135-2001, BACnet.
- #### B.
- Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

- C. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 239250 – Sequences of Operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- D. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- F. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable the system to both read and write data.
  - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
  - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
  - 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.

## 2.3 OPERATOR INTERFACE

- A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.
- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2001, BACnet Annex J.
- C. Workstation: Existing webservers shall access the new control systems.
- D. Operator Functions: Operator interface shall allow each authorized operator to execute the following functions as a minimum:
  - 1. Log In and Log Out: System shall require user name and password to log in to operator interface.
  - 2. Point-and-click Navigation: Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
  - 3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
  - 4. View and Adjust Operating Schedules: Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
  - 5. View and Respond to Alarms: Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
  - 6. View and Configure Trends: Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
  - 7. View and Configure Reports: Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

8. Manage Control System Hardware: Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
9. Manage Operator Access: Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

E. System Software

1. Operating System: Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows XP Pro, Red Hat Linux, or Sun Solaris.
2. System Graphics: Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
  - a. Functionality: Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
  - b. Animation: Graphics shall be able to animate by displaying different image files for changed object status.
  - c. Alarm Indication: Indicate areas or equipment in an alarm condition using color or other visual indicator.
  - d. Format: Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

- F. System Tools: System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be

installable on standard IBM-compatible PC's with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration: Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download: Operators shall be able to download memory from the system database to each controller.
3. System Configuration: Operators shall be able to configure the system.
4. Online Help: Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security: System shall require a user name and password to view, edit, add, or delete data.
  - a. Operator Access: Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.
  - b. Automatic Log Out: Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
  - c. Encrypted Security Data: Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics: System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing: System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 15925 Sequences of Operation. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

8. Alarm Messages: Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions: Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance: Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
11. Trend Configuration: Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 239250 (Sequences of Operation). Trends shall be BACnet trend objects.
12. Object and Property Status and Control: Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
13. Reports and Logs: Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports: Furnish the following standard system reports:
  - a. Objects: System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
  - b. Alarm Summary: Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
  - c. Logs: System shall log the following to a database or text file and shall retain data for an adjustable period:
    - 1) Alarm History.
    - 2) Trend Data: Operator shall be able to select trends to be logged.
    - 3) Operator Activity: At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

15. Custom Reports: Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
16. Graphics Generation: Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
17. Graphics Library: Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
18. Custom Application Programming: Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
  - a. Language: Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
  - b. Programming Environment: Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
  - c. Independent Program Modules: Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.

- d. Debugging and Simulation: Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
  - e. Conditional Statements: Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
  - f. Mathematical Functions: Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
  - g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
    - 1) Time Variables: Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
    - 2) System Variables: Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
19. Portable Operator's Terminal: Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.
20. BACnet: Web server or workstation shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

## 2.4 CONTROLLER SOFTWARE

- A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security: See Paragraph 2.3.F.5 (Security).
- C. Scheduling: See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:
  - 1. Weekly: Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
  - 2. Exception: Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
  - 3. Holiday: Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- D. System Coordination: Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary and Analog Alarms: See Paragraph 2.3.F.7 (Alarm Processing).
- F. Alarm Reporting: See Paragraph 2.3.F.9 (Alarm Reactions).
- G. Remote Communication: System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- H. Maintenance Management: System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 239250 Sequences of Operation.
- I. Sequencing: N/A.
- J. PID Control: System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
- K. Staggered Start: System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

- L. Energy Calculations
  - 1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
  - 2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
  - 3. System shall calculate a fixed-window average. Window interval start shall be defined by utility meter digital input signal to synchronize system's and utility's fixed-window averages.
- M. Anti-Short Cycling: Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- N. On and Off Control with Differential: System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- O. Runtime Totalization: System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 239250 (Sequence of Operations).

## 2.5 CONTROLLERS

- A. Controllers
  - 1. Utilize existing building gateway controller Automated Logic LGR controllers.
- B. Communication
  - 1. Service Port: Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
  - 2. Signal Management: Operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
  - 3. Data Sharing: Each controller shall share data as required with each networked controller.
  - 4. Stand-Alone Operation: Each air handling unit shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for an air handling unit shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

- C. Environment: Controller hardware shall be suitable for anticipated ambient conditions.
  - 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
  - 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- D. Keypad: Provide a local keypad and display for each controller. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each controller, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- E. Real-Time Clock: Controllers that perform scheduling shall have a real-time clock.
- F. Serviceability
  - 1. Controllers shall have diagnostic LED's for power, communication, and processor.
  - 2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
  - 3. Each controller shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- G. Memory
  - 1. Controller memory shall support operating system, database, and programming requirements.
  - 2. Each controller shall retain BIOS and application programming for at least 72 hours in the event of power loss.
  - 3. Each controller shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- H. Immunity to Power and Noise: Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- I. Transformer: ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

## 2.6 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to controllers.
- B. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- C. Binary Inputs: Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- E. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs: Binary outputs shall send a pulsed low-voltage signal for pulse width modulation control or an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs: Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs: Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as duct-mounted heating coils.
- I. Pulse-Width Modulation: Control actuators designed for pulse-width modulation with a single binary output that cycles with variable on and off times as determined by the application software. Pulse-width modulation may be used to provide analog output control in zone control and terminal unit control applications such as duct-mounted heating coils.
- J. Universal Inputs and Outputs: Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

## 2.7 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
  - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
    - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
    - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering
  - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
    - a. Dielectric strength of 1000 V minimum.
    - b. Response time of 10 nanoseconds or less.
    - c. Transverse mode noise attenuation of 65 dB or greater.
    - d. Common mode noise attenuation of 150 dB or greater at 40-100 Hz.

## 2.8 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

## 2.9 FIBER OPTIC CABLE SYSTEM

- A. Optical Cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- B. Connectors: Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
- B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
- C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 239200 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

### 3.2 PROTECTION

- A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
- B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

### 3.3 COORDINATION

- A. Site
  - 1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
  - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Test and Balance
  - 1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
  - 2. Train Test and Balance Contractor to use control system interface tools.
  - 3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
  - 4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

### 3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

### 3.5 FIELD QUALITY CONTROL

- A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 239200 Article 1.6 (Codes and Standards).
- B. Continually monitor field installation for code compliance and workmanship quality.
- C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

### 3.6 WIRING

- A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 239200 differ from Division 26, Section 239200 shall take precedence.
- B. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.
- C. Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.
- D. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- E. Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- F. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

- G. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- H. Do not install wiring in raceway containing tubing.
- I. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.
- J. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- K. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- L. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
- M. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- N. Use color-coded conductors throughout.
- O. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- P. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
- Q. Adhere to requirements in Division 26 where raceway crosses building expansion joints.
- R. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
- S. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- T. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- U. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

### 3.7 COMMUNICATION WIRING

- A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.06 (Wiring).
- B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- D. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- G. Label communication wiring to indicate origination and destination.
- H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

### 3.8 FIBER OPTIC CABLE

- A. During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

### 3.9 COMPRESSED AIR TUBING

- A. Run compressed air lines in ¼-inch copper tubing utilizing Swagelok compression fittings.
- B. Polyethylene tubing may be used in lieu of copper tubing if run in EMT. EMT shall be terminated with bushings to prevent chafing of poly tubing lines.
- C. Within the confines of temperature control panels (i.e., TCP's), use polyethylene tubing run in appropriate gutter chases.

### 3.10 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.
- C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
- F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m<sup>2</sup> (1 ft<sup>2</sup>) of coil area.
- G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- I. Differential Air Static Pressure
  - 1. Supply Duct Static Pressure: Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
  - 2. Return Duct Static Pressure: Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
  - 3. Building Static Pressure: Pipe pressure sensor's high-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator to an outdoor zone pressure pick-up port BAFI ZPS-ACC-10. Pipe low-pressure port to a location as noted on the Drawings to an indoor zone pressure pick-up port BAFI ZPS-ACC-01.
  - 4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
  - 5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
  - 6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

- J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

### 3.11 ACTUATORS

- A. General: Mount actuators and adapters according to manufacturer's recommendations.
- B. Electric and Electronic Damper Actuators: Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
  1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
  2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
  3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
  4. Provide necessary mounting hardware and linkages for actuator installation.
- C. Valve Actuators: Connect actuators to valves with adapters approved by actuator manufacturer.

### 3.12 WARNING LABELS

- A. Affix permanent warning labels to equipment that can be automatically started by the control system.
  1. Labels shall use white lettering (12-point type or larger) on a red background.
  2. Warning labels shall read as follows.

**CAUTION**

This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
  1. Labels shall use white lettering (12-point type or larger) on a red background.
  2. Warning labels shall read as follows.

**C A U T I O N**

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

- A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.
- B. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show instrument or item served.
- D. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.
- F. Label room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Label identifiers shall match record documents.

3.14 PROGRAMMING

- A. Point Naming: Name points as shown on the equipment points list provided with each sequence of operation. See Section 239250 Sequences of Operation. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- B. Software Programming: Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.
  - 1. Application Programming: Provide application programming that adheres to sequences of operation specified in Section 239250. Program documentation or comment statements shall reflect language used in sequences of operation.
  - 2. System Programming: Provide system programming necessary for system operation.

C. Operator Interface

1. Standard Graphics: Provide graphics as specified in Section 239200 Article 2.3 Paragraph E.2 (System Graphics). Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List on the Drawings. Point information on graphics shall dynamically update.
2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 239200.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing: Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.
1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 239200.
  2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
  3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
  4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
  5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
  6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
  7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
  8. Alarms and Interlocks
    - a. Check each alarm with an appropriate signal at a value that will trip the alarm.

- b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
- c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

### 3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.15 (Control System Checkout and Testing). Provide BNL with log documenting completion of startup tests.
  - 1. BNL will be present to observe and review system demonstration. Notify BNL at least 10 days before system demonstration begins.
  - 2. Demonstration shall follow process submitted and approved under Section 239200 Article 1.8 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
  - 3. Demonstrate actual field operation of each sequence of operation as specified in Section 239250. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
  - 4. Demonstrate compliance with Section 239200.
  - 5. Demonstrate compliance with sequences of operation through each operational mode.
  - 6. Demonstrate complete operation of operator interface.
  - 7. Demonstrate each of the following.
    - a. DDC Loop Response: Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
    - b. Demand Limiting: Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.

- c. Building fire alarm system interface.
  - d. Trend Logs for each System: Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 239250. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 239200 Article 2.3 Paragraph F.11 (Trend Configuration).
8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance

- 1. After tests described in this specification are performed to the satisfaction of BNL, BNL will accept control system as meeting completion requirements. BNL may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. BNL will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
- 2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 239200 Article 1.8 (Submittals).

3.17 CLEANING

- A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
- B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.
- C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

3.18 TRAINING

- A. Provide training for BNL's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

- B. Training shall enable students to accomplish the following objectives.
1. Proficiently operate system
  2. Understand control system architecture and configuration
  3. Understand DDC system components
  4. Understand system operation, including DDC system control and optimizing routines (algorithms)
  5. Operate workstation and peripherals
  6. Log on and off system
  7. Access graphics, point reports, and logs
  8. Adjust and change system setpoints, time schedules, and holiday schedules
  9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
  10. Understand system drawings and Operation and Maintenance manual
  11. Understand job layout and location of control components
  12. Access data from DDC controllers
  13. Operate portable operator's terminals
  14. Create and change system graphics
  15. Create, delete, and modify alarms, including configuring alarm reactions
  16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
  17. Configure and run reports
  18. Add, remove, and modify system's physical points
  19. Create, modify, and delete application programming
  20. Add operator interface stations
  21. Add a new controller to system
  22. Download firmware and advanced applications programming to a controller
  23. Configure and calibrate I/O points
  24. Maintain software and prepare backups
  25. Interface with job-specific, third-party operator software
  26. Add new users and understand password security procedures

- C. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.
  - 1. Day-to-day Operators (objectives 1-13)
  - 2. Advanced Operators (objectives 1-13 and 14-23)
  - 3. System Managers and Administrators (objectives 1-13 and 24-26)
- D. Provide course outline and materials according to Section 239200 Article 1.10 (Submittals). Provide one copy of training material per student.
- E. Instructors shall be factory-trained and experienced in presenting this material.
- F. Perform classroom training using a network of working controller's representative of installed hardware.

END OF SECTION 239200

DIVISION 23 – HVAC

SECTION 239250 – SEQUENCES OF OPERATION

PART 1 – GENERAL

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

3.1 NEW COMPUTER ROOM AIR CONDITIONING SYSTEM (AC/5 ONLY)

- A. Evaporator fan runs continuously. A variable speed drive shall vary the supply fan speed from 100 to 60% rated speed for response to room conditions.
- B. The microprocessor controller in the unit shall stage and unload the refrigeration compressors to maintain the room temperature setpoint as determined by a return air temperature sensor in the unit.
- C. Should space temperature drop below setpoint, the microprocessor controller shall unload the compressors and energize the electric resistance heat as required to achieve the room temperature setpoint.
- D. During dehumidification the microprocessor controller shall operate the refrigeration compressors to cool the air below dew point and then energize the electric resistance heat to reheat the air to achieve room temperature and humidity setpoint.
- E. During humidification the microprocessor controller shall modulate the electric SCR controller to achieve the desired room humidity setpoint. The humidifier shall have a timed purge drain cycle.
- F. CRAC unit shall be equipped with a Modbus IP communication card. The units shall be connected to the BNL LAN via Category 6 Ethernet cable.

3.2 NEW DRYCOOLER AND PUMP PACKAGE (AC/5 ONLY)

- A. Drycooler and pump package shall be controlled via Liebert iCom™ control system. Drycooler and pump package furnished with Liebert iCom™ control system.
- B. Only one pump shall run continuously and one pump shall be standby.
- C. Pump stations shall be monitored through Liebert iCom™ control system.
- D. When rotating the lead/lag pump, the standby pump shall start and prove operation prior to shutting off the lead pump.

- E. In event of pump failure, an alarm signaling failure shall be sent to designated personnel via email.
- F. Update graphics on site web control system to show drycooler and pump operational status and amperage reading.

3.3 EXISTING COMPUTER ROOM AIR CONDITIONING SYSTEM (XACU/8 ONLY)

- A. Evaporator fan runs continuously.
- B. The microprocessor controller in the unit shall throttle the control valve at the chilled water coil to maintain the room temperature setpoint as determined by a return air temperature sensor in the unit.
- C. Should space temperature drop below setpoint, the microprocessor controller shall cause the control valve at the heating hot water coil to open. The valve shall throttle as required to achieve the room temperature setpoint.
- D. During dehumidification, the microprocessor controller shall modulate the control valve at the chilled water coil to cool the air below dew point and then modulate the heating hot water valve open to reheat the air to achieve room temperature and humidity setpoint.
- E. During humidification the microprocessor controller shall modulate the electric SCR controller to achieve the desired room humidity setpoint. The humidifier shall have a timed purge drain cycle.

3.4 SENSORS

- A. Room temperature and humidity sensors shall monitor room temperature (dry bulb), relative humidity (% RH), and dew point. High and low dew point alarms shall be set at 57°F and 45°F, respectively (adjustable).

3.5 RUN-HOUR TRACKING

- A. CRAC unit run hours shall be displayed and logged in the ALC Building Automation System.

END OF SECTION 239250

DIVISION 23 – HVAC

SECTION 239300 – AIR CONDITIONING SYSTEM START-UP

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. When directed by BNL, schedule an equipment start-up date with equipment manufacturer.
  - 1. BNL has secured and paid for 1 day services of equipment manufacturer's Service Engineer to assist in start-up. BNL will not be responsible for resulting expenses of manufacturer's Service Engineer after 1 day.
  - 2. Arrange for a member of each trade involved to be present at start-up to assist Service Engineer in start-up procedures and for correcting all malfunctioning systems.
  - 3. Perform start-up tests until all equipment and systems are accepted.

END OF SECTION 239300

DIVISION 23 – HVAC

SECTION 239350 – BALANCING OF AIR AND WATER SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Arrange, schedule, and pay for the services of an independent Testing and Balancing Agency that specializes in and whose business is limited to the testing and balancing of air and water systems. The Agency will meet the requirement necessary for membership in AABC or NEBB. The work will be performed under the direction of and be certified by a licensed Professional Engineer.
- B. Accomplish balancing in the presence of PE.
- C. Provide at least one (1) representative from each trade involved to assist Balancing Engineer.

1.2 REFERENCE STANDARDS

- A. All procedures listed herein shall be in accordance with ANSI/ASHRAE Standard 111-1988, "Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems" or the AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" and NEBB's "Procedural Standards for Testing-Balancing-Adjusting of Environmental Systems".

PART 2 – PRODUCTS

NOT APPLICABLE

PART 3 – EXECUTION

3.1 PRELIMINARY STEPS

- A. Balancing Engineer shall thoroughly familiarize himself with all aspects of operational and control sequences before starting balancing, see "SEQUENCE OF OPERATIONS."
- B. Prior to balancing, submit a copy of the report for approval of its informational content.

3.2 GENERAL BALANCING PROCEDURES

- A. Refer to air and water "Flow Diagrams" and "Plans" on Drawings when balancing systems.

3.3 AIR SYSTEMS

- A. Before balancing air systems, ascertain fan rotations are correct, filters are new and clean, and automatic dampers (AD) are functioning in their proper sequences.

B. Air Flow:

1. Accomplish air balancing of floor air outlets as indicated on Drawings by using their respective dampers.

3.4 WATER SYSTEMS

- A. Before balancing systems, ascertain pump rotations are correct, existing systems are operating, systems are completely filled with water, normally opened shutoff valves are wide open, strainers are clean, control valves are functioning in their proper sequences, and throwaway start-up strainer in pump's suction diffuser is removed.
- B. Water Flow: Accomplish water balancing by using balancing valves, not shutoff valves. (Balance flow rates as indicated on flow diagrams on Drawing 12780-M3).

3.5 SUBMITTALS

- A. After balancing is accomplished, submit five (5) copies of a certified balancing report. Report shall ascertain equipment and systems are functioning as outlined in Specifications and as indicated on Drawings, and include air and water flow quantities, pressure drops across equipment, and water and air temperatures.

END OF SECTION 239350

DIVISION 26 – ELECTRICAL

SECTION 260100 – ELECTRICAL SPECIAL CONDITIONS

A. General:

1. Furnish all materials, tools, labor, equipment, and accessories necessary for electrical work specified in other sections of Divisions 26, 27 and 28, to deliver, install, connect, test, and adjust in accordance with the appropriate Electrical Special Conditions specified herein, as well as the General and Supplementary Conditions of Contract.

B. Codes and Standards:

1. Conform to applicable sections of the latest revisions of the following:
  - a. National Electrical Code (NEC)
  - b. Occupational Safety and Health Act (OSHA)
  - c. National Electric Safety Code (NESC)
  - d. National Electric Manufacturer's Association (NEMA)
  - e. Institute of Electrical and Electronic Engineers (IEEE)
  - f. American National Standards Institute (ANSI)
  - g. National Fire Protection Association (NFPA)
2. In cases of conflict, the standard providing the greater protection shall govern.
3. All material and manufactured assemblies shall bear a listed mark of Underwriters' Laboratories or a nationally recognized testing laboratory (NRTL) such as Factory Mutual. Electrical devices that are installed in assemblies that are not provided by a specific manufacturer and do not bear a U/L Listing or approved NRTL marking shall have the entire assembly approved by the "Authority Having Jurisdiction" (AHJ). The AHJ at BNL is the Laboratory Electrical Safety Officer (LESO). No assembly of this nature will be installed without prior approval of the designated AHJ.
4. After a thorough inspection, the AHJ will provide documentation that indicates that the assembly has been approved for installation or will list the deficiencies that need to be corrected. The AHJ can request a second inspection of the assembly to ensure that all deficiencies have been rectified prior to use. Contractor shall be responsible for all material and labor necessary to correct any deficiencies that the AHJ identifies.

C. Electrical Standard Drawings:

1. Meet the requirements of BNL Electrical Standard Drawings, specifically the following available for reference at the MPO of Facilities and Operations - Bldg. 134C.

a. Drawings:

No.	Title	Rev. Date
E-040.1	Nameplate & Tags - Standard Details	7/86
E-450.1	Grounding Details - Ground Rods	6/86
E-450.3	Grounding Detail - Copper Bar Connections	8/86

D. Drawings, Specifications and Shop Drawings:

1. Turn over to each Subcontractor a full set of Drawings and Specifications, and to individual Subcontractors concerned one set of Shop Drawings. Drawings, Specifications, and Shop Drawings of BNL provided equipment are available at MPO.

E. Rigging:

1. All equipment rigging shall be performed by a qualified rigger in the presence of MPO.
2. Prior to rigging, and in accordance with the Supplementary Conditions, submit a rigging plan for approval. Notify MPO 2 days in advance of actual rigging operation.
3. Exercise extreme caution in all operations. Replace, as approved, at own expense, any damage incurred to BNL property.

F. Scaffolding:

1. Erect and maintain scaffolds in strict accordance with OSHA 29 CFR 1926.451.
2. Comply with Supplementary Conditions clause, "Construction Safety."

G. Confined Space Entry: Refer to Supplementary Conditions, "Construction Safety."

1. Oxygen Deficiency Testing and Precautions in Manholes, Handholes and Unventilated Vaults:
  - a. The atmosphere shall be tested for oxygen deficiency and flammable gas before entry.
  - b. Where flammable gases are detected, the work area shall be ventilated and made safe before entry.
  - c. When an oxygen deficient atmosphere is detected, provisions shall be made for an adequate continuous supply of air and the work area made safe before entry.

H. Electrical Construction Safety: Refer to Supplementary Conditions, "Construction Safety."

1. Safety hardhats shall be worn at all times when working in manholes.
2. When working in manholes a minimum of one person must be present outside the manhole in close proximity to monitor the safety of persons working in the manhole.

3. One individual ("Competent Person" per OSHA) at each work area shall be designated as the Contractor's Safety Representative. The Contractor's Safety Representative shall be responsible for the implementation of BNL Standards-Based Management System (<https://sbms.bnl.gov>), BNL Electrical Safety Procedure (ESH 1.5.0), Facilities and Operations Electrical Safety Procedure (FO-ESH-102), Lock-Out/Tag-Out Requirements (FO-ESH-103), Standard for Electrical Safety in the Workplace (NFPA 70E), and all other applicable codes and safety requirements identified by the BNL Safety Coordinator. The Contractor's Safety Representative shall attend all safety meetings requested by the BNL Safety Coordinator.

END OF SECTION 260100

DIVISION 26 – ELECTRICAL

SECTION 260500 – BASIC ELECTRICAL MATERIALS AND METHODS

A. General:

1. Provide all material, labor, equipment, and accessories, including, but not limited to, raceways, conduits, underfloor ducts, cable trays, underground ducts and manholes, wires and cables, boxes, wiring devices, cabinets and enclosures, supporting devices, electrical identification, and equipment installation necessary for basic electrical materials work.

B. Materials and Methods:

1. Raceways:

a. Material:

- 1) New and free from flaws of any kind.
- 2) Do not use waste or short lengths for making up raceway runs.
- 3) Dow Corning "Fire Stop System" for sealing penetrations through fire rated assemblies.
- 4) Greenfield flexible metal conduit.

b. Installation:

- 1) Do not interfere with the operation of valves, established head room, work-space and/ or egress clearances, removal of equipment, electrical fixtures, ductwork, and access doors.
- 2) Match existing raceways.
- 3) Raceways which penetrate fire-rated assemblies shall be noncombustible. Seal the complete assembly to maintain the established fire ratings as defined by UL Building Materials Directory and UL Standard 1479.

c. Routing: Shown diagrammatically, field run unless otherwise noted.

2. Conduits:

a. Material:

- 1) Exterior and Underground Installations: Heavy wall rigid steel-threaded, hot dipped galvanized conduit and fittings. Minimum size 3/4".

- 2) Interior Applications: Electric metallic tubing (EMT thinwall conduit) for exposed and concealed. Minimum size 3/4". Flexible metal conduit is allowed under Computer Room raised floor. Minimum size 3/4".
- 3) Connection to Motors and Heaters: Use flexible metallic conduit, liquid tight for all exterior applications.
- 4) Insulating Type Bushings: OZ Conduit Type 'B' or T&B EMT set screw connector nylon insulated, insulating material permanently fastened to the fitting.
- 5) Grounding - Type Bushings: OZ Type 'BLG.'
- 6) Hanger Rods: 3/8" minimum diameter galvanized steel or cadmium-plated, attached to building structure.
- 7) Supports: Unistrut #P-1000.
- 8) Conduit Seals: Appleton Type ESUF, with APELCO type sealing cement.
- 9) Caulking: GE Silicone No. 2571-912, caulk around conduits passing through exterior floors or walls.

b. Installation:

- 1) Outdoors: Provide rigid steel conduit and fittings. Provide liquid tight flexible conduit for connections to vibrating equipment including motors.
- 2) Interior: Provide electric metallic tubing (EMT thinwall conduit) except for hazardous areas and security systems. Provide galvanized rigid steel conduit for hazardous areas and security systems. Provide flexible conduit for connections to vibrating equipment and routing control and instrument conductor under raised Computer Room floor.
- 3) Damp or Wet Interior: Provide rigid steel conduit and watertight flexible conduit.
- 4) Where new threads are cut in conduit, paint ends with a homogenized blend of colloidal copper and rust corrosion inhibitors T&B "Kopr Shield." Paint all threads when conduit is direct buried or concrete encased. Bond metallic conduits to the grounding system, with grounding-type bushings.
- 5) Secure conduits where they enter panelboards, pull boxes, safety switches or outlet boxes, with galvanized locknuts and bushings.
- 6) Support two or more conduits run in parallel, by trapeze hangers, and conduit clamps.

- 7) Run concealed conduits in a direct line with long sweep bends and offsets. Run exposed conduits parallel to and at right angles to building lines.
  - 8) Flexible conduit shall be a minimum length of 3'-0" and installed with a minimum of one bend to vibrating equipment.
  - 9) Flexible conduit under Computer Room raised floor shall be strapped to floor uprights to keep conduit off the concrete floor.
  - 10) Label fire alarm conduit every 15' and at all penetrations between rooms and floors. See contract drawings for labeling requirements.
3. Wiring Trough:
- a. Hoffman Engineering Company, 18 gauge steel, NEMA 1, lay-in type, devoid of knockouts, cover furnished with all required fittings, hangers, screws, supports and end plates.
4. Wires and Cables:
- a. Wiring:
    - 1) 600 Volt insulated copper conductors. Use solid wire for sizes #10 or smaller and stranded wire for sizes #8 and larger, except where noted below. Do not use mechanical means for pulling in wires #8 or smaller. Wire types as follows:
      - a) Type MC: Used for applications including in air plenums and structures exceeding three floors above grade.
      - b) Type THHN/THWN: Used for sizes up to and including #4 AWG in all raceway except cable trays.
      - c) Type XHHW: Used for sizes #2 AWG and larger in all raceway except cable trays, except for sizes 250 MCM or larger when the cable is rated for cable tray use.
      - d) Type TC: Used for cable tray installations in all sizes.
      - e) Control Wire: #14 AWG stranded.
      - f) Fire Alarm Wire: #16 AWG minimum, solid, only Type FPLR for all applications except air plenums which shall be Type FPLP. Use #12 AWG for audible and audible/visible device circuits. Where cable is run in free air, mark cable with FA sticker every 15' and at all penetrations between rooms and floors. See contract drawings for labeling requirements.

- 2) Terminations and Splicing:
  - a) Use compression-type connectors on cables #8 and larger. Use round or hexagonal die and compression tools, indent type compression terminations not acceptable. Splice conductors #10 and smaller with "Scotchlock" wire nuts.
- 3) Connections to Terminal Blocks:
  - a) Use plastic self-insulated ring or locking spade terminals.
- 4) Uninsulated Splices:
  - a) Cover uninsulated splices, joints, and free ends of conductors with rubber and high-dielectric tape .007" thick.
- 5) Wire Markers:
  - a) Epoxy Film Tape 3M "Scotch Code" for color coding or cable identification. Mark wires at panelboards, auxiliary gutters, junction boxes, pull boxes, outlets, circuit breakers, and as directed. Identify wires, by wire markers, at the termination point to indicate panel, circuit, and feeder origin.
- 6) Phase Relationship:
  - a) Retain the existing sequence and rotation on the new electrical installation as on the existing electrical distribution system.
- 7) Fire Alarm Wire:
  - a) Only solid copper wiring shall be acceptable. Furnish #16 AWG minimum 2 pair twisted shielded with drain wire for Type FPLR.
- 8) Ampacity:
  - a) Use 75°C for calculating ampacity of wires.
- 9) Color code all wiring at terminations and splices as follows:
  - a) 240/120 Volt
    - (1) White - Grounded neutral
    - (2) Green or Bare - Grounding conductor
    - (3) Black - Ungrounded conductor
    - (4) Red - Ungrounded conductor

- b) 208Y/120 Volt
  - (1) White - Grounded neutral
  - (2) Green or Bare - Grounding conductor
  - (3) Black - Phase "A"
  - (4) Red - Phase "B"
  - (5) Blue - Phase "C"

- c) 480Y/277 Volt
  - (1) Gray - Grounded neutral
  - (2) Green or Bare - Grounding conductor
  - (3) Brown - Phase "A"
  - (4) Orange - Phase "B"
  - (5) Yellow - Phase "C"

10) Abandonment:

- a) Wiring abandoned in place shall be taped on each end and labeled as abandoned. Labels shall state the location of the other taped end.

b. Cables:

- 1) General: The maximum cable reel size shall be 8'-0" high by 57" wide when used on the BNL cable trailer.
- 2) Cable Pulling:
  - a) Adjust the cable pulling speed just fast enough to keep the cable and reel moving at a uniform, speed not to exceed 40 fpm.
  - b) It is the responsibility of the Contractor to cut cable to the appropriate length. Before cutting cables, submit for approval cutting length as determined from field measurements. Immediately after cutting, seal all cable ends.
  - c) Do not exceed the maximum permissible pulling force stated by the cable manufacturer. Provide proof of compliance, in the form of a cable pulling calculation, when requested by MPO.
  - d) Use cable pulling ropes of an inelastic nature such as hemp or polypropylene wire.

- 3) Splicing and Terminations:
  - a) Make all splices and terminations using qualified splicers as approved by MPO.
  - b) Termination and splicing kits shall be as approved by cable manufacturer.
  - c) Make splices and terminations of 15kV cable with at least one Class A splicer per splice and termination.
  
5. Boxes:
  - a. Outlet Boxes:
    - 1) Use Crouse-Hinds "FS" cast steel boxes for surface mounted applications for switches and receptacles.
    - 2) Recessed and semi-recessed.
  - b. Pull and Junction Boxes:
    - 1) Furnish 18 gauge steel NEMA 1, lay-in type and sized per application and construction drawings, devoid of knockouts, cover furnished with all required fittings, hangers, screws and supports to install in selected location.
  
6. Wiring Devices:
  - a. Receptacles:
    - 1) Hubbell Cat. No. 5362, wall mounted duplex convenience outlets, 3-wire grounding, 20 Ampere, 125 Volt specification grade. Mount centerline 1'-6" above floor unless noted.
    - 2) Hubbell Cat. No. GTF 5352I, duplex outlet, ground fault interrupter. Straight blade. 2 pole 3 wire, 20 Ampere, 125 Volt specification grade.
    - 3) Floor mounted duplex convenience outlets shall be as above, mounted in a Hubbell Type SC-3091 floor box for duplex receptacle w/ cover Hubbell Type S-2525.
  - b. Plates:
    - 1) Hubbell Series 97000, stainless steel surface plates for recessed switches and receptacles.
    - 2) Use Crouse-Hinds die cast aluminum weatherproof cover plates with spring door and gaskets, in damp locations.
    - 3) Use Crouse-Hinds sheet steel Type "DS" plates for interior "FS" box installations.

7. Supporting Devices:

a. Structural Supports:

- 1) Supply and install 1-1/2" x 1-1/2" steel channel, fittings and supports as manufactured by Unistrut Cat. No. P-1000, to suit installation of lighting fixtures, conduit, panels and boxes, etc.

8. Electrical Identification:

- 1) Provide electrical identification with permanent, with embossed plastic laminate-type self-adhesive labeling using black letters on white background. Minimum size is 3-inch plastic placard with 2-inch high lettering.

C. Equipment Installation:

1. Equipment shall be installed in accordance with manufacturers recommendations and as indicated on Shop and Contract Drawings.
2. Where floor steel is not required, grout to concrete floor and/or foundation to assure level. Provide hold down fastenings as required.
3. Arrange, schedule and pay for the services of a manufacturer's representative to supervise testing and adjustment of (equipment).
4. Provide sheet metal skirting to enclose any openings between substation switchgear and floor or equipment pad.

END OF SECTION 260500

DIVISION 26 – ELECTRICAL

SECTION 260573 – SHORT-CIRCUIT/ PROTECTIVE DEVICE COORDINATION/ ARC FLASH  
STUDY

A. General

1. Related Work

- a. Section 260500 – Basic Electrical Materials and Methods
- b. Section 264000 – Service, Distribution
- c. Section 268000 – Testing
- d. Electrical Calculation JE-12-015-1; Short Circuit/ Protective Device Coordination/ Arc Flash Study (Prepared by Jaker Engineering, PC for Brookhaven National Labs)

2. Reference

- a. The Work under this Section is subject to requirements of the Contract Documents including the General Conditions, Supplementary Conditions, and sections under Division 1 General Requirements.

3. Description of Work

- a. Short circuit, protective device coordination, and arc flash studies have been performed for equipment. In general, equipment and protective devices have been selected and analyzed to minimize arc flash incident energies. Results are available for Contractor's use.
- b. The study has been performed using acceptable manufacturers from individual specification sections. Equipment and protective device settings selected shall reduce incident energy below 8.0 cal./cm<sup>2</sup> (Arc Flash Hazard Category 2) whenever possible.
- c. Protective devices analyzed per this section that allow an arc flash hazard greater than a Category 2 (> 8.0 cal/ cm<sup>2</sup>) shall require justification prior to installation.
- d. Alternate approved manufacturers are acceptable. Equipment will be evaluated during shop drawing submission and review. Equipment which would cause arc flash energies to increase above 8 cal./cm<sup>2</sup> will be cause for rejection.
- e. Equipment suppliers may perform independent studies to verify performance of proposed devices. Studies must be performed using "SKM System Analysis, Inc.," Power Tools Electrical Engineering Software.

- f. Contractor must submit as-built system data for inclusion in a final study report prior to equipment startup.
  - g. Contractor shall install arc flash PPE labels prior to startup. BNL standard labels will be provided for Contractor's use.
4. Reference Standards
- a. BNL SBMS Subject Area: Electrical Safety (Section 5, Design and Installation of Electrical Equipment)
  - b. IEEE 141 - Recommended Practice for Electric Power Distribution and coordination of Industrial and Commercial Power Systems.
  - c. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings.
  - d. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
  - e. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis.
  - f. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
  - g. ANSI C37.13 - Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
  - h. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
  - i. NFPA-70E – Standard for Electrical Safety in the Workplace
  - j. IEEE 1584 – Guide for Performing Arc Flash Hazard Calculations
5. Submittals
- a. Submit equipment data in accordance with referenced specification sections. Owner will evaluate proposed submissions utilizing the SKM computer model prepared to support this project. Refer to the SKM model prepared for this project, which includes the drawings and final report prepared for this project as part of the construction documents.
  - b. If elected, submit independent SKM model of proposed equipment for Owner's approval. Refer to PART C – EXECUTION for directions and deliverables of the submission from the SKM model.

- c. Preliminary short-circuit and protective device coordination studies are required to evaluate the submission of distribution equipment shop drawings.
  - 1) The drawings and specifications indicate the general requirements for the electrical equipment being provided. Upgrade and modification to equipment characteristics and ratings will be finalized by the results of the short circuit and protective device coordination studies at no additional cost to the owner.
  - 2) Field settings of devices and adjustments to the new equipment to accomplish conformance with the accepted short circuit and protective device coordination studies shall be carried out by the contractor at no additional cost to the owner.
  - 3) Any proposed deviations from the system indicated on drawings and in specifications shall include demonstration of short circuit and breaker coordination. Refer to PART C – EXECUTION for directions and deliverables of the submission justifying proposed deviation.
  - 4) Short circuit study shall be approved prior to manufacture or ordering of equipment.
  - 5) Coordination and arc flash studies shall be approved prior to energizing equipment.
  - 6) Arc flash labeling shall be installed prior to energizing equipment.
- d. Submit as built one line diagrams to reflect approved shop drawings, actual cable lengths, breaker settings, and any other approved field changes.
- e. Final short-circuit, protective device coordination studies, and arc flash analysis shall be issued after equipment is installed but before it is energized.
- f. Final Report shall include:
  - 1) One-Line Diagrams with Input Data, Short Circuit and Arc Flash.
  - 2) Descriptions and Scope of the Study.
  - 3) Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
  - 4) Time versus current coordination curves, tabulations of circuit breaker trip unit settings and fuse selection.
  - 5) Fault current calculations.
  - 6) Three-phase arcing current ratings for each piece of electrical equipment indicated on One-Line Diagram.

- 7) Required PPE (Personal Protective Equipment) level labels for each piece of electrical equipment (medium voltage switches, substations, switchboards, switchgear, motor control centers, distribution panels, panelboards, UPS and downstream panels, Inverters and down stream panels, remote motor controllers, enclosed switches, etc.)
  - 8) Recommendations.
  - g. If Contractor has prepared all studies, submit all electronic files associated with short circuit, coordination and arc flash studies to allow review and future use of the files. Provide (2) copies on CD and (2) hard copies in binders. Files shall be complete to allow exact regeneration of all studies.
  - h. If Owner completes studies, Contractor will be provided with (1) hard copy of the one line drawing containing all final arc flash results.
6. Qualifications
- a. Electrical analysis has been performed by Owner or his designated representative.
  - b. B.If elected, short circuit, coordination studies, and arc flash analysis may be conducted by the Contractor under the supervision and approval of a Registered Professional Electrical Engineer.
- B. Products
- 1. (Not applicable)
- C. Execution
- 1. Compliance
    - a. An Electrical Study was prepared in accordance with Sections C.2, C.3, C.4 and C.5. The Final Report provides the documented analyses, references and drawings for the selection, interconnection and location of equipment. Any change to the make/ model, field settings, interconnection and location would affect the bases of the study and require revision of the study by the Electrical Contractor. Compliance with Sections C.6 and C.7 are required by the EC during field installation.
    - b. Refer to SECTION 000800, Clause SC-2.O regarding the requirements to supply, locate and interconnect the proposed electrical equipment as per the Electrical Study Final Report.

2. Short Circuit Study

- a. Entire electrical system including lighting and appliance panelboards and all upstream equipment (automatic transfer switches, remote motor controllers, enclosed switches, etc.) shall be modeled to facilitate the arc flash study as required below.
- b. Use typical conductor impedances.
- c. Transformer design impedances shall be used when test impedances are not available.
- d. Provide:
  - 1) Calculation methods and assumptions.
  - 2) Selected base per unit quantities.
  - 3) One-line diagram(s).
  - 4) Source impedance data, including utility system and motor fault contribution characteristics.
  - 5) Typical calculations.
  - 6) Tabulations of calculated quantities.
  - 7) Results, conclusions, and recommendations.
- e. Calculate short circuit momentary and interrupting duties for a three phase bolted fault at:
  - 1) Utility's supply termination point.
  - 2) Branch circuit panelboards, if above 10,000 AIC.
  - 3) Enclosed fused and non-fused switches.
- f. Protective Device Evaluation:
  - 1) Evaluate equipment and protective devices and compare to short circuit ratings.

3. Protective Device Coordination Study

- a. Entire electrical system including lighting and appliance panelboards and all upstream equipment (automatic transfer switches, remote motor controllers, enclosed switches, etc.) shall be modeled to facilitate the arc flash study as required below.
- b. Time-current curves shall be displayed on log-log scale paper.

- c. Include on each curve sheet a title and legend, identifying portion of the system covered.
  - d. Identify device by manufacturer type, function and tap, time delay, and instantaneous settings recommended.
  - e. Selective Coordination
    - 1) All circuit breakers associated with the fire pump, elevator, and emergency lighting shall be selectively coordinated per the National Electric Code NEC 2005.
  - f. Plot characteristics where applicable:
    - 1) Electric utility's protective device.
    - 2) Low voltage fuses including minimum melt, total clearing and damage bands.
    - 3) Low voltage circuit breaker trip devices.
    - 4) Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.
    - 5) Conductor damage curves.
    - 6) Ground fault protective devices, as applicable.
    - 7) Motor starting characteristics and motor damage points for motors > 75Hp.
    - 8) Generator short circuit decrement curve and generator damage point, as applicable.
    - 9) All CT ratios, as applicable.
4. Arc Flash Hazard Study
- a. Arc Flash Hazard study shall be performed after short circuit and protective device coordination studies have been completed.
  - b. Three phase arcing currents for each piece of electrical equipment shall be indicated on a one line diagram of the entire electrical system, including panelboards and all upstream equipment.
  - c. Calculations shall be performed using an iterative process.
    - 1) Study shall include calculations for minimum flash protection boundary (measured in meters and feet), incident energy at working distance of 18" (measured in cal/cm<sup>2</sup>), required PPE level, limited approach, restricted approach and prohibited approach boundaries (measured in meters and feet).

- 2) Calculations shall be performed using both NFPA 70E and IEEE 1584 methods for each piece of equipment. Worst case calculation for each piece of equipment shall be used for report.
  - a) Minimum Flash Protection Boundary shall be 4'-0" even if calculated to be less.
  - b) Assume maximum arc duration to be 2 seconds.
  - c) Do not exclude equipment below 240V fed from transformers rated 125kVA or below. BNL requirements exceed those outlined in NFPA 70E and IEEE 1584
- 3) Pieces of equipment that will require PPE greater than level 1 shall be investigated.
  - a) Investigation shall include adjustment of upstream breaker settings to determine if required PPE level can be reduced with minimal compromise to breaker coordination with other upstream breakers.
  - b) Investigation shall continue until lowest PPE level for each piece of electrical equipment can be reached with minimal impact to breaker coordination.
  - c) Compromises to breaker coordination as a result of lowering the required PPE level shall be listed and documented for review by Architect/Engineer.

5. Final Reports

- a. One Line Diagrams
- b. Input Data:
  - 1) Cable and conduit materials.
  - 2) Transformers.
  - 3) Circuit resistance and reactive values.
- c. Short Circuit Data:
  - 1) Source fault impedance.
  - 2) Generator contributions.
  - 3) X to R ratios.
  - 4) Asymmetry factors.

- 5) Motor contributions.
- 6) Short circuit kVA.
- 7) Symmetrical and asymmetrical fault currents.
- d. Recommended Protective Device Settings:
  - 1) Circuit Breakers:
    - a) Adjustable pickups and time delays (long time, short time, ground).
    - b) Adjustable time-current characteristic.
    - c) Adjustable instantaneous pickup.
  - 2) Phase and Ground Relays:
    - a) Current setting.
    - b) Time setting.
    - c) Instantaneous setting.
    - d) Specialty non-overcurrent device settings (ex. Relay 27/47, 81 O/U, 25, etc.).
  - 3) Fuses:
    - a) Types
    - b) Rating
- e. Arc Flash Potential Study Data
  - 1) Calculated three phase arcing currents for all electrical equipment.
  - 2) PPE rating for all electrical equipment.
  - 3) BNL standard PPE labels will be provided by BNL and installed by Contractor.
  - 4) Compromises to breaker coordination resulting from lowering of PPE value at a particular piece of electrical equipment.
6. Field Adjustment
  - a. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
  - b. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
  - c. Notify Owner in writing of any required major equipment modifications.

7. Label and Signage Installation

- a. Install BNL standard PPE labels on each piece of equipment prior to energizing equipment.
- b. PPE label shall be clearly visible upon approach to equipment.
- c. For large pieces of equipment, label shall be placed near main overcurrent device or incoming feeder to equipment.
- d. Label shall be mounted at a minimum of 42” to bottom and maximum of 66” above finished floor.
- e. Laminate final One-Line Diagram and mount within the facility where directed by Owner.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 260600 – GROUNDING AND BONDING

A. General:

1. This section includes grounding of electrical systems and equipment.

B. Execution:

1. Exothermically weld, mechanical connections passing IEEE 837 standard, or, where approved by MPO, braze ground connections. MPO will inspect and approve all ground connections.
2. Use 250 kcmil AWG bare copper conductor loop suspended in concrete curb for substation grounding system. Connect steel fence posts by 250 kcmil AWG bare copper conductor directly to the station grounding system. Weld post grounds not less than 1'-0" above the finished floor.
3. Connect electrical equipment directly to the grounding system, including separately derived grounding for neutral for 3-phase, 4-wire transformer secondary for power system conversion for BlueGene Q computers.
4. Use 2" x 1/4" copper bar main ground buses with ground buses and connections anchored on walls and ceiling by 3/8" diameter cinch anchors.
5. Make conduit ground connections to equipment with a threaded hub, or bushing with two locknuts, one on either side of the box or cabinet.
6. Connect power transformer neutral and lightning arrester discharge circuit ground connections to main ground bus only.
7. Ground instrument transformer secondary for relays and precision instruments.
8. Measure the resistance to ground of all motors, transformers, control equipment, cables, and buses with a Megger. MPO approval of resistance values is required before energizing any equipment.

END OF SECTION 260600

DIVISION 26 – ELECTRICAL  
SECTION 264000 – SERVICE AND DISTRIBUTION

I. General:

- A. Provide all material, labor, equipment, and accessories, including, but not limited to, safety switches, mechanical interlocks, starters and fuses, motor switches, panelboards, grounding and transformers, complete with all accessories and appurtenances required, and noted, for service and distribution work.
- B. Related Work:
  - 1. Section 260500 – Basic Electrical Materials and Methods
  - 2. Section 260573 – Short Circuit/ Protective Device Coordination/ Arc Flash Study
  - 3. Section 268000 – Testing
  - 4. Electrical Calculation JE-11-025-1; Short Circuit/ Protective Device Coordination/ Arc Flash Study (Prepared by Jaker Engineering, PC for Brookhaven National Labs)

II. Materials and Products:

- A. Safety Switches:
  - 1. GE Type TH, heavy duty construction, visual contacts, with flexible copper conductor between switch blades and fuse holder/ cable connector, as shown on Drawings, to prevent hinge from being primary current path, or rotary blades providing double break action, of the electric arc.
    - a. Voltage, amperage, fusible/non-fusible, NEMA construction type 1 or 3R, as shown on Drawings.
- B. Fuses:
  - 1. Provide fuses for all fusible switches, including power panels, and combination starters, Gould Shawmut UL Type A6D, a 600V Class RK1 fuse, sized in accordance with load requirements and for motor running protection in motor circuits. Refer to Electrical Analysis and Drawings.
- C. Circuit Breakers:
  - 1. Provide circuit breakers which match the recommended make and model by original equipment manufacturer, sized in accordance with load requirements and for motor running protection in motor circuits. Refer to Electrical Analysis and Drawings.

D. Grounding:

1. Refer to Specification section 260600; Grounding and Bonding.

III. General Equipment Installation:

- A. Equipment shall be installed in accordance with manufacturer's recommendations and, as indicated on Drawings.
- B. Where floor steel is not required, grout to concrete floor and/or foundation to assure level. Provide hold down fastenings as required.

END OF SECTION 264000

DIVISION 26 – ELECTRICAL  
SECTION 268000 – TESTING

A. General:

1. Furnish all materials, labor, equipment, and accessories necessary for electrical testing work.

B. Materials:

1. Test:

- a. Completed installation shall be tested; demonstrate proper installation, equipment operation, electrical continuity, phase orientation, grounding and insulation resistance in accordance with applicable codes and standards.
- b. The Contractor shall perform a point to point termination check for all power and control wiring as per contract drawings and specification. The Contractor shall notify MPO prior to the start of the test. Any deviation from contract drawings shall be marked clearly on "as-built" drawing set, and submitted to MPO.
- c. Contractor shall furnish labor, equipment, and instruments required. Instruments and their accessories shall be rated for the circuits and equipment that they will be connected to during the testing phase. Voltage and current ratings on equipment and instruments shall be clearly visible. Equipment that doesn't clearly indicate these ratings will not be allowed to be used for any reason.
- d. Tests shall be made in the presence of authorized BNL personnel.
- e. Testing where energy is available to the equipment shall be treated as "Working On or Near" and shall conform to the Standard for Electrical Safety in the Workplace (NFPA 70E), and the requirements of the BNL Safety Coordinator.
- f. Equipment integrity tests must be performed before acceptance by BNL whenever a field modification of manufactured equipment is made or have the manufacturer authorize such modification to assume warantee.

2. Overall Systems Testing:

- a. The following systems shall require functional testing:
  - 1) Electrical Distribution System
- b. Test and inspect in accordance with applicable standards.
- c. No major repairs or parts replacements are to be made without prior approval in writing by the Buyer.

- d. Work shall be accomplished Monday through Friday from 0830–1700 hrs.
  - e. Contact BNL Electrical Inspector to coordinate start of the work.
3. Closeout:
- a. Maintain documentation of all electrical testing. Collect all testing documentation in a single 3-ring binder as the record of project to support the commissioning and turnover of the completed power, lighting, control and fire alarm systems.

END OF SECTION 268000

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY  
SECTION 285000 – DETECTION AND ALARM, FIRE ALARM SYSTEMS

A. General:

1. Furnish all materials, labor, equipment and accessories, including but not limited to, fire alarm systems, initiating devices, notification appliances, controls, supervisory devices and accessories for expansion of the existing B515 Network Lab Computer Room Fire Detection and Alarm System.
  - a. The expanded Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
    - 1) Fire alarm and detection operations
    - 2) Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
  - b. Notify a BNL representative two (2) days in advance of any necessary interruption of the fire alarm system required to complete the scope of this Contract. All final connections and terminations to the existing system or interruption of service to existing equipment will be performed by BNL personnel. Obtain from the BNL representative standard BNL “Out of Service” signs to be installed on all new fire alarm stations and/or fire alarm stations rendered temporarily inoperable during the scope of this Contract. Cover all “Out of Service” fire alarm stations with cardboard enclosures until activated. Remove and return signs to BNL representative after stations are activated. Paint fire alarm junction boxes “BLUE” and mark with adhesive labels furnished by BNL.
  - c. Record of Completion:
    - 1) See NFPA 72 1-7: Requirements for Certificate of Completion. Contractor to comply with NFPA 72 1-7 and all BNL standards. Issue to BNL a “Record of Completion” after completing operational acceptance tests. (Record of Completion form shall be supplied to the Contractor by BNL.)
    - 2) Every system shall include the following documentation, which shall be delivered to BNL upon final acceptance of the system. Final payment will be dependent on all items below being submitted to BNL.
      - a) A manufacturer’s operations and maintenance manual and installation instructions covering all systems and system equipment.
      - b) As-built drawings.

- c) Acceptance Tests: Upon completion of an installation or alterations, all functions of the system shall be tested, including operation of the system in various alarm and trouble modes for which it is designed (e.g., open circuit, grounded circuit, power outage, etc.). Satisfactory tests of the entire system shall be made in the presence of BNL Construction Inspector and BNL's authority having jurisdiction.
- d) Provide training to cognizant BNL personnel on installation, testing and maintenance of the system installed or altered.
- e) Record of Completion form issued by BNL – Completed.

2. Acceptable Manufacturers:

- a. Match system component with existing Manufacturer, which is a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians.

3. Related Documents:

- a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- b. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
  - 1) Division 26: Basic Electrical Materials and Methods
  - 2) Division 23: HVAC
- c. The system and all associated operations shall be in accordance with the following:
  - 1) NFPA 72, National Fire Alarm Code (latest edition)
  - 2) NFPA 70, National Electrical Code (latest edition)
  - 3) NFPA 101, Life Safety Code (latest edition)
  - 4) NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems (latest edition)
  - 5) Underwriter Laboratories (UL)
  - 6) Factory Mutual (FM)
  - 7) BNL ES&H Standard 4.4.0
  - 8) ADA Accessibility Guidelines
- d. All equipment shall be UL or FM listed for the intended use.

4. System Description:

- a. General: Non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices capable of communicating back to the fire command center via the existing data gathering panel (DGP) and multi-zone 20 fire alarm panels, as indicated on the drawings and as specified herein.
- b. Wiring/Signal Transmission:
  - 1) Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation, or addressable signal transmission, dedicated to fire alarm service only, as required.
  - 2) System connections for initiating (signaling) circuits and notification appliance circuits shall be Class B.
  - 3) Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
- c. Power Requirements:
  - 1) The control unit shall receive 120 VAC power via a dedicated branch circuit with a disconnecting means, and shall be identified (in red marking) as “Fire Alarm Circuit.” The location of the circuit disconnecting means shall be permanently identified at the fire alarm control panel.
  - 2) The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 48 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure.
  - 3) All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.

5. Submittals:

- a. General: Submit the following according to Conditions of Contract and Division 01 Specification Sections.
  - 1) Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

- 2) Wiring diagrams from manufacturer.
  - 3) Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
  - 4) System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
  - 5) System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor, and auxiliary control circuits.
  - 6) Operating instructions for FACP.
  - 7) Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
  - 8) Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
  - 9) Record of field tests of system.
  - 10) Record of Completion (supplied by BNL) based on NFPA 72 (paragraph 1c).
6. Quality Assurance:
- a. Installer Qualifications: A factory authorized installer is to perform the work of this section.
  - b. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the “UL” label and/or FM listed.
- B. Products:
1. High Sensitivity Smoke Detector (HSSD)
    - a. The High Sensitivity Smoke Detector (HSSD<sup>®</sup>) shall be an AnaLaser II Detector manufactured by Fenwal Protection Systems.
    - b. The HSSD shall be mounted in a NEMA-1 (IP-31) polycarbonate enclosure, which contains a fan, detector head, and termination board.

- c. The HSSD shall contain a brushless, radial fan that is powered by a regulated voltage supply. The fan speed must not be variable.
  - d. The HSSD shall have an optional rear or side exhaust.
  - e. The HSSD detector adjustable sensitivity range shall be 0.00075% – 0.3%/ft. (0.0025% – 1%/m).
  - f. Each HSSD shall provide coverage for an area up to 20,000 sq. ft.
  - g. The HSSD shall detect smoke through laser particle counting technology.
  - h. Mechanical filters are not acceptable for dust and large particle removal. Only electronic filtration with a laser based, particle size discriminator is acceptable.
  - i. The HSSD shall monitor airflow through the detector.
  - j. The HSSD shall be capable of storing no less than 128 events such as alarm or trouble activation, configuration changes or operator actions.
  - k. The detector shall be capable of storing no less than 40,320 samples of smoke data (up to 28 days of smoke history). Each sample stores the smoke level and date and time of data recording. The data sample rate shall be programmable from 1 to 60 seconds.
  - l. The HSSD shall be equipped with six relays for Pre-Alarm 1, Pre-Alarm 2, Alarm 1, Alarm 2, Trouble and Isolate that allow the detector to directly interface with a fire alarm control panel.
2. HSSD Configuration
- a. A computer running LaserNET software shall configure the HSSD to the environment it is installed in.
  - b. The HSSD detector sensitivity range shall be set either automatically by the HSSD or manually by the installer. For automatic detector sensitivity setting, the HSSD shall be set by the HSSD Auto-Setup™ feature. Auto-Setup shall be set for a learning time period of fifteen minutes to two weeks.
  - c. The HSSD shall have two pre-alarm levels and two alarm levels that are programmable in increments of 5% of the HSSD selected output.
  - d. A second set of programmed pre-alarm and alarm levels for nighttime shall be available.
  - e. The HSSD shall allow programming of 0 to 60 second alarm delays on all pre-alarm and alarm levels.

- f. The HSSD shall provide the option to allow all outputs to remain latched until reset, or to automatically reset after a programmable delay of 0 to 60 seconds.
  - g. The HSSD shall provide the option to average smoke levels of a programmable 2, 4, or 8 second period.
  - h. HSSD airflow shall be represented as a deviation from the normal operating airflow level.
  - i. Low and High Airflow Trouble thresholds shall be programmable through the HSSD configuration software.
3. Display
- a. The HSSD shall have a single tri-color status LED that reports the following conditions: Normal, Auto-Setup, Trouble/Isolation, Pre-Alarm and Alarm.
  - b. The HSSD shall have no more than one LED on the HSSD assembly.
  - c. The HSSD shall have a liquid crystal display (LCD) screen display module either integrated into the HSSD assembly or installed remotely, up to 1000 feet from the HSSD.
  - d. The display module shall provide visual indication of the following:
    - 1) Real-time smoke and airflow level
    - 2) Alarm level thresholds
    - 3) Trouble conditions
    - 4) Date and time
  - e. The display module shall be capable of performing the following detector functions:
    - 1) Reset
    - 2) Isolate
    - 3) Test
    - 4) Silence
  - f. All HSSD functions on the display module shall be password protected. Two levels of passwords, for owner and installer, shall be provided.
  - g. The display module shall contain a programmable internal sounder that provides audible indication of detector alarm, pre-alarm and trouble conditions.
  - h. The display module shall be capable of remote mounting to a standard 2-gang backbox, 4" backbox or 19" rack.

4. Power Supplies

- a. Power shall be supplied to the HSSD by one of the following methods.
  - 1) A Multi-Zone Power Supply that can provide 24 Vdc power, with 24 hour backup, for up to eight HSSD detectors. The Multi-Zone Power Supply shall accept 120 or 240 Vac or 48 Vdc.

5. Sampling Pipe Network

- a. The HSSD shall be connected to an air sampling pipe network through which air is drawn from the protected area to the HSSD.
- b. The sampling pipe network shall be made of any smooth bore type pipe. The pipe may be metallic or non-metallic, as directed.
- c. All joints in the sampling pipe network shall be airtight to prevent leakage.
- d. All sampling pipe shall be clearly marked as “smoke detection sample pipe.”
- e. All sampling points and ports shall be clearly marked as smoke detection sampling points or ports; suction pipe network shall be marked with stickers that read “Fire Alarm”.
- f. The sampling pipe network shall be designed using “SNIFF” pipe network design calculation software.
- g. All sampling points and ports shall be designed to be dynamically balanced with equal suction pressure measured at each point and port.
- h. The maximum transport time of the entire pipe network shall not exceed local codes, specified end-user limitations, or NFPA 72 requirements of 120 seconds.

C. Submittals:

1. “SNIFF” Reports:

- a. The Contractor shall provide the following air sampling pipe network reports and drawings generated by the “SNIFF” pipe design software.
- b. Isometric Drawing
- c. Plan and Elevation Drawing
- d. Detailed List of all Pipes and Pipe Fittings designed in the pipe network
- e. Calculation Report that lists the calculated transport time of the system, all sample hole diameters, suction pressures and % of flow.

2. Commissioning Check Sheets:
    - a. The Contractor shall provide a commissioning check sheet for each installed detector. The check sheet shall list all installed equipment, configurations and measured ambient conditions.
  3. Test Plan:
    - a. The Contractor shall submit a test plan that describes how the system shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be used. Tests shall not be scheduled or conducted until the engineer of record approves the test plan.
  4. Shop Drawings:
    - a. Six (6) copies of shop drawings and product data sheets shall be submitted.
  5. Operation and Maintenance Manuals:
    - a. Five (5) copies of the HSSD Installation, Operation and Maintenance Manual shall be submitted after complete installation.
- D. System Installation and Commissioning:
1. Detection Equipment:
    - a. The Contractor shall install the system in accordance with the manufacturer's installation, operation and maintenance manual.
  2. Training Requirements:
    - a. The Contractor shall be certified and trained by the manufacturer on installation, design and maintenance of High Sensitivity Smoke Detection Systems.
  3. Commissioning Tests:
    - a. The Contractor shall record all equipment, tests and system configurations in a format supplied by the manufacturer.
    - b. A copy of the commissioning results shall be provided to the end-user and sent to the manufacturer.
- E. Execution:
1. Installation General:
    - a. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

- b. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

- 1) Factory trained and certified personnel.

F. Execution:

1. Installation General:

- a. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- b. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
  - 1) Factory trained and certified personnel.

END OF SECTION 285000