HARRIMAN

Saint Anselm College
Lower Level Cooling
Carr Center
Manchester, New Hampshire

Project No. 17343

April 18, 2017

100% Review

This Page Intentionally Left Blank

Saint Anselm College
Lower Level Cooling
Carr Center

TABLE OF CONTENTS

DIVISIONS 27 - 33

Not used.

LIST OF DRAWINGS

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:
1. Section 014000 "Quality Requirements" for submitting test and inspection reports and for mockup requirements.
2. Division 01 to 33 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will not be provided by Architect for Contractor's use in preparing submittals.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
5. No products shall be incorporated into the work unless they have been approved by the Contractor and Architect. No work will be paid for until required submittals for applicable work have been submitted and approved.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 14 calendar days minimum for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 14 calendar days minimum for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 calendar days minimum for initial review of each submittal.

D. Electronic Submittals: **Architect is using Newforma software to process electronic submittals**. Identify and incorporate information in each electronic submittal file as follows:
1. Assemble complete submittal package into single files incorporating submittal requirements of a single specification section and transmittal form.
    a. Provide a separate transmittal form for Product Data, a separate transmittal form for Shop Drawings, and a separate transmittal form for Informational Submittals required by each Specification Section.
    b. Maximum File Size: A single file size, up to 18 MB can be received. Contact Architect for instructions if file exceeds 18 MB.
    c. For each transmittal, attach one single PDF only. Where multiple PDFs are required for a transmittal, utilize Adobe Acrobat combine feature to merge the PDFs into a single PDF.
        1) Unacceptable Formats: In order to process the transmittals in Newforma, the single PDF file protocol must be followed. Transmittals zip files or grouped PDFs (portfolio) cannot be electronically processed and will be returned without action for correction and resubmittal.
        2) Submittals will be returned without action for correction and resubmittal if:
            a) Submittal does not have an electronic Transmittal Form.
            b) Multiple specification sections are contained within a single Transmittal form. Submittals must be separated into individual Specification Sections.
2. Name file with submittal number or other unique identifier, including revision identifier.
    a. File name shall use project identifier and Specification Section number followed by a dash and then a sequential number (e.g., LNHS-061000-01). Resubmittals shall include an alphabetic suffix after another dash (e.g., LNHS-061000-01-A).
3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:
    a. Project name.

b. Date.
c. Name and address of Architect.
d. Name of Construction Manager.
e. Name of Contractor.
f. Name of firm or entity that prepared submittal.
g. Names of subcontractor, manufacturer, and supplier.
h. Category and type of submittal.
i. Submittal purpose and description.
j. Specification Section number and title.
k. Specification paragraph number or drawing designation and generic name for each of multiple items.
l. Drawing number and detail references, as appropriate.
m. Location(s) where product is to be installed, as appropriate.
n. Related physical samples submitted directly.
o. Indication of full or partial submittal.
p. Transmittal number.
q. Submittal and transmittal distribution record.
r. Other necessary identification.
s. Remarks.

E. Options: Identify options requiring selection by Architect.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
1. Submit electronic submittals by either of the following methods:
a. Via email as PDF electronic file to **submittals@harriman.com** .
1) Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

b. Post electronic submittals as PDF electronic files directly to Architect's FTP site specifically established for Project.
1) Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.
4. For equipment, include the following in addition to the above, as applicable:
a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:
a. PDF electronic file.
7. Do not submit Material Safety Data Sheets (MSDSs).

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.
2. Submit Shop Drawings in the following format:
a. PDF electronic file.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
   1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
   2. Identification: Attach label on unexposed side of Samples that includes the following:
      a. Generic description of Sample.
      b. Product name and name of manufacturer.
      c. Sample source.
      d. Number and title of applicable Specification Section.
      e. Specification paragraph number and generic name of each item.
   3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
   4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
      a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
      b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
   5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
      a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
   6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
      a. Number of Samples: Submit two sets of Samples. Architect will retain one Sample sets; remainder will be returned.
         1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
         2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
   1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
   2. Manufacturer and product name, and model number if applicable.
   3. Number and name of room or space.
   4. Location within room or space.
   5. Submit product schedule in the following format:
      a. PDF electronic file.

F. Coordination Drawing Submittals: Comply with requirements specified in Section 013100 "Project Management and Coordination."

G. Contractor's Construction Schedule: Comply with requirements specified in Section 013200 "Construction Progress Documentation."

H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 012900 "Payment Procedures."

I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 014000 "Quality Requirements."

J. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 017700 "Closeout Procedures."

K. Maintenance Data: Comply with requirements specified in Section 017823 "Operation and Maintenance Data."

L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
   1. Name of evaluation organization.
   2. Date of evaluation.
   3. Time period when report is in effect.
   4. Product and manufacturers' names.
   5. Description of product.
   6. Test procedures and results.
   7. Limitations of use.

U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

Y. Material Safety Data Sheets (MSDSs): Submit information directly to Owner at end of the project; do not submit to Architect. Maintain copy at the site for the duration of the construction.
   1. Architect will not review submittals that include MSDSs and will return them.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
   1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
   1. The Contractor shall review submittals for completeness and compliance with the Contract Documents. If submittal contains substitutions, Contractor shall process substitutions in accordance with Division 01 Section “Substitutions and Product Options,” and not part of specified Shop Drawings or Product Data submittals. Contractor is responsible for keeping Subcontractors on time with the submittal schedule. If the Contractor submits submittals that are repeatedly rejected, requiring the Architect to perform multiple reviews of the same submittal because of the failure to properly prepare and complete the submittals:
      a. Owner will compensate Architect for such additional services.
      b. Owner will deduct the amount of such compensation from the final payment to the Contractor.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 017700 "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. Action Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
   1. The Architect’s marking of “Approved,” Approved as Noted” or similar verbiage means submittal has been reviewed for general conformance to the contract documents only and does not mean unqualified acceptance. The Contractor is fully responsible for compliance with the contract documents.

B. Informational Submittals: Architect will review each submittal and will not return it, or will return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Architect without action.

END OF SECTION 013300

AGREEMENT BETWEEN ARCHITECT OF RECORD AND OWNER OR CONTRACTOR FOR TRANSFER OF COMPUTER AIDED DRAFTING (CAD) FILES ON ELECTRONIC MEDIA

Architect of Record (Architect):
Harriman
46 Harriman Drive
Auburn, ME 04210

Recipient:

Project No. 16609 Date:

Project Name:
Location:

The Architect will provide the following CAD files, dated for the project use by the Recipient:

1. 5.
2. 6.
3. 7.
4. 8.

Drawings were prepared on the following:
Computer Hardware: PC Operating System: Windows 7 64 bit or Windows 8.1
Software: (Arris 8) or (Microstation V8i) or Autocad 2017 or (Revit 2017)

Converted to: (Autocad 2004 thru 2017) (DWG)

This signed agreement and payment of any applicable fees are required prior to transferring the files.

Transfer method (check one):

_____ E-mail, provide email address: _____
_____ Electronic File Transfer (FTP) provide email address: _____
_____ CD-ROM
_____ USB Flash Drive

TERMS AND CONDITIONS:

1. It is understood and agreed that all drawings, specifications, or other documents of any kind prepared by Architect or its subconsultants, whether in hard copy or in electronic or machine readable format including Electronic Documents (collectively the "Architect's Documents"), are instruments of their services prepared solely for use in connection with the single project for which they were prepared and that Architect and its subconsultants retain all common law, statutory and other reserved rights, including the copyright. This agreement is not intended in any way to alter the respective interests of the parties in the Instruments of Service as set forth in the Owner/Architect Agreement, notwithstanding Architect's agreement to release the Electronic Documents to Recipient.

2. The Electronic Documents are provided as a convenience to the Recipient for informational purposes only in connection with the Recipient's performance of its responsibilities and obligations relating to the Project. The Electronic Documents do not replace or supplement the paper copies of the Drawings and Specifications, which are, and remain, the Contract Documents for the Project. In all instances, it is the responsibility of the Recipient to insure that the Electronic Documents are consistent with the Contract Documents.

3. The parties agree that the Electronic Documents are not, nor shall they be construed to be, a product. It is expressly agreed by the Recipient that there are no warranties of any kind in such Electronic Documents or in the media in which they are contained, either express or implied.

4. Architect makes no representation as to the compatibility of the CAD files with any hardware or software.

5. Since the information set forth on the CAD files can be modified unintentionally or otherwise, the Architect reserves the right to remove all indicia of its ownership and/or involvement from each electronic display.

6. If any differences exist between printed Instruments of Service and Electronic Documents, the information contained in the printed documents shall be presumed to be correct and take precedence over the Electronic Documents.

7. Recipient agrees not to add to, modify or alter in any way, or to allow others to add to, modify or alter in any way, the Electronic Documents or any printed copies thereof.

8. The Electronic Documents are supplied in a translatable format. Any conversion of the format is solely the responsibility of the Recipient. Recipient understands and agrees that the conversion of hard copies of Instruments of Service into electronic or machine readable format or the conversion of Electronic Documents from the machine readable formats used by Architect to some other format may introduce errors or other inaccuracies. Recipient agrees to accept all responsibility for any errors or inaccuracies and to release Architect, and its subconsultants from any liability or claims for recovery of damages or expenses arising as the result of such errors or inaccuracies.

9. Where the Recipient has received specific permission to use the Electronic Documents in connection with the Recipient's obligation to prepare certain documents for Project, Recipient shall, in addition to the other obligations set forth therein, be obligated to remove Architect's or Architect's Consultant's title block from the copy of the Electronic Documents used by Recipient. It is understood and agreed that, without the separate express written permission of the Architect to do so, the Electronic Documents are not to be used by any contractor or any of its subcontractors of any tier of material supplier or vendor as a shop drawing or any other type of submittal or as the basis for preparing such shop drawing or submittal. The sole exception to this prohibition shall be that the Recipient may use the Electronic Documents as a clearly distinguishable separate background upon which to prepare its shop drawings or other submittal.

10. Recipient further agrees that the Architect's Documents were prepared for use in connection with this project only and that the Electronic Documents are supplied to Recipient for the limited use stated above only. Recipient agrees not to use, or to allow others to use, the Electronic Documents, in whole or in part, for any purpose other than as stated above.

11. The Architect believes that no licensing or copyright fees are due to others on account of the transfer of the CAD files, but to the extent any are, the Contractor will pay the appropriate fees and hold the Architect harmless from such claims.

12. Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not a part of this agreement.

13. Harriman has prepared these Cad files for the sole purpose of plotting and printing a hard copy of the design documents. Harriman believes only the hard copy print to be the accurate representation of all drawing information. Hard copy written dimensions override electronic measured dimensions. User must verify computer data against hard copy prints.

14. Electronic Cad files are an inherently unstable medium and subject to "bugs," deterioration, modifications, and viruses. Cad files are subject to inadvertent changes in the process of moving from one computer to another; or by compressing and decompressing the data; or by moving from one software revision to another; or any kind of manipulation of the data will lead to defects.

15. This agreement shall be governed by the laws of the principal place of business of the Architect. Only printed copies of the Instrument of Service shall be signed and sealed.

16. Recipient agrees to waive any and all claims and liability against Architect and its subconsultants resulting in any way from any failure by Recipient to comply with the requirements of this Agreement for the Delivery of Documents in Electronic Format.

17. The Recipient agrees that no third party beneficiary status or any other right of action is created in favor of any contractor, subcontractor, materialmen or other third party against the Architect by virtue of this Agreement or in connection with its delivery of Electronic Documents, and no third party beneficiary status is intended.

18. Recipient further agrees to indemnify and save harmless the Architect and its subconsultants and each of their partners, officers, shareholders, and directors and employees from any and all claims, judgments, suits, liabilities, damages, costs or expenses (including reasonable defense and attorneys fees including claims asserted in breach of contract, breach of warranty, negligence, or any other tort) arising as a result of either: 1) Recipient's failure to comply with any of the requirements of Agreement for the Delivery of Documents in Electric Format; or 2) a defect, error or omission in the Electronic Documents or the information contained therein, which defect, error or omission was not contained in the Contract Documents as defined in Paragraph 2 or where the use of such Contract Documents would have prevented the claim, judgment, suit, liability, damage, cost, or expense.

19. Architect reserves the right to deny a request to translate files.

AUTHORIZED ACCEPTANCE

by Architect of Record (Architect)	by Recipient
_____	_____
Signature	Signature (by officer)*
_____	_____
Print Name and Title	Print Name and Title
_____	_____
Date	Date
	Witness: _____

*NOTE: Original signature required, do not FAX.

This Page Left Intentionally Blank

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
   1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
   2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
   3. Requirements for Contractor to provide quality-assurance and -control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:
   1. Division 01 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
   2. Divisions 02 through 33 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size, physical assemblies that are constructed on-site. Mockups are used to verify selections made under sample submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.

F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

G. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

H. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Description of test and inspection.
   3. Identification of applicable standards.
   4. Identification of test and inspection methods.
   5. Number of tests and inspections required.
   6. Time schedule or time span for tests and inspections.
   7. Entity responsible for performing tests and inspections.
   8. Requirements for obtaining samples.
   9. Unique characteristics of each quality-control service.

C. Reports: Prepare and submit certified written reports that include the following:
   1. Date of issue.
   2. Project title and number.
   3. Name, address, and telephone number of testing agency.
   4. Dates and locations of samples and tests or inspections.
   5. Names of individuals making tests and inspections.
   6. Description of the Work and test and inspection method.
   7. Identification of product and Specification Section.
   8. Complete test or inspection data.
   9. Test and inspection results and an interpretation of test results.
   10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
   11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
   12. Name and signature of laboratory inspector.
   13. Recommendations on retesting and reinspecting.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
   1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
      e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
      f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
   2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

J. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Demonstrate the proposed range of aesthetic effects and workmanship.
   4. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
   5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   6. Demolish and remove mockups when directed, unless otherwise indicated.

K. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 2 through 33.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
   3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 1 Section "Submittal Procedures."

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Submit schedule within 30 days of date established for commencement of the Work.
   1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.8 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Owner will engage a qualified registered engineer to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, in compliance with applicable building code.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Architect.
   4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

This Page Left Intentionally Blank

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(703) 358-2960
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABAA	Air Barrier Association of America www.airbarrier.org	(866) 956-5888
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
ACI	ACI International (American Concrete Institute) www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530

AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHA	American Hardboard Association (Now part of CPA)	
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
ALCA	Associated Landscape Contractors of America (Now PLANET - Professional Landcare Network)	
ALSC	American Lumber Standard Committee, Incorporated www.alsc.org	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts, Inc. www.aosaseed.com	(405) 780-7372
APA	Architectural Precast Association www.archprecast.org	(239) 454-6989
APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600

APA EWS	APA - The Engineered Wood Association; Engineered Wood Systems (See APA - The Engineered Wood Association)	
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute www.ari.org	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association www.asphaltroofing.org	(202) 207-0917
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute (See ASCE)	
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (973) 882-1170
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9585
AWCI	AWCI International (Association of the Wall and Ceiling Industry International) www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (Now WCSC)	
AWI	Architectural Woodwork Institute www.awinet.org	(571) 323-3636
AWPA	American Wood-Preservers' Association www.awpa.com	(205) 733-4077
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711

BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.bia.org	(703) 620-0010
BICSI	BICSI www.bicsi.org	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.org	(866) 342-4772
CCC	Carpet Cushion Council www.carpetcushion.org	(610) 527-3880
CDA	Copper Development Association www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.canelect.ca	(613) 230-9263
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CGA	Compressed Gas Association www.cganet.com	(703) 788-2700
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CRRC	Cool Roof Rating Council www.coolroofs.org	(866) 465-2523 (510) 485-7175
CPA	Composite Panel Association www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607

CRI	Carpet & Rug Institute (The) www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	Canadian Standards Association	(800) 463-6727 (416) 747-4000
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(866) 797-4272 (416) 747-4000
CSI	Cast Stone Institute www.caststone.org	(717) 272-3744
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIA	Electronic Industries Alliance www.eia.org	(703) 907-7500
EIMA	EIFS Industry Members Association www.eima.com	(800) 294-3462 (770) 968-7945
EJCDC	Engineers Joint Contract Documents Committee www.ejdc.org	(703) 295-5000
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association www.esda.org	(315) 339-6937
FIBA	Federation Internationale de Basketball (The International Basketball Federation) www.fiba.com	41 22 545 00 00
FIVB	Federation Internationale de Volleyball (The International Volleyball Federation) www.fivb.ch	41 21 345 35 35

FM Approvals	FM Approvals www.fmglobal.com	(781) 762-4300
FM Global	FM Global (Formerly: FMG - FM Global) www.fmglobal.com	(401) 275-3000
FMRC	Factory Mutual Research (Now FM Global)	
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridaroof.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council www.fsc.org	49 228 367 66 0
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GRI	(Now GSI)	
GS	Green Seal www.greenseal.org	(202) 872-6400
GSI	Geosynthetic Institute www.geosynthetic-institute.org	(610) 522-8440
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
HMMA	Hollow Metal Manufacturers Association (Part of NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAS	International Approval Services (Now CSA International)	

IBF	International Badminton Federation www.internationalbadminton.org	(6-03) 9283-7155
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IESNA	Illuminating Engineering Society of North America www.iesna.org	(212) 248-5000
IEST	Institute of Environmental Sciences and Technology www.iest.org	(847) 255-1561
IGCC	Insulating Glass Certification Council www.igcc.org	(315) 646-2234
IGMA	Insulating Glass Manufacturers Alliance www.igmaonline.org	(613) 233-1510
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
ISO	International Organization for Standardization www.iso.ch	41 22 749 01 11
	Available from ANSI www.ansi.org	(202) 293-8020
ISSFA	International Solid Surface Fabricators Association www.issfa.net	(877) 464-7732 (702) 567-8150
ITS	Intertek Testing Service NA www.intertek.com	(972) 238-5591
ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LMA	Laminating Materials Association (Now part of CPA)	
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864

MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MFMA	Maple Flooring Manufacturers Association, Inc. www.maplefloor.org	(847) 480-9138
MFMA	Metal Framing Manufacturers Association, Inc. www.metalframingmfg.org	(312) 644-6610
MH	Material Handling (Now MHIA)	
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(312) 332-0405
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(800) 797-6623 (281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAGWS	National Association for Girls and Women in Sport www.aahperd.org/nagws/	(800) 213-7193, ext. 453
NAIMA	North American Insulation Manufacturers Association www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCAA	National Collegiate Athletic Association (The) www.ncaa.org	(317) 917-6222
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900

NCPI	National Clay Pipe Institute www.ncpi.org	(262) 248-9094
NCTA	National Cable & Telecommunications Association www.ncta.com	(202) 775-3550
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(888) 300-6382 (303) 697-8441
NFHS	National Federation of State High School Associations www.nfhs.org	(317) 972-6900
NFPA	NFPA (National Fire Protection Association) www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NGA	National Glass Association www.glass.org	(866) 342-5642 (703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	NOFMA: The Wood Flooring Manufacturers Association (Formerly: National Oak Flooring Manufacturers Association) www.nofma.com	(901) 526-5016
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010

NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. (The) www.ntma.com	(800) 323-9736 (540) 751-0930
NTRMA	National Tile Roofing Manufacturers Association (Now TRI)	
NWWDA	National Wood Window and Door Association (Now WDMA)	
OPL	Omega Point Laboratories, Inc. (Now ITS)	
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting & Decorating Contractors of America www.pdca.com	(800) 332-7322 (314) 514-7322
PDI	Plumbing & Drainage Institute www.pdionline.org	(800) 589-8956 (978) 557-0720
PGI	PVC Geomembrane Institute http://pgi-tp.ce.uiuc.edu	(217) 333-3929
PLANET	Professional Landcare Network (Formerly: ACLA - Associated Landscape Contractors of America) www.landcarenetwork.org	(800) 395-2522 (703) 736-9666
PTI	Post-Tensioning Institute www.post-tensioning.org	(602) 870-7540
RCSC	Research Council on Structural Connections www.boltcouncil.org	
RFCI	Resilient Floor Covering Institute www.rfci.com	(301) 340-8580
RIS	Redwood Inspection Service www.calredwood.org	(888) 225-7339 (415) 382-0662
SAE	SAE International www.sae.org	(877) 606-7323 (724) 776-4841
SDI	Steel Deck Institute www.sdi.org	(847) 458-4647
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010

SEFA	Scientific Equipment and Furniture Association www.sefalabs.com	(516) 294-5424
SEI/ASCE	Structural Engineering Institute/American Society of Civil Engineers (See ASCE)	
SGCC	Safety Glazing Certification Council www.sgcc.org	(315) 646-2234
SIA	Security Industry Association www.siaonline.org	(703) 683-2075
SIGMA	Sealed Insulating Glass Manufacturers Association (Now IGMA)	
SJI	Steel Joist Institute www.steeljoist.org	(843) 626-1995
SMA	Screen Manufacturers Association www.smacentral.org	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SMPTE	Society of Motion Picture and Television Engineers www.smpte.org	(914) 761-1100
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPRI	Single Ply Roofing Industry www.spri.org	(781) 647-7026
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333

SWRI	Sealant, Waterproofing, & Restoration Institute www.swrionline.org	(816) 472-7974
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute, Inc. www.tpinst.org	(703) 683-1010
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 649-5555
TRI	Tile Roofing Institute www.tileroofing.org	(312) 670-4177
UL	Underwriters Laboratories Inc. www.ul.com	(877) 854-3577 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USAV	USA Volleyball www.usavolleyball.org	(888) 786-5539 (719) 228-6800
USGBC	U.S. Green Building Council www.usgbc.org	(202) 828-7422
USITT	United States Institute for Theatre Technology, Inc. www.usitt.org	(800) 938-7488 (315) 463-6463
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (Now WCSC)	
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association) www.windowcoverings.org	(800) 506-4636 (212) 297-2109

WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WI	Woodwork Institute (Formerly: WIC - Woodwork Institute of California) www.wicnet.org	(916) 372-9943
WIC	Woodwork Institute of California (Now WI)	
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WSRCA	Western States Roofing Contractors Association www.wsrca.com	(800) 725-0333 (650) 570-5441
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

BOCA	BOCA International, Inc. (See ICC)	
IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICBO	International Conference of Building Officials (See ICC)	
ICBO ES	ICBO Evaluation Service, Inc. (See ICC-ES)	
ICC	International Code Council www.iccsafe.org	(888) 422-7233 (703) 931-4533
ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587 (562) 699-0543
SBCCI	Southern Building Code Congress International, Inc. (See ICC)	
UBC	Uniform Building Code (See ICC)	

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the

following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.army.mil	
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-7923
DOC	Department of Commerce www.commerce.gov	(202) 482-2000
DOD	Department of Defense http://.dodssp.daps.dla.mil	(215) 697-6257
DOE	Department of Energy www.energy.gov	(202) 586-9220
EPA	Environmental Protection Agency www.epa.gov	(202) 272-0167
FAA	Federal Aviation Administration www.faa.gov	(866) 835-5322
FCC	Federal Communications Commission www.fcc.gov	(888) 225-5322
FDA	Food and Drug Administration www.fda.gov	(888) 463-6332
GSA	General Services Administration www.gsa.gov	(800) 488-3111
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley National Laboratory www.lbl.gov	(510) 486-4000
NCHRP	National Cooperative Highway Research Program (See TRB)	
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
PBS	Public Building Service (See GSA)	
PHS	Office of Public Health and Science www.osophs.dhhs.gov/ophs	(202) 690-7694

RUS	Rural Utilities Service (See USDA)	(202) 720-9540
SD	State Department www.state.gov	(202) 647-4000
TRB	Transportation Research Board http://gulliver.trb.org	(202) 334-2934
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	Postal Service www.usps.com	(202) 268-2000

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080
CFR	Code of Federal Regulations Available from Government Printing Office www.gpoaccess.gov/cfr/index.html	(866) 512-1800 (202) 512-1800
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
	Available from Defense Standardization Program www.dps.dla.mil	
	Available from General Services Administration www.gsa.gov	(202) 619-8925
	Available from National Institute of Building Sciences www.wbdg.org/ccb	(202) 289-7800

FTMS	Federal Test Method Standard (See FS)	
MIL	(See MILSPEC)	
MIL-STD	(See MILSPEC)	
MILSPEC	Military Specification and Standards Available from Department of Defense Single Stock Point http://dodssp.daps.dla.mil	(215) 697-2664
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web sites are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation www.dca.ca.gov/bhfti	(800) 952-5210 (916) 574-2041
CCR	California Code of Regulations www.calregs.com	(916) 323-6815
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(415) 703-2782
TFS	Texas Forest Service Forest Resource Development http://txforestservice.tamu.edu	(979) 458-6650

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

This Page Left Intentionally Blank

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:
   1. Division 01 Section "References" for applicable industry standards for products specified.
   2. Divisions 02 through 33 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
   1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
   2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
   3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
   1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
   2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

B. Delivery and Handling:
   1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
   2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
   3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
   4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

C. Storage:
   1. Store products to allow for inspection and measurement of quantity or counting of units.
   2. Store materials in a manner that will not endanger Project structure.
   3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
   4. Store cementitious products and materials on elevated platforms.
   5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
   6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
   7. Protect stored products from damage and liquids from freezing.
   8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
   1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
   2. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
   1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
   2. Specified Form: When specified forms are included with the Specifications, prepare a written document using appropriate form properly executed.
   3. Refer to Divisions 2 through 33 Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.
   1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
   2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
   3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
   4. Where products are accompanied by the term "as selected," Architect will make selection.
   5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
   6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
   7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in Division 01 Section “Substitutions and Product Options” to obtain approval for use of an unnamed product.

B. Product Selection Procedures:
   1. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
   2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
   3. Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
   4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
   5. Available Products: Where Specifications include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
   6. Available Manufacturers: Where Specifications include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product.
   7. Product Options: Where Specifications indicate that sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide the

specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.

8. Basis-of-Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
    a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.
10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.
    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Architect will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 017300 - EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
   1. Construction layout.
   2. General installation of products.
   3. Coordination of Owner-installed products.
   4. Progress cleaning.
   5. Starting and adjusting.
   6. Protection of installed construction.
   7. Correction of the Work.

B. Related Sections include the following:
   1. Division 01 Section "Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
   1. Before construction, verify the location and points of connection of utility services.

B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
   1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
      a. Description of the Work.
      b. List of detrimental conditions, including substrates.
      c. List of unacceptable installation tolerances.
      d. Recommended corrections.

2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings.

B. General: Lay out the Work using accepted surveying practices.
1. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
2. Inform installers of lines and levels to which they must comply.
3. Check the location, level and plumb, of every major element as the Work progresses.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
4. Maintain minimum headroom clearance of 8 feet in spaces without a suspended ceiling, unless indicated otherwise.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
   1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
   2. Allow for building movement, including thermal expansion and contraction.
   3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.
   1. No asbestos containing materials shall be used in the work.

3.5 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction forces.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
   1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
   2. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
   1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
   2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
   3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work. It is the Contactor's responsibility for job site safety.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
      a. Clean interior spaces prior to the start of finish painting, and continue cleaning on an as-needed basis until painting is finished.
      b. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly coated surfaces.
   3. Remove materials and debris that create tripping hazards.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove dirt, debris and garbage from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 01 Section "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.9 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Division 01 Section "Cutting and Patching."
   1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

This Page Left Intentionally Blank

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Salvaging nonhazardous demolition and construction waste.
   2. Recycling nonhazardous demolition and construction waste.
   3. Disposing of nonhazardous demolition and construction waste.
   4. Recycling of DEP-Regulated Universal waste.

B. Related Requirements:
   1. Division 02 Section "Selective Structure Demolition and Alterations" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.
   2. Refer to drawings for additional information.

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Reused or Salvaged: Recovery of demolition or construction waste and subsequent sale, donation, or reuse in another facility or incorporated into the Work.

F. Universal Waste: Any waste designated by the New Hampshire Department of Environmental Protection as Universal Waste i.e. fluorescent lamps, ballasts, thermostats and other lead and mercury containing devices.

1.4 PERFORMANCE REQUIREMENTS

A. General: Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators by sorting prior to leaving the jobsite. Facilitate recycling and salvage of materials. All waste must be disposed of at facilities that operate in accordance with all local, state, and federal waste regulations. Documentation of compliance can be requested by of Southern Maine Community College at any time.

1.5 SUBMITTALS

A. Submit 'Anticipated Project Waste Sheet' before commencement of work.

B. Submit 'Waste Reporting Sheet' monthly with each Pay Requisition during the course of the project and prior to Final Requisition.
   1. Include the following information on Waste Reporting Sheet:
      a. Date of disposal
      b. Type of material(s)
      c. Method(s) of disposal: recycled, reused/salvaged, landfilled, incinerated.
      d. Weight(s): attach copies of scale tickets to form (see below).

C. Copies of scale tickets from waste facilities, including transfer and processing facilities, for each haul must be attached to monthly 'Project Waste Sheet' on which the waste is listed.

D. Copies of Certificates of Recycling from DEP-approved consolidators for all hauls over the course of the project which involved Universal Waste must be attached to final Waste Reporting Sheet at conclusion of project.

E. Copy of Certificate of Refrigerant Recovery must be attached to Waste Reporting Sheet on which device is listed. Refrigerant Recovery must be performed by an EPA-approved Refrigerant Recovery Technician.

1.6 QUALITY ASSURANCE

A. Contractors must designate someone in their employ (a direct paid employee of the general contractor) to be the contact for waste reporting for the duration of the project.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
   1. For any questions or clarifications of waste handling procedures contact the UNH project manager directly.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 RECYCLING / SALVAGING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers in accordance with UNH Waste Minimization policy.

B. Preparation of Waste: Prepare and maintain recyclable and salvageable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling or reusing process.

C. Procedures: Separate recyclable and salvageable waste from other waste materials, trash, and debris. Sort recyclable waste by type at Project site to the maximum extent practical.
   1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
   2. Inspect containers and bins for contamination and remove contaminated materials if found.

3.2 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged/reused or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
   1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

END OF SECTION 017419

This Page Left Intentionally Blank

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
   1. Inspection procedures.
   2. Warranties.
   3. Final cleaning.

B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion.
   2. Division 01 Section "Execution Requirements" for progress cleaning of Project site.
   3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   5. Division 01 Section "Demonstration and Training" for requirements for instructing Owner's personnel.
   6. Divisions 02 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, the Contractor shall complete the following. List items below that are incomplete in request.
   1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
   3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
   4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Prepare and submit Project Record Documents, operation and maintenance manuals.
   6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
   7. Coordinate final changeover of permanent locks with Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete startup testing of systems.
   9. Advise Owner of changeover in heat and other utilities.

10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
11. Complete final cleaning requirements, including touchup painting.
12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
13. Submit initial draft copy of operation and maintenance manuals at least 15 days before requesting inspection for Substantial Completion.
14. Extra materials, spares and attic stock have been turned over to the Owner.
15. Demonstration and training is complete.
16. Completion and acceptance of final operation and maintenance manuals.
17. Project record documents completed and submitted.
18. Required warranties submitted.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. The Owner and Architect will inspect the Project or designated portion thereof with the Contractor, verify list of items to be completed and corrected (punch list), and supplement list upon discovery of additional items. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
   2. Results of completed inspection will form the basis of requirements for Final Completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:
   1. Submit a final Application for Payment according to Division 01 Section "Payment Procedures."
   2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
   3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
   4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
   5. Verify all required inspections, testing, operation and maintenance data, project record documents, and demonstration and training has been finalized.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect and Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
   1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 INSPECTION FEES

A. If the Architect Performs Reinspections Repeatedly Due to Failure of the Work to Comply with the Claims of Status of Completion Made by the Contractor, Or, Should the Contractor fail to complete the work, Or, Should the Contractor fail to promptly correct warranty items or work later found to be deficient:
   1. Owner will compensate Architect for such additional services.
   2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

B. If the Work is not completed by the date set in the Agreement, and the Architect needs to perform additional Contract Administrative and on site observation duties:
   1. Owner will compensate Architect for such additional services.
   2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: List shall be prepared by the Contractor. Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
   1. Organize list of spaces in sequential order.
   2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
   3. Include the following information at the top of each page:
      a. Project name.
      b. Date.
      c. Name of Architect.
      d. Name of Contractor.
      e. Page number.
   4. Owner and Architect will supplement list with additional items found incomplete and additional items needing correction.

1.7 WARRANTIES

A. Submittal Time: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated in the contract documents.
   1. Unless indicated otherwise, all warranties shall commence on the date of Substantial Completion.

B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
   1. Submit final warranties as a package for the entire project, assembled and identified.
   2. Bind warranties and bonds in heavy-duty, D-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents but not greater than 2 inches, and sized to receive 8-1/2-by-11-inch paper. Do not over fill D-ring, allowing 1/2-inch space for future additions.
   3. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or

installation, including the name of the product and the name, address, and telephone number of Installer.

4. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
5. Electronic Media: Submit copy of warranties on CD-R in .PDF format. Bookmark based on the table of contents, and for each warranty within each section.
6. Provide additional electronic media copies of each warranty to include in operation and maintenance manuals.

C. Warranty Response Time: The Contract shall respond and begin to take necessary action within 7 days of receipt of written notification from the Owner. Response time for life safety items, and for building perimeter security shall be within 24 hours of receipt of written notification from the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations for areas disturbed and dirtied by construction operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
    a. Clean Project site, yard, and grounds that have been.
    b. Sweep paved areas broom clean.
    c. Remove tools, construction equipment, machinery, and surplus material from Project site.
    d. Clean exposed interior hard-surfaced finishes, including walls, floors and ceilings, to a dirt-free/dust-free condition, free of stains, films, and similar foreign substances that were made dirty by construction operations. Restore reflective surfaces to their original condition.
    e. Remove debris and surface dust created by the work from limited access spaces.
    f. Vacuum and wash floors.
    g. Vacuum carpet and similar soft surfaces made dirty by construction operations, removing debris and excess nap; shampoo if visible soil or stains remain.

h. Resilient flooring made dirty by construction operations shall be scrubbed and cleaned with specialty floor cleaner just prior to occupation by Owner.

i. New floors shall be waxed just prior to occupation by Owner. Strip floors with Owner approved floor stripper after VCT adhesive has fully cured. Finish shall consist of three coats of floor finish used by the Owner, properly buffed to a uniform sheen. Work shall be done by a floor care subcontractor. Coordinate selection of finish with flooring manufacturer and Owner's maintenance program.

j. Clean transparent materials, including glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish glass, taking care not to scratch surfaces. Clean windows on interior sides just before Owner occupancy.

k. Remove labels that are not permanent.

l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

   1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

m. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and other foreign substances.

n. Replace parts subject to unusual operating conditions.

o. Replace disposable air filters exposed to demolition and construction activities and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

p. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

q. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700

This Page Left Intentionally Blank

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation and maintenance documentation directory.
   2. Operation manuals for systems, subsystems, and equipment.
   3. Maintenance manuals for the care and maintenance of products, materials, and finishes, systems and equipment.

B. Related Sections include the following:
   1. Division 01 Section "Payment Procedures" for submitting copies of final operation and maintenance manuals before payment.
   2. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   3. Division 01 Section "Closeout Procedures" for submitting operation and maintenance manuals.
   4. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
   5. Divisions 02 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Initial Submittal: Submit 1 electronic PDF draft copy of each manual to the Architect, and one copy concurrently to the Owner at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect will return draft and mark whether general scope and content of manual are acceptable.
   1. Correct or modify each manual to comply with Architect's and Owner's comments.

B. Final Submittal: Submit two hard copy sets of manuals and one electronic PDF copy of each manual in final form at least 15 days before final inspection at substantial completion.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:
   1. List of documents.
   2. List of systems.
   3. List of equipment.
   4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
   1. Title page.
   2. Table of contents.
   3. Manual contents.

B. Title Page: Include the following information:
   1. Subject matter included in manual.
   2. Name and address of Project.
   3. Name and address of Owner.
   4. Date of submittal.
   5. Name, address, and telephone number of Contractor and primary subcontractors.
   6. Name and address of Architect.
   7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
   1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder. For the electronic copy, bookmark data and information based on the table of contents.
   1. Include Record Shop Drawings and Product Data on CD-R in .PDF format.
   2. Binders: Heavy-duty, D-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents but not greater than 2 inches, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets. Do not over fill D-ring, allowing 1/2-inch space for future additions.
      a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
      b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
   3. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
   4. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
   5. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
   6. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
      a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
      b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

E. Electronic Media: Submit one copy of each final completed manual, including Record Shop Drawings and Product Data on CD-R in .PDF format. Bookmark based on the specifications table of contents and manual dividers.

2.3 OPERATION MANUALS

A. Content: Daily operations and management of systems and equipment. In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
   1. System, subsystem, and equipment descriptions.
   2. Performance and design criteria if Contractor is delegated design responsibility.
   3. Operating standards.

4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.
11. Emergency operations and shutdown information that must be immediately available during emergency situations to protect life and property and to minimize disruptions to building occupants.

B. Descriptions: Include the following:
1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

F. Emergency Instructions and Procedures: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties. Include the following, as applicable:
1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:
   1. Product name and model number.
   2. Manufacturer's name.
   3. Color, pattern, and texture.
   4. Material and chemical composition.
   5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
   1. Inspection procedures.
   2. Types of cleaning agents to be used and methods of cleaning.
   3. List of cleaning agents and methods of cleaning detrimental to product.
   4. Schedule for routine cleaning and maintenance.
   5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

G. Copy of approved submittals.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
   1. Standard printed maintenance instructions and bulletins.
   2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.

3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate electronic manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
   1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
   1. Do not use original Project Record Documents as part of operation and maintenance manuals.

F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

This Page Left Intentionally Blank

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
   1. Record Drawings.
   2. Record Specifications.
   3. Record Product Data.
   4. Record Shop Drawings.
   5. Record Test Reports.

B. Related Sections include the following:
   1. Division 01 Section "Closeout Procedures" for general closeout procedures.
   2. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
   3. Divisions 02 through 33 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

A. Submit all project record documents as one submittal package.

B. Record Drawings: Comply with the following:
   1. Number of Copies: Submit copies of Record Drawings as follows:
      a. Submit one set(s) of marked-up Record Prints and one copy on CD in .PDF format.

C. Record Specifications: Submit one hard copy and one copy on electronic media of Project's Specifications, including addenda and contract modifications.

D. Record Submittals: Submit one hard copy and one copy on electronic media of each approved Shop Drawings, Product Data and miscellaneous submittals.
   1. Where Record Shop Drawings and Product Data is required as part of operation and maintenance manuals, include one hard copy and one copy on electronic copy of marked-up Shop Drawings and Product Data as an insert in manual in addition to submittal as Record Shop Drawings and Product Data.
   2. Electronic Media: In addition to paper copy, submit record copy of record submittals on CD in .PDF format. Bookmark Product Data based on the table of contents.

E. Directories: Subcontractor directory.
   1. Submit one hard copy and one copy on electronic media CD-R in .PDF format.

F. Record Test Reports: Submit one hard copy and one copy on electronic media of project Test Reports. Bookmark Test Reports based on the project manual table of contents.

PART 2 - PRODUCTS

2.1 RECORD (AS-BUILT) DRAWINGS

A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
   1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
      a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
      b. Accurately record information in an understandable drawing technique.
      c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
   2. Content: Types of items requiring marking include, but are not limited to, the following:
      a. Dimensional changes to Drawings.
      b. Revisions to details shown on Drawings.
      c. Depths of foundations below first floor.
      d. Locations and depths of underground and under slab utilities.
      e. Revisions to routing of piping and conduits.
      f. Revisions to electrical circuitry.
      g. Actual equipment locations.
      h. Duct size and routing.
      i. Locations of concealed internal utilities.
      j. Changes made by Change Order or Construction Change Directive.
      k. Changes made following Architect's written orders.
      l. Changes made by field sketches and supplemental drawings.
      m. Changes made as a result of requests for information (RFI's).
      n. Details not on the original Contract Drawings.
      o. Field records for variable and concealed conditions.
      p. Record information on the Work that is shown only schematically.
   3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
   4. Mark field record sets during construction with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
   5. Mark important additional information that was either shown schematically or omitted from original Drawings.
   6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
   7. Mechanical, Electrical, Fire Suppression, Fire Alarm, Security, and Plumbing record drawings shall be based on record site drawings and record floor plan drawings.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize Record Prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Electronic Format: In addition to a hard copy, submit one electronic copy on CD in PDF format. Bookmark each drawing with Drawing number and title.
   3. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Architect.
      e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions, change orders and product options selected.
   3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
   4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
   5. Note related Change Orders, Record Product Data, Requests for Information (RFI's), and Record Drawings where applicable.
   6. Electronic Media: Submit one record hard copy and one of record specification on CD in .PDF format. Bookmark based on the table of contents.

2.3 RECORD SHOP DRAWINGS AND PRODUCT DATA

A. Preparation: Mark Shop Drawings and Product Data to indicate the actual product installation where installation varies substantially from that indicated in Shop Drawings and Product Data submittal.
   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
   3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.
   4. Electronic Media: Submit record copy of marked-up and approved Shop Drawings and Product Data on CD in .PDF format. Bookmark based on the table of contents, and for each Shop Drawings and Product Data within each section. Where Record Shop Drawings and Product Data is required as part of operation and maintenance manuals, submit electronic media of marked-up Shop Drawings and Product Data as part of manual in addition to submittal as Record Shop Drawings and Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Subcontractor Directory: Name, address and telephone number for all major subcontractors, organized by specification section. Provide a separate list in alphabetical order.

C. Test Reports: Provide copy of all project test reports.
   1. Electronic Media: Submit record copy of Test Reports on CD-R in .PDF format. Bookmark based on the project manual table of contents.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Provide labor, materials, accessories, and other related items as required to complete operations in connection with the complete installation of the HVAC and mechanical systems as indicated on the Drawings and as specified herein.

1.2 RELATED REQUIREMENTS

A. Conditions of the Contract apply to the work, including the work of this Division. Examine Contract Documents for requirements affecting the work.

B. Provide cooperation with, and assistance to, the Testing and Balancing (TAB) Agent specified in Division 23 Section “Testing, Adjusting, and Balancing for Mechanical Systems.”

1.3 MECHANICAL PRE-CONSTRUCTION MEETING

A. Conduct a mechanical conference at Project site to comply with requirements of Division 01 Section “Project Management and Coordination” and the following:
   1. At least 14 days prior to beginning of mechanical work, conduct a meeting to review detailed requirements for mechanical systems installation and testing requirements. Review mechanical Drawings and Specifications, discuss project specific details and requirements, and review and discuss expectations for quality control. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with mechanical systems installation to attend conference, including, but not limited to, the following:
      a. General Contractor's superintendent.
      b. Mechanical Subcontractors’ project managers.
      c. Mechanical Subcontractors’ job foremen.
      d. Sheetmetal job foreman.
      e. Plumbing job foreman.
      f. Controls job foreman.
      g. Project mechanical Engineer/designer.
      h. Job clerk.
      i. Architect’s construction administrator.

1.4 CONTRACT DOCUMENTS

A. The general location of the apparatus and the details of the work are indicated on the Drawings. Exact locations not indicated shall be determined at the site as the work progresses and shall be subject to the Architect's approval.

B. It is not intended that the Drawings shall show every pipe, pipe rise, pipe drop, duct rise, duct drop, pipe fitting, duct fitting, or appliance, but it shall be a requirement to furnish, without additional expense, material and labor necessary to complete the systems in accordance with the design intent and with the highest possible quality available.

C. The Contractor shall take no advantage of any apparent error or omission in the Drawings and Specifications, and the Designer shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the Drawings and Specifications. Where errors or omissions appear in the Contract Documents, the Contractor shall promptly notify the Designer in writing of such errors or omissions. Inconsistencies in the contract documents are to be reported before proposals are received, whenever found.

D. Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.

1.5 ALTERATIONS

A. Execute alterations, additions, removals, relocations, new work, and other related items as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents, including changes required by building alterations.

B. Existing work disturbed or damaged by the alterations or the new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.

C. Existing ductwork, piping, and other systems indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

1.6 CONTINUITY OF SERVICE

A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect’s approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the Bid.

1.7 REQUIREMENTS

A. Installation Instructions: Obtain manufacturer’s printed installation instructions to aid in properly executing work on major pieces of equipment. Install equipment in accordance with manufacturer’s recommendations.

B. Objectionable Noise, Fumes and Vibration:
1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes, or vibration, as determined by the Architect.
2. If such objectionable noise, fumes, or vibration is produced and transmitted to occupied portions of building by apparatus, piping, ducts, or any other part of mechanical and electrical work, make necessary changes and additions, as approved, without extra cost to Owner.

C. Equipment Design and Installation:
   1. Uniformity: Unless otherwise specified, equipment or material of same type or classification, used for same purposes, shall be product of same manufacturer.
   2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog number shall be designed in conformity with ASME, IEEE, or other applicable technical standards, suitable for maximum working pressure, and with neat and finished appearance.
   3. Installation: Erect equipment aligned, level, and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, as approved.

D. Hanging of Equipment, Ductwork and Piping:
   1. Support equipment, ductwork, and piping from the top chord of bar joists at the “Panel Points” or from the top flange of beams. Provide intermediate support consisting of steel angle or equal as required where supports are installed between joist spaces.
   2. Piping 2-inch (50 mm) nominal and smaller may be supported from the bottom chord of the bar joists at the “Panel Points” or from the bottom flange of the beams.

E. Protection of Equipment and Materials: Responsibility for care and protection of materials and mechanical work rests with the Contractor until the entire project has been completed, tested and the project is accepted by the Owner.

F. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform, threaded rod, or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, or rods, as required; brace and fasten to building structure or to inserts as approved, or as detailed.

G. Foundations: Where floor mounting is indicated, locate equipment on 4-inch (102 mm) high reinforced concrete pad of adequate size with anchors and base plates as required, on pressure-treated sleepers, or on structural steel frame as detailed. The corners of pads shall be chamfered 1 inch (25 mm). Pad and steel sizes and location shall be coordinated with the approved equipment

1.8 ACCESS PANELS

A. Access panels required for items furnished under Division 23 shall be provided under this Division.

B. Access panels shall be standard panels, 12 inch x 16 inch (305 mm x 406 mm) minimum unless indicated otherwise. Panels installed in areas of high moisture concentration, such as locker rooms, near plumbing fixtures, food preparation areas, or outdoors, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance.

C. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.

D. Provide access panels in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, volume dampers, motorized dampers in ductwork, duct smoke detectors, and other related items.

1.9 ELECTRIC WORK

A. Provide motors, pilot lights, controllers, limit switches, and other related items for equipment provided under Division 23.

B. Except as noted, required line switches, fused switches, and other related items and necessary wiring to properly connect equipment to motors and switches shall be furnished and installed under Division 26, Electric.

C. Provide complete wiring system for automatic temperature controls as specified under Section Division 23 Section "Instrumentation and Controls for Mechanical Systems."

D. Wiring shall conform to the requirements of the National Electrical Code.

1.10 FIRESTOPPING

A. Firestopping for penetrations of ductwork, piping and equipment through fire rated and smoke rated building assemblies, including but not limited to partitions, walls, floors, ceilings, and roofs, shall be furnished and installed under this Section.

B. Selection of firestopping materials and installation of firestopping materials shall be in accordance with **Division 07 Section "Through Penetration Firestop Systems."** Coordinate with other trades for a consistent installation.

C. Refer to Architectural Drawings for locations of fire rated building assemblies.

1.11 SUBMITTALS

A. After award of Contract and before installation, submit for approval Shop Drawings, bulletins, Product Data, Samples, and other related items.

B. Submit Shop Drawings and Product Data as required in each Section. Submittal shall include physical data and performance data required to verify compliance with the Contract Documents.

C. Submit Samples as required in each Section, and as indicated on the Drawings. These will generally be retained by the Architect/Engineer, unless otherwise indicated. Contractor may request these items returned; provide return shipping for returns.

D. Submit Mock-Ups as required in each Section, and as indicated on the Drawings. For general mock-up procedures, refer to Division 01 Section "Quality Requirements." Deliver to the Architect/Engineer for review if so indicated. Provide return shipping.

E. Architect/Engineer's review will not include the review, coordination, or verification of dimensions or quantities; these shall be the responsibility of the Contractor.

1.12 SUBSTITUTIONS

A. Comply with provisions of the Instructions to Bidders and General Requirements of the Specifications.

B. The first item listed under "Acceptable Manufacturers", "Approved Manufacturers" or

"Manufacturers" is the design basis.

1. Other manufacturers listed may be used in the base Bid, but conformance with details of the Specifications, as well as dimensional and electrical data, shall be verified by the Contractor.
2. Architect/Engineer has not verified that each listed manufacturer has the ability to provide an acceptable substitution for the basis-of-design product. Contractor may not assume that substitutions will be approved.
3. Modifications required as a result of differences between the design basis item and the submitted and approved item must be approved by the Architect and made at the Contractor's expense. As an example, if a rooftop HVAC unit is submitted and approved and if the unit's dimensions and weight are different from those of the unit which was used as the design basis, the Contractor shall be responsible for building structural modifications required to accommodate the submitted and approved unit, at no additional cost to the Owner.
4. For items which have no manufacturers listed, any item conforming with the Contract Documents is acceptable.

C. Substitutions from manufacturers or providers which are not listed may be proposed within the time allowed in the General Requirements of the Specifications.

1. The exception to this is products for which the list of manufacturers or providers is limited by the wording "no substitutions" or similar wording.

1.13 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Divisions having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and clean-up of work of separate Sections in preparation for Substantial Completion.

F. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.14 REQUESTS FOR ARCHITECT'S CADD DRAWINGS

A. In lieu of generating their own CADD drawings, the Contractor may elect to use the Architect's electronic copies of CADD drawings for the purpose of developing coordination

drawings, developing control system graphics or for other reasons that pertain to the requirements of this Contract. If the Contractor elects to utilize the Architect's electronic copies of CADD drawings, the electronic files shall be purchased from the Architect at the Architect's current billing rate per drawing. The Contractor shall provide payment and shall sign a release-of-liability form before electronic CADD drawings are released.

1.15 CLEANING

A. Remove debris from site daily.

B. Material and pieces of equipment shall be turned over to the Owner free of dust and dirt, both inside and out.

C. At the completion of the Project, equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.

D. At the completion of the Project, surfaces exposed to view shall have a clean, neat appearance of finish free from smudges and scratches by cleaning or repainting as required.

1.16 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Architect/Engineer 7 days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturer's instructions.

G. When specified in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

1.17 FACTORY START-UP AND START-UP REPORTS

A. Provide factory start-up of mechanical equipment listed below. Factory start-up shall be performed by a factory authorized representative of the equipment manufacturer. When factory start-up is successfully completed for each piece of mechanical equipment listed below, submit a formal start-up report to the Architect for approval. Start-up report shall be formatted in accordance with equipment manufacturer's recommendations. Start-up report shall be typed, not hand written, and shall be submitted in a clean and legible form.

B. Equipment requiring factory start-up
1. Condensing Unit

1.18 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

A. After completion of the installation work called for in the Contract Documents, furnish necessary mechanics or engineers for the adjustment and operation of the systems, to the end that the systems are perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing framed instruction charts, directions, and other related items.

B. Instructors providing Owner training shall be experienced and familiar with the jobsite.

1.19 TESTING

A. After the entire installation is completed and ready for operation, test the systems as outlined in Division 23 Section "Testing, Adjusting and Balancing for HVAC." These tests are supplementary to detailed tests specified herein or directed. The Owner will provide water and electric current for the test. Provide necessary labor, test pump, gauges, meters, other instruments, and materials. Perform tests in the presence of the Architect or their representative.

B. Perform other tests specified in individual Sections of this Specification.

1.20 COMPLETION OF SYSTEMS

A. The following mechanical systems shall not be complete until the following conditions are satisfied:
1. Ductwork Systems:
   a. Ductwork and related components and accessories shall be completely installed and insulated as specified.
   b. Ductwork leakage testing shall be completed and leakage testing reports shall be submitted and approved.
   c. Ductwork shall be balanced and a balancing report shall be submitted and approved.
   d. Commissioning shall be completed.
2. Piping Systems:
   a. Piping, valves and accessories shall be completely installed, insulated and labeled as specified.
   b. Piping pressure testing be completed and pressure testing reports shall be submitted and approved.
   c. Piping systems shall be balanced and a balancing report shall be submitted and approved.
   d. Commissioning shall be completed.
3. Equipment:
   a. Equipment, including but not limited to heat exchangers, pumps, condensing units, shall be completely installed.
   b. Equipment start-up reports shall be completed, submitted and approved.
   c. Equipment balancing shall be completed and the balancing report shall be submitted and approved.
   d. Commissioning shall be completed.

4. Automatic Temperature Controls (ATC):
    a. ATC system shall be completely installed.
    b. Commissioning shall be completed.
    c. ATC system shall operate in an automatic mode for a minimum of 4 months during Owner occupancy without substantial deficiencies.

1.21 OPERATING AND MAINTENANCE MANUALS

A. Furnish quantity required in Division 01 of the Specifications, of bound operating and maintenance manuals. Deliver to the Architect for review. Required quantity is for the Owner; the Architect will not retain a bound copy.

B. For maintenance purposes, provide approved Submittals, parts lists, specifications, and manufacturer's maintenance bulletins for each piece of equipment. For materials used which have been submitted to the Architect for approval but do not require regular maintenance, such as piping, ductwork, and insulation, provide one copy of approved Submittals.

C. Provide name, address and telephone number of the manufacturer's representative and service company, for each piece of equipment or material so that service or spare parts can be readily obtained.

1.22 WARRANTY

A. Provide guarantees and warranties for work under this Contract as indicated in the General Requirements of the Specifications.

B. Provide manufacturers' standard warranties and guarantees for work by the mechanical trades. However, such warranties and guarantees shall be in addition to and not in lieu of other liabilities which the manufacturer and the Mechanical Contractor may have by law or by other provisions of the Contract Documents.

C. Guarantee that elements of the systems provided under this Contract are of sufficient capacity to meet the specified performance requirements as set forth in these Specifications or as indicated on the Drawings.

D. Upon receipt of notice from the Owner of failure of any part of the mechanical systems or equipment during the warranty period, the Mechanical Subcontractor shall replace the affected part or parts.

E. Furnish a written guarantee covering the above requirements before submitting the application for final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230500

SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Shaft Grounding Rings.

B. Starters.

C. Thermal Overload Protection.

D. Belt Drives.

E. Variable Speed Drives.

1.2 REFERENCES

A. Division 01 Section “References”: Requirements for references and standards.

B. AFBMA.

C. NEMA MG 1 - Motors and Generators.

D. NFPA 70 - National Electrical Code.

E. UL.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.4 REGULATORY REQUIREMENTS

A. Conform to UL Component Recognition for appropriate sizes.

B. Conform to NFPA 70 and local energy code.

1.5 DELIVERY, STORAGE, AND PROTECTION

A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.

B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MOTORS

A. Acceptable Manufacturers:
   1. A.O. Smith.
   2. Baldor.
   3. Emerson Motor Technologies.
   4. General Electric.
   5. Greenheck Fan Corporation
   6. Marathon Electric.
   7. Siemens.
   8. Teco-Westinghouse.
   9. Toshiba.
   10. U.S. Motors (division of Emerson Motor Technologies).

B. General Construction and Requirements:
   1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these Specifications.
   2. Motors shall have integral thermal overload protection.
   3. Single Phase Motors for general applications: PSC (permanent split capacitor) where available.
   4. Single Phase Motors for fans:
      a. EC (electronically commutated) where available.
      b. PSC (permanent split capacitor) where available, if EC is not available.
   5. Open drip-proof type except where specifically noted otherwise.
   6. Design for continuous operation in 40 degrees C environment.
   7. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   8. Explosion-Proof Motors: UL approved for hazard classification.
   9. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.

C. Inverter Duty: Motors for use with variable frequency drives shall be rated for "inverter duty", with winding insulation rated for 1600 Volts and Class H (180 degrees C) temperature rating.

D. Single-Phase Power for Fans - Electronically-Commutated (EC) Motors - Also Known As Brush-Free DC (BFDC) Motors:
   1. Drive: Direct-drive only, not for use with belt drive.
   2. Power Supply: Internal motor circuitry shall convert AC power supplied to DC power to operate the motor.
   3. Turndown: Speed-controllable down to 20 percent of full speed (80 percent turndown).
   4. Speed Control: Integral potentiometer with screwdriver setting, remote potentiometer dial with 24 VDC transformer to generate a 0-10 VDC signal, or integral circuitry to accept a 0-10 VDC signal from the building control system, as indicated and specified.
   5. Efficiency: Minimum of 85 percent efficient at all speeds.
   6. Soft-start type, capable of reliable start at any speed setting.
   7. Enclosure: Open drip-proof.
   8. Bearings: Permanently lubricated heavy duty ball bearings.

9. Overload Protection:
    a. Automatic Speed Control: In the event of overheating or overloading, the motor electronics slow the motor to operate within its acceptable range.
    b. Thermal Overload: Internally fused, one-shot type as a last resort to prevent fires.
    c. Locked Rotor: If the motor sees a locked rotor condition, it will automatically shut itself down, then try to restart 3 times. After the 3rd try, the motor will not attempt to restart until the power is cycled.

E. Single Phase Power - Permanent-split Capacitor Motors:
1. Starting Torque: Exceeding one fourth of full load torque.
2. Starting Current: Up to six times full load current.
3. Multiple Speed: Through tapped windings.
4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

F. Single Phase Power - Capacitor Start Motors:
1. Starting Torque: Three times full load torque.
2. Starting Current: Less than five times full load current.
3. Pull-up Torque: Up to 350 percent of full load torque.
4. Breakdown Torque: Approximately 250 percent of full load torque.
5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated bearings.
7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

G. Single Phase Power - Split Phase Motors:
1. Starting Torque: Less than 150 percent of full load torque.
2. Starting Current: Up to seven times full load current.
3. Breakdown Torque: Approximately 200 percent of full load torque.
4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

H. Three Phase Power - Squirrel-cage Motors:
1. Starting Torque: Between 1 and 1-1/2 times full load torque.
2. Starting Current: Six times full load current.
3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy-efficient motors.
5. Insulation System: NEMA Class B or better.
6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000

hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

8. Sound Power Levels: To NEMA MG 1.
9. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
10. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
11. Nominal Efficiency: To NEMA MG 1, energy efficient for motor sizes 10 and larger.

2.2 SHAFT GROUNDING RINGS

A. Manufacturers:
   1. Electro Static Technology Inc. - Aegis SGR product line.
   2. Inpro/Seal, a division of Waukesha Bearings Corpororation - CDR product line.

B. Provide shaft grounding rings (SGRs) on 3-phase motors which are intended to be used with variable-frequency drives (VFDs). The SGRs may be furnished by the motor manufacturer as an integral part of the motor, furnished factory-installed by the equipment manufacturer, or furnished for field installation by the equipment installer.

C. Description: Circumferential micro-fiber ring with metal frame, designed to conduct VFD-induced bearing currents from the motor shaft to ground. Provides protection recommended in NEMA MG 1. Provide with mounting kit including bolts and bracket, or conductive epoxy to adhere to motor casing, to ensure ground connection from the SGR to the motor frame.

D. Provide SGRs on at least one end of the motor. On motors above 100 hp (74.5 kW), provide a bearing insulation kit on the end of the motor without an SGR.

2.3 STARTERS AND OVERLOADS

A. Acceptable Manufacturers:
   1. Cerus Industrial, Inc.
   2. Allen-Bradley (division of Rockwell Automation).
   3. Cutler Hammer (division of Eaton Corporation).
   4. General Electric.
   5. Siemens.
   6. Square D (division of Schneider Electric).

B. Provide motor starters for motors provided under this Division of these Specifications.

C. Cerus Industrial “BAS” building automation HVAC starters are the basis of design. Features of starters/contactors, disconnects, and temperature controls shall be combined in a single package using these starters. Coordination with Automatic Temperature Controls supplier and installer is required to reduce total project costs.
   1. 3-phase starter features include:
      a. Multi-tap control power transformer (CPT) for universal control voltage.
      b. Motor circuit protector disconnect (MCP) with high interrupt rating and lockable operator handle.

c. Contactors rated as high as 2.5 million electrical operations and 25 million mechanical operations.
d. Anti-cycling feature.
e. Solid-state electronic overloads with wide adjustment range and highly accurate digital motor protection, including protection for phase loss, phase unbalance, stall and locked rotor conditions. Class 1-30.
f. Digital keypad, featuring an H-O-A (Hand, Off, Auto) panel with large, clearly labeled push buttons including a front panel reset function and high-intensity LED indicators for settings.
g. Damper and valve actuator control, to open the actuator before starting the fan or pump motor.
h. Permissive auto control to disable auto inputs. Commonly used with a high pressure limit switch.
i. Universal control inputs, including auto dry input, and wet input for voltages from 20 to 138 VAC or VDC.
j. Power failure reset.
k. Fireman's override.
l. NEMA 1 enclosure with prepunched knockouts. NEMA 3R, 4, 4X, and 12 as required.
m. BACnet embedded communications option available.
n. UL Listed assembly.
o. 5-year warranty.
p. Factory printed label or engraved nameplate, designating the equipment served.

2. Single-phase starter (Cerus BAS-1P series) features include:
a. Manually operated quick-make toggle mechanism lockable in the "Off" position, which shall also function as the motor disconnect.
b. Hand/Auto switch, concealed behind sliding cover to discourage tampering.
c. Capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output, and fault output.
d. Control terminals integrated in the starter.
e. Power, run status, and fault LED pilot lights.
f. Interposing run relay and current sensing status output relay.
g. Voltage and dry inputs for auto run command.
h. System override mode (fireman's, occupancy, or manual).
i. Solid-state electronic overload with wide adjustment range and highly accurate digital motor protection, including protection for stall and locked rotor conditions. Class 10. Concealed adjustment behind sliding cover.
j. Surface mount enclosure, UL Type 1, single gang box installation, with sliding covers for concealed items.
k. Power Input: 1-phase, 110-240 VAC, 1-16 Amps, 0.1-1 HP (75 to 745 W).
l. Universal Control Inputs: Voltage auto-run 10-130 VAC/DC to energize. Dry auto-run normally-open dry contact closure.
m. Control Outputs: Proof of run and fault, normally-open 0.3 Amps at 125 VAC, 1 Amp at 24 VAC.
n. Ambient operating temperature -5 to 140 degrees F (-20 to 60 degrees C).
o. UL 508A Listed.
p. 5-year warranty.

D. Feature Descriptions:
   1. Fireman's Override Input: Causes the starter to run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
   2. Emergency Shutdown Input: Disables the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
   3. Phase Failure Protection: Initiates when phase loss is greater than 70 percent for 3 seconds or phase unbalance is greater than 50 percent for more than 5 seconds.
   4. Cycling Fault Protection: Activates whenever the starter is cycled at a rate of more than 1000 cycles in a one hour period. This feature shall be selectable to be disabled. Cycling fault shall cause overload LED to blink rapidly.

E. Contactors in starters shall be general purpose NEMA rated for connected H.P. (definite purpose starters not acceptable). Coordinate control voltage with Controls Contractor. Provide auxiliary contacts where required for interlocking of electrical equipment. Provide 2-speed motor starters where indicated or required.

F. Single phase motors shall have one of the following factory wired methods of motor protection:
   1. Integral thermal overload protection in motor and cord with plug and receptacle in unit casing.
   2. Integral thermal overload protection in motor and disconnecting switch mounted in or on casing as specified with equipment.
   3. Switch with thermal overload protection for unprotected motors with switch serving as disconnect device.

G. For starters associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.

2.4 V-BELT DRIVES

A. Provide self-aligning roller-bearings mounted in sealed housings with grease fittings and grease overflow valves. Fan wheels and shafts shall be designed for critical speed at least 20 percent higher than the maximum fan speed. The assembled fan shall be statically and dynamically balanced at the factory. Bearings shall be certified to have an average life per AFBMA of not less than 200,000 hours.

B. The drive base shall be constructed to allow adjustment of belt tension without having to loosen motor hold-down bolts.

C. Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
   1. Provide adjustable-sheave belt drives for motors, except as otherwise specified in individual Sections of the Specifications.
   2. Sheaves on motors 25 hp (18.6 kW) and over shall be fixed type.

2.5 VARIABLE FREQUENCY DRIVES

A. Acceptable Manufacturers
   1. ABB (ACH550 Series) (basis of design).
   2. Danfoss (VLT FC-100 Series).
   3. Toshiba (Q7 Series).
   4. Yaskawa (E7 Series).
   5. No substitutions.

B. The variable frequency drives (VFDs) with options shall be UL listed as a complete assembly and shall be built in compliance with the latest standards of ANSI, IEEE, NEMA and the National Electric Code.

C. The VFDs shall be designed to meet the requirements of the following standards: IEC801-2, IEC801-4, IEC255-4.

D. Quality Assurance:
   1. Manufacturer: Shall specialize in manufacture, assembly, and field performance of VFDs with minimum 5 years' experience.
   2. The VFD manufacturer shall have an existing representative, exclusively for HVAC applications, an independent service and start-up organization, and a parts stocking depot local to the installation.

E. Warranty and Start-Up Service:
   1. Start-Up Service: The VFD manufacturer shall provide a start-up service package. Service shall include inspection, final adjustment, operational checks, coordination with interface to building's ATC system (coordinate with Division 23 Section "Instrumentation and Controls for HVAC") and a final report for record purpose. Start-up service shall be performed by a factory approved and certified technician.
   2. Report: Submit a report of start-up and initial settings and readings.
   3. Owner Training: Provide a session of at least 4 hours, to train 2 or more of the Owner's representatives in the operation and maintenance of the drives. Schedule the training at the Owner's convenience within normal working hours, within 2 months after Substantial Completion.
   4. Warranty: For a period of 2 years after factory start-up, the VFD manufacturer shall include a full parts and labor on-site warranty at no additional cost.

F. Construction:
   1. Pulse Width Modulated design converting the fixed utility voltage and frequency to a variable voltage and frequency output. The VFD shall employ a full wave bridge rectifier, DC bus choke, DC bus filter capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device. SCRs, GTOs and Darlington transistors are not acceptable. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
   2. 6-pulse (minimum) converter section.
   3. NEMA 1 ABS plastic or metal enclosure. Verify suitability of this enclosure for the application, and provide suitable enclosures either instead of or in addition to the basic enclosure.

4. Standard operating conditions are:
    a. Incoming AC power at building power system design's phase and voltage (see Contract Drawings) ±10 percent, 60 Hz. Output voltage, phase and frequencies compatible with equipment served (see Contract Drawings).
    b. Humidity 0 to 95 percent (noncondensing and noncorrosive).
    c. Altitude 0 to 3,300 feet above sea level, without derating.
    d. Ambient temperature 0 to 40 degrees C.
    e. Verify actual operating conditions, and derate drive capacity as required.
5. VFDs shall include the following features:
    a. Customer interface, including digital display in plain English (code numbers are not acceptable), keypad and customer connections.
    b. Carrier (Switching) Frequency: Optimized for a 3 kHz or 4 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up technician, in a range at least as low as 1 kHz and as high as 8 kHz. Provide at least the following settings to allow fine tuning: 1 kHz, 4 kHz, and 8 kHz.
    c. Built-in program to automatically vary the carrier (switching) frequency. Acceptable types of control include:
        1) ABB's switching frequency foldback control, reduces heat generated by the IGBTs by reducing the carrier frequency if the heatsink temperature rises above 176-194 degrees F (80-90 degrees C).
        2) Danfoss automatic switching frequency modulation, reduces noise at low loads (below 60 percent) by adjusting the carrier frequency up to a selected maximum, and provides maximum power and efficiency at higher loads by adjusting the carrier frequency downward to a more efficient setting.
    d. The option of either (1) displaying a fault, (2) running at a preset speed, or (3) running at the last known speed (average of last 10 seconds) if the input reference (4-20mA or 2-10V) is lost.
    e. Automatic restart after an overcurrent, overvoltage, or undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.
    f. The ability to start into a rotating load (forward or reverse) and accelerate or decelerate without safety tripping or component damage (flying start).
    g. Automatic power loss ride through circuit that will utilize the inertia of the load to keep the drive powered. Minimum power loss ride through shall be 1 cycle based on full load and no inertia.
    h. Isolated power for control circuits.
    i. Input line fuses.
    j. Acceptable start/stop commands shall include closure of a contact or switch, application and removal of input power and optional application and removal of 115 VAC on-off signal.
    k. Load loss detection. Each VFD shall provide a dry contact closure at a field adjustable load threshold to indicate a loss of motor load (for example, broken fan belt or pump cavitation).
    l. Pilot light cluster to provide visual indication of protective functions and circuit status, including the following LEDs:
        1) Power on (Red): Illuminates when main power is applied to the controller.
        2) AFC Run (Green): Illuminates to annunciate a drive run condition.
        3) AFC Fault (Yellow): Illuminates to annunciate a fault condition.
    m. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.

n. PI setpoint controller integral to the drive, allowing a pressure or flow signal to be connected to the VFD, using the VFD for the closed loop control, eliminating the need for external controllers.
o. Three programmable digital relay outputs, rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS.
p. Seven programmable preset speeds.
q. Six programmable digital inputs for interface with energy management system.
r. Two independently adjustable acceleration and deceleration ramps, adjustable from 1 to 1800 seconds.
s. Ramp or coast to a stop.
t. Two programmable analog outputs to provide 4-20 ma signals linear to output frequency, motor speed, output current, motor torque, motor power, DC bus voltage, and motor voltage.

6. VFD door mounted operator digital display shall include:
   a. Output Frequency
   b. Motor Speed (RPM)
   c. Motor Current
   d. Calculated Motor Torque
   e. Calculated Motor Power
   f. DC Bus Voltage
   g. Output Voltage
   h. Heat Sink Temperature
   i. Analog Input Values
   j. Keypad Reference Values
   k. Elapsed Time Meter
7. VFD speed command input shall include:
   a. Keypad.
   b. Two analog inputs, each capable of accepting a 0-20 mA, 4-20mA, 0-10V, and 2-10V signal inputs isolated from ground, and programmable via the keypad for different uses. Inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The input shall be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed.
   c. Floating point input to accept a three wire input from a Dwyer Photohelic gauge or equivalent type instrument.
   d. RS-485 communications.
8. The VFD shall include the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in plain words.
   a. Overcurrent trip, 200 percent of the VFD's variable torque current rating.
   b. Overvoltage trip, 130 percent of the VFD's rated voltage.
   c. Undervoltage trip, 60 percent of the VFD's rated voltage.
   d. Over temperature, + 70 degrees C.
   e. Ground fault.
   f. Adaptable Electronic Motor Overload Protection: Shall protect the motor based on speed, load curve, and external fan parameter. Circuits that protect the motor only at full speed are unacceptable.
   g. Power line surge protection by means of a metal oxide varistor (m.o.v.).

9. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure (the use of more than one enclosure is not acceptable):
    a. Protection From Harmonics and Voltage Spikes: Provide one of the following:
        1) Line Reactors: 3-percent AC input line reactors to reduce harmonic current distortion to the incoming power line, and to provide some protection to the drive from incoming voltage spikes. Provide reactors in each phase of incoming power to each VFD. Install between the input power and the drive's input bridge rectifier (so they protect the rectifier). The line reactor shall provide attenuation of line side voltage transients, thus preventing overvoltage trips or other unnecessary VFD shutdowns and providing a reduction in harmonic current distortion. Line reactors shall be manufactured by TCI of Milwaukee, WI and must meet the following requirements: provide a minimum of 2-1/2 percent line impedance, have a saturation rating of no less than 2.5 times the continuous current rating, and be UL recognized.
        2) ABB Design: Integral 5 percent swinging chokes in the AC input lines, configured between the input power and the drive's input bridge rectifier (so they protect the rectifier from spikes in input power).
            a) The swinging choke is an inductor with an inductance value inversely proportional to its operating current. Over a substantial portion of the normal operating current range, the inductance decreases as the current in the choke increases. A conventional or linear choke has a fixed inductance value that changes very little as the operating current varies in the normal operating range.
            b) The harmonic limiting effectiveness of the swinging choke increases when the operating point is less than maximum power.
            c) Compared to a standard linear choke, the swinging choke provides superior line harmonic current reduction when the drive's output power is less than or equal to rated output.
            d) The effective inductance value of a swinging choke at full load is higher than the value of a linear choke of the same physical size.
            e) The efficiency of a swinging choke is higher than the efficiency of a linear choke of the same inductance value.
            f) Since the design point BHP is nearly always less than the nameplate horsepower of the selected motor, with swinging chokes the harmonic contribution of the drive will nearly always be less than that at maximum rated output power.
            g) See U.S. Patent No. 6,774,758, "Low harmonic rectifier circuit" using non-linear inductor(s).
        3) Danfoss Design: Harmonic suppression and surge suppression integral to the drive using separate components.
            a) Harmonic Suppression: DC link chokes (inductors) installed between the drive's input bridge rectifier and the inverter bus capacitor, consisting of a dual, 5 percent DC-link reactor on the positive and negative rails of the DC bus. This reactor reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drive's input, and improves input power factor. The reactor is non-saturating (linear) to provide full harmonic filtering throughout the entire load range. In performance, the harmonic suppression of the DC-link reactor is equivalent to a 5 percent AC line reactor.

b) Incoming Power-Line Surge Suppression: Fast-acting Metal Oxide Varistor (or (MOV) installed between the input power and the drive's input bridge rectifier, Zener diodes and oversized DC bus capacitors to provide protection against high potential spikes. When the voltage exceeds 2.3 times the expected incoming voltage for 1.3 milliseconds, the MOV shorts, protecting the internal parts of the drive including the 3-phase full-wave diode bridge. The reactor also acts to reduce input current caused by power line disturbances. Provide 4 MOVs, one on each of the 3 inputs and one attached to the DC Link. Comply with the German specification for surge suppression (VDE 0160).

4) Linear chokes or DC link chokes used alone without surge suppression on the incoming power are NOT acceptable as alternatives to line reactors. If they are standard and integral to the VFD, they may be provided in addition to line reactors.

b. Bypass: Manual transfer to line power via contactors and including class 20 bimetal motor thermal overload relays and fuse or circuit breaker protection while in bypass operation, with automatic bypass capability.
   1) [Provide bypass on drives which serve single non-redundant motors, such as fan motors in air handling units and air conditioning units.
   2) Bypass is not required on drives which serve one of a pair of matching and fully-redundant motors with individual drive per motor (such as a pair of pumps where one is the lead pump and one is a 100 percent backup, and each pump has its own VFD).]

c. Service switch which provides the ability to service the controller (electrically isolated while in bypass operation) without having to remove power to motor.

d. Hand-off automatic switch (HOA), prewired. The HOA switch shall be operable in both the Normal and Bypass (if provided) modes of operation. The switch may be dial type, or momentary-contact pushbutton type with LED indicator lights. The switch may be integral to the standard VFD keypad, if it is a dedicated physical switch that is always available, but it is not allowed to serve any other functions, and it may not be a virtual switch such as on a touchscreen.
   1) When Auto mode is selected, the external start command and external reference speed signal shall control the motor.
   2) When Hand mode is selected, the motor shall run and the manual potentiometer shall control the motor speed. Other controls and inputs/outputs shall function as in Auto mode.

e. Manual potentiometer, dial type with calibrated nameplate. Provide an analog (dial-type) or digital meter to indicate selected speed.
   1) If the HOA switch is a dedicated button integral to the VFD keypad, and the potentiometer function is immediately available without any further steps when the HOA is in "Hand" position (such as up-down pushbuttons on the face of the keypad), the potentiometer may be integral to the standard VFD keypad. The speed meter may be a display on the general display screen.

f. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. External interlocks and start/stop contacts shall function with drive in hand, auto or bypass.

g. Door interlocked disconnect or circuit breaker, padlockable in off position.

h. For drives that control fans or pumps which are specified to operate in an automatic lead/lag arrangement, provide automatic alternation device in VFD enclosure. (coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems").

10. Energy Management System Interface
    a. Drive shall have the capability to be controlled and monitored via analog and digital inputs and outputs.
    b. In addition to analog and digital I/O the VFD shall be capable of communicating with the following controls companies' communication buses with no extra hardware:
        1) Johnson Controls
        2) Siemens Controls
    c. Drive shall have integral capability to be controlled and monitored through BACnet, LonWorks, Modbus, or other serial communication protocol compatible with the building automatic temperature control system. Provide adapter modules as required.
    d. Coordinate with suppliers and installers of building automatic temperature control system to ensure compatibility and full functionality. See Division 23 Section "Instrumentation and Controls for Mechanical Systems."
11. In the event of a power failure and upon restoration of power, the variable frequency drive shall remain responsive to its command signal from the building's energy management/temperature control system. The drive shall not require manual resetting after a power outage in order to respond to the energy management/temperature control system's command signal.
12. For drives that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the VFD enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the VFD shall be turned off. Circuitry shall be provided to ensure that power is off whether the VFD is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the VFD manufacturer, provide a contactor on the line side of the VFD to accomplish the same function. The contactor shall meet the requirements of the Electrical Division of the Specifications.
13. Occasional input and output power circuit switching shall be able to be accomplished without interlocks or damage to the drive. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive as specified in Part 3 – Execution in this Section.

G. Compliance with IEEE-519:
    1. Input Line Reactors: Provide as specified in "Construction" paragraph of this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Division 01 Section "Quality Requirements": Manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Coordinate with Division 26 "Electrical."

D. Check line voltage and phase and direction of rotation, and ensure agreement with nameplate.

E. Install guards in accordance with Codes and OSHA requirements.

F. Adjust motor overload devices based on motor amperage ratings and field measurements of running amps, to ensure protection of the motor and eliminate nuisance trips.

G. Disconnect Switch Mounting Height: Install at height above finished floor in accordance with NFPA 70.
   1. In most instances, the center of the grip of the disconnect switch operating handle in its highest position shall be no more than 79 inches (2.0 m) above finished floor or working platform.
   2. Switches and circuit breakers installed adjacent to the equipment served (and within 79 inches (2.0 m) above finished floor or working platform.

H. Variable Frequency Drives:
   1. Mounting Height:
      a. Install with the disconnect switch height in accordance with NFPA 70, as described in the paragraph "Disconnect Switch Mounting Height" in this Section.
      b. The VFD shall be considered to be a piece of equipment served by its disconnect switch, for purposes of NFPA 70, unless otherwise indicated, or otherwise directed by the Authority Having Jurisdiction or by the Owner.
         1) If the motor served by the VFD is within sight of the VFD, and within 50 feet (15.2 m) measured in a straight line, this disconnect switch may also serve the motor unless otherwise indicated.
      c. When possible, install VFDs with their operator-interface display at 79 inches (2.0 m) or less above finished floor, unless otherwise indicated or directed.
         1) To restrict unauthorized access, VFDs in locations accessible to the public (such as but not limited to classrooms, unrestricted storage rooms, and corridors) shall be mounted with the disconnect switch at 72 to 79 inches (1.8 to 2.0 m) above finished floor, with the VFD operator display and other accessories mounted above the disconnect switch, where ceiling height allows, unless otherwise indicated. In mechanical rooms and other restricted-access locations, mount VFDs at a height for greatest user convenience.
      d. When possible, mount groups of adjacent VFDs with tops at uniform height above finished floor.
      e. Because VFDs produce heat, do not install a VFD above another one, or above another heat-producing device. Do not install a VFD below or too near to any heat-sensitive device or room temperature sensor. Provide ventilation space and other means of cooling as required by the manufacturer.
      f. Install with service and installation clearances as required by the manufacturer.
   2. Electrical Connections:
      a. Provide separate metal conduits for drive input power, output power to the motor, and control wiring. Output motor cables from multiple drives shall be run separately.
      b. Ground each drive separately.
      c. Ensure that a fused disconnect switch is provided upstream between the transformer and the drive. Fuses are required because they are faster-acting than circuit breakers.

d. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive, and coordinate with installers to ensure that no unnecessary switching is installed.
    1) When the VFD is out of sight from the equipment served, or is more than 50 feet (15.2 m) from the equipment served, a disconnect switch mounted on or adjacent to the equipment is generally required in Division 26 "Electrical" or by the Authority Having Jurisdiction. If such a disconnect or other switching device is indicated or required, provide protective devices as required by the VFD manufacturer. Such devices typically include an "early-break" auxiliary set of contacts or a "Stop" button on the disconnect switch, field-wired to the VFD's external fault input or stop input, so that if the switch is opened while the VFD is running, the input will shut off the output of the VFD. The VFD stop method must be set to "Coast." Provide field wiring in conduit.
    2) Provide engraved nameplates at disconnect switches and other devices, instructing users on the proper operation of these devices to prevent damage to the VFD.

3. Carrier Frequency: Adjust to minimize noise, but also to minimize the potential for motor bearing damage due to VFD-induced shaft voltage.
    a. VFDs convert line AC voltage to a pulse width modulated (PWM) AC voltage of variable frequency. The switching frequency of these pulses is referred to as the "carrier frequency." The switching induces a voltage on the rotor shaft, which, if it builds up to a sufficient level, can discharge as "bearing current" to ground through the bearings. This has an electric discharge machining (EDM) effect, causing pitting of the bearing's rolling elements and raceways. This effect can be minimized by proper setup.
    b. The higher the carrier frequency, the higher the rate of the current discharge pulses, and the more likely EDM will occur. At higher carrier frequencies the VFD will generally run quieter; however, it becomes more destructive on the motor insulation and bearings.
    c. Adjust the carrier frequency as low as possible without creating unacceptable audible noise levels, and to avoid frequencies above 6 kHz altogether if possible.
4. Coordinate with building controls systems as specified in Part 2 of this Section.
5. Perform startup service, and submit report.
6. Provide warranty service.
7. Provide Owner training.

END OF SECTION 230513

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Labels.

D. Stencils.

E. Pipe Markers.

1.2 RELATED SECTIONS

A. Division 09 Section “Painting”: Identification painting.

1.3 REFERENCES

A. Division 01 Section “References”: Requirements for references and standards.

B. ASME A13.1 - Scheme for the Identification of Piping Systems (2007 edition or newer).

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

D. NFPA 99 - Standard for Health Care Facilities.

1.4 SUBMITTALS

A. Division 01 Section “Submittal Procedures.”

B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

D. Product Data: Provide manufacturers catalog literature for each product required.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under Division 01 Section “Closeout Procedures.”

B. Record actual locations of tagged valves; include valve tag numbers.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

B. Include valve tag chart.

1.7 REGULATORY REQUIREMENTS

A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
1. Seton Identification Products.
2. E.R. Perry Signs & Engraving.
3. Brimar Industries, Inc., PipeMarker division.
4. No substitutions.

B. Plastic Nameplates: Laminated 3-layer plastic with beveled edges and engraved letters on contrasting background color, 1/16 inch (1.58 mm) thick. Letters shall be black on light backgrounds, or white on dark backgrounds, as applicable. Service temperature range -40 to 175 degrees F (-40 to 79 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.

C. Aluminum Nameplates: For higher temperature applications, and for outdoor applications when manufacturer does not recommend their plastic nameplates for use outdoors, provide aluminum nameplates, with integral anodized or painted surface color coating and natural aluminum engraved letters, 1/32-inch (0.78 mm) thick. Service temperature range -40 to 350 degrees F (-40 to 177 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.

D. Colors: Select background color as appropriate for the application. Color for general applications shall be white (except that aluminum nameplate standard color shall be black). Color for general warnings shall be red or yellow. Colors for fluid services shall comply with ASME A13.1-2007. Comply with ASME/ANSI standards and other regulations as applicable.

E. Provide with factory adhesive, and with side holes for fastener attachment as applicable. Mechanical fasteners are required for applications which are outdoors or otherwise exposed to weather or sunlight, or in moist areas such as kitchens and locker rooms, or on cooled surfaces subject to condensation, or on surfaces with operating temperatures above 150 degrees F (65 degrees C). Where nameplate is on an irregular surface and cannot make complete contact, provide mechanical fasteners or ties in addition to adhesive.

2.2 TAGS

A. Plastic Tags:
1. Manufacturers:
a. Seton Identification Products.
b. E.R. Perry Signs & Engraving.
c. Brimar Industries, Inc., PipeMarker division.
d. No substitutions.

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches (38 mm) diameter.

B. Metal Tags:
1. Manufacturers:
a. Seton Identification Products.
b. Brady Worldwide, Inc.
c. Brimar Industries, Inc., PipeMarker division.
d. No substitutions.
2. Brass with stamped letters; tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges.

C. Information Tags:
1. Manufacturer: Seton Identification Products.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches (83 x 143 mm) with grommet and self-locking nylon ties.

D. Tag Chains and Hooks: Brass or stainless steel compatible with tag material for general applications. Brass where in contact with copper piping or other copper-alloy materials.

E. Tag Chart: Typewritten letter size list in anodized aluminum frame with plexiglass cover.

2.3 CEILING DOTS WITH LABEL-MAKER LABELS

A. Ceiling Dots:
1. Manufacturer: Avery – Division of Avery Dennison Corporation.
2. Description: Self-adhesive 1/2 inch (12.7 mm) diameter color coded label.

B. Label-Maker Labels:
1. Label Maker:
a. Manufacturer:
1) Brother.
2) Brady.
3) Dymo.
b. Label width capacity: Maximum tape width at least 3/4 inch (19 mm).
c. Technology: Thermal transfer.
2. Labels:
a. Color:
1) Clear with black lettering for white or off-white ceiling grids.
2) White with black lettering for dark-colored or metallic-colored ceiling grids.
b. Width:
1) 3/4 inch (18 mm) for standard 15/16 inch (23.8 mm) wide ceiling grids.
2) 1/2 inch (12 mm) for narrow 9/16 inch (14.3 mm) wide ceiling grids.
c. Lettering Height: Maximum size available, for ease of viewing from floor. Typical sizes as follows:
1) 36 point (1/2 in. (12 mm)) on 3/4 inch (18 mm) wide labels.
2) 24 point (1/3 in. (8 mm)) on 1/2 inch (12 mm) wide labels.

C. Color code as follows:
1. Cooling Valves: Blue.

2.4 LABELS

A. Manufacturer: Seton Identification Products.

B. Description: Polyester, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

2.5 STENCILS

A. Manufacturers:
   1. Seton Identification Products.
   2. Brimar Industries, Inc., PipeMarker division.

B. Stencils: With clean cut symbols and letters of following size:
   1. Ductwork: 1-3/4 inches (44 mm) high letters.

C. Stencil Paint: Semi-gloss enamel, colors and lettering size conforming to ASME A13.

2.6 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:
   1. Manufacturers:
      a. Seton Identification Products.
      b. Brady Worldwide, Inc.
      c. Brimar Industries, Inc., PipeMarker division.
      d. No substitutions.
   2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 Section “Painting” for stencil painting.

3.2 INSTALLATION

A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.

B. Install identifying devices after completion of coverings and painting.

C. Install plastic or aluminum engraved nameplates with corrosion-resistant mechanical fasteners, or adhesive, as specified. In outdoor locations, where lifetime of nameplates is limited, fasteners shall be removable screws or bolts for ease of nameplate replacement.

D. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

E. Install tags using corrosion resistant chain. Number tags consecutively by location.

F. Identify items of mechanical equipment such as condensing unit, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.

G. Identify control panels and major control components outside panels with plastic nameplates.

H. Identify valves in main and branch piping with metal tags.

I. Tag automatic controls, instruments, and relays. Key to control schematic.

J. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch (20 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (6 m)on straight runs including risers and drops, at each branch and riser take-off, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

K. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

L. Identify duct access doors at fire dampers, smoke dampers, and smoke detectors with 1/2 inch (12.7 mm) lettering to indicate the fire protection device(s) within, in accordance with NFPA 90A.

M. Provide ceiling dots with label-maker labels to locate valves, dampers and equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

N. Secure valve tag chart on an easily accessible wall in the mechanical room or in a location as otherwise directed by the Architect.

3.3 COORDINATION WITH EXISTING EQUIPMENT

A. Where an existing equipment identification system is involved, the new system shall be coordinated and compatible with the existing system.

END OF SECTION 230553

This Page Intentionally Left Blank

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Testing, Adjustment, and Balancing of Air Systems.

B. Testing, Adjustment, and Balancing of Hydronic, Refrigeration Piping Systems.

C. Measurement of Final Operating Condition of HVAC Systems.

1.2 RELATED SECTIONS

A. Division 01 Section "Quality Requirements": Testing laboratory services: Employment of testing agency and payment for services.

B. Division 01 Section "General Commissioning Requirements."

1.3 REFERENCES

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.4 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.

C. NEBB: National Environmental Balancing Bureau.

D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

E. TAB: Testing, Adjusting, and Balancing.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures."

B. Submit name of TAB Agency for approval within 30 days after award of Contract.

C. Design Review Reports:
   1. Submit prior to commencement of construction under provisions of Division 01 Section "Quality Requirements."
   2. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

D. Preliminary Report Submittals:
   1. Prior to commencing work of this Section, and no more than 30 days after approval of TAB Agency submittals, submit report forms or outlines indicating adjusting, balancing, and equipment data required, with columns of design data filled in. By means of plan views, equipment profiles, and similar graphical descriptions, indicate where measurements will be taken.
   2. Submit the procedures to be used.

E. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

F. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

G. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

H. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, or NEBB forms, or forms containing information indicated in Schedules.

1.6 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; or ASHRAE 111; or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.7 QUALIFICATIONS

Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum 3 years' experience and certified by AABC or NEBB, or equivalent experience which would qualify for membership in these testing organizations. Agency shall be one of those listed under article 3.1 AGENCIES in this Section.

A. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or registered Professional Engineer experienced in performance of this Work and licensed at the place where the Project is located.[

B. SEQUENCING

C. Sequence work under the provisions of Division 01 Section "Summary."

D. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AGENCIES

A. Tekon Technical Consultants, Rochester, NH. Contact: Charles Corlin, (603) 335-3080.

B. Air Solutions, Auburn, NH, Contact: Jeremy Reid, (603) 262-9292

C. Hood T.A.B. LLC, Andover, MA. Contact: Michael Hood, (978) 474-7595.

D. NETB Associates LLC, East Kingston, NH. Contact: Frank Collamore, (978) 270-7547.

E. H&S Associates, Rochester, NH. Contact: Harry Wiggin, 603-742-2456.

F. Advantage Engineering, 19 Technology Way, Nashua, NH. Contact: Dan LaPlante 603-731-3880

G. No Substitutions.

3.2 EXAMINATION

A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. For belt driven equipment, provide sheave and belt modifications and/or replacements as required to ensure design flow rates as specified. Variable-frequency drives shall generally be set near full speed, between 60 Hz and 55 Hz output frequency, to preserve as much frequency range as possible for controllability.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.

G. Provide system schematic (in floor-plan or line-diagram view) with outlets and inlets numbered with the reference numbers used in the TAB Agent's tabular data, and with required and actual air quantities recorded at each outlet or inlet.
   1. Indicate locations of duct traverses.
   2. Indicate locations of duct pressure sensors, airflow monitoring stations, and other devices which require measurements for control settings.

H. Measure static air pressure conditions on air supply units, air return units, exhaust units, and heat recovery units, including pressure drops across filters, coils, dampers, mixing boxes, and heat recovery devices, and total pressure across the fan. Make allowances for 50 percent loading of filters, and indicate actual filter drop as well as the allowances. Provide equipment diagram indicating internal components and measurement points.

I. Provide duct traverse diagrams with measurement points indicated, with readings recorded at each point, and with calculated velocity and airflow.

J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Adjust at minimum position and maximum position, and use manual dampers and actuator limit stops to minimize differences.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

N. Where available fan capacity is less than total flow requirements of individual system parts (due to system diversity), full flow in one part may be simulated by temporary restriction of flow to other parts.

O. Coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems" for calibration of air handling units' static pressure sensors and determination of pressure setpoints.

P. Set pattern-control vanes and other devices in air inlets and outlets to provide the spread and throw patterns indicated, without objectionable noise or air motion to the occupants. Split the flow of linear slot diffusers in directions as required for good coverage. At completion, patterns shall be uniform and pleasing to the eye.

3.7 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing.

F. Where available pump capacity is less than total flow requirements of individual system parts (due to system diversity), full flow in one part may be simulated by temporary restriction of flow to other parts.

G. Coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems" for calibration of pump static pressure sensors and determination of pressure setpoints.

H. When the available pump head is more than 15 percent above the required head to meet the design flow, trim the pump impeller to bring the head within 100 to 110 percent of the required head to meet the design flow. At least one balancing valve in the system, and one balancing valve per each multi-circuit sub-main branch served by a branch balancing valve, shall be fully open when balancing is complete.[

3.8 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. HVAC Pumps
   2. Air Cooled Water Chillers
   3. Air Coils
   4. Air Handling Units

B. Report Forms:
   1. Title Page:
      a. Name of Testing, Adjusting, and Balancing Agency
      b. Address of Testing, Adjusting, and Balancing Agency
      c. Telephone number of Testing, Adjusting, and Balancing Agency
      d. Project name
      e. Project location
      f. Project Architect
      g. Project Engineer
      h. Project Contractor
      i. Project altitude
      j. Report date
   2. Summary Comments:
      a. Design versus final performance
      b. Notable characteristics of system
      c. Description of systems operation sequence
      d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
      e. Nomenclature used throughout report
      f. Test conditions

3. Instrument List:
    a. Instrument
    b. Manufacturer
    c. Model number
    d. Serial number
    e. Range
    f. Calibration date
4. Electric Motors:
    a. Manufacturer
    b. Model/Frame
    c. HP/BHP
    d. Phase, voltage, amperage; nameplate, actual, no load
    e. RPM
    f. Service factor
    g. Starter size, rating, heater elements
    h. Sheave Make/Size/Bore
5. V-Belt Drive:
    a. Identification/location
    b. Required driven RPM
    c. Driven sheave, diameter and RPM
    d. Belt, size and quantity
    e. Motor sheave diameter and RPM
    f. Center to center distance, maximum, minimum, and actual
6. Variable Frequency Drive (VFD):
    a. Motor(s) served
    b. Manufacturer
    c. Model/Frame
    d. HP/BHP ratings
    e. Phase, voltage, amperage; nameplate, actual, no load
    f. Input and output frequency (Hz)
    g. Reference speed command from control system
    h. Carrier frequency setting
    i. Speeds programmed out for vibration
    j. Speed adjustment for motor balancing (if allowed)
7. Pump Data:
    a. Identification/number
    b. Manufacturer
    c. Size/model
    d. Impeller
    e. Service
    f. Design flow rate, pressure drop, BHP
    g. Actual flow rate, pressure drop, BHP
    h. Discharge pressure
    i. Suction pressure
    j. Total operating head pressure
    k. Shut off, discharge and suction pressures
    l. Shut off, total head pressure
8. Air Cooled Condensing Unit:
    a. Identification/number
    b. Location
    c. Manufacturer and Model number

d. Serial number
e. Capacity
f. Entering DB air temperature, design and actual
g. Leaving DB air temperature, design and actual
h. Number of compressors
i. Refrigerant and oil types and quantities
j. Refrigerant saturated suction temperature, design and actual
k. Refrigerant superheat temperature
l. Secondary water leaving temperature, design and actual
m. Secondary water leaving temperature, design and actual
n. Secondary water flow, design and actual
o. Secondary water pressure drop, design and actual

9. Cooling Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Rows, and fins per inch
   f. Air flow, design and actual
   g. Entering air DB temperature, design and actual
   h. Entering air WB temperature, design and actual
   i. Leaving air DB temperature, design and actual
   j. Leaving air WB temperature, design and actual
   k. Water flow, design and actual
   l. Water pressure drop, design and actual
   m. Entering water temperature, design and actual
   n. Leaving water temperature, design and actual
   o. Air pressure drop, design and actual
10. Air Moving Equipment:
   a. Location
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Arrangement/Class/Discharge
   f. Air flow, specified and actual
   g. Return air flow, specified and actual
   h. Outside air flow, specified and actual
   i. Total static pressure (total external), specified and actual
   j. Inlet pressure
   k. Discharge pressure
   l. Component pressure drops
   m. Sheave Make/Size/Bore
   n. Number of Belts/Make/Size
   o. Fan RPM
11. Return Air/Outside Air Data:
   a. Identification/location
   b. Design air flow
   c. Actual air flow
   d. Design return air flow
   e. Actual return air flow

f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature
j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

12. Duct Traverse:
    a. System zone/branch
    b. Duct size
    c. Area
    d. Design velocity
    e. Design air flow
    f. Test velocity
    g. Test air flow
    h. Duct static pressure
    i. Air temperature
    j. Air correction factor

END OF SECTION 230593

This Page Intentionally Left Blank

SECTION 230713 – DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ductwork Insulation.

B. Insulation jackets.

1.2 RELATED SECTIONS

A. Division 23 Section “Identification for HVAC Piping and Equipment.”

B. Division 23 Section “Metal Ducts”: Ductwork.

1.3 REFERENCES

A. Division 01 Section “References”: Requirements for references and standards.

B. ASTM

C. ISO 6944 - 1985 - Fire Resistance Tests - Ventilation Ducts.

D. NAIMA - National Insulation Standards.

E. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

H. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Division 01 Section “Submittal Procedures”.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.6 REGULATORY REQUIREMENTS

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).

B. Insulation materials shall be asbestos free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

C. Maintain temperature during and after installation for minimum period of 24 hours.

1.9 EXISTING DUCTWORK

A. Insulate and seal existing supply ductwork as on the Drawings. Contractor shall be responsible to field-verify quantities and sizes. Provide access to existing ductwork as required for complete insulation. Remove existing finishes and existing insulation as required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Glass Fiber Products:
   1. Knauf Insulation.
   2. Certainteed Corporation.
   3. Johns Manville.
   4. Owens Corning.
   5. No substitutions.

B. Glass Fiber Insulation Sealing Tapes:
   1. Venture Tape Corporation.
   2. 3M Company.
   3. Ideal Tape Co., division of American Biltrite Inc.
   4. Nashua Tape Products, division of Berry Plastics Corp.

5. No substitutions.

C. Accessories:
1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
4. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).
5. Venture Tape Corporation (product: Jacket for outdoor insulation).

2.2 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.
1. 'K' ('Ksi') value: ASTM C518, 0.25 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum service temperature: 250 degrees F (121 degrees C) faced and 350 degrees F (176 degrees C) unfaced.
3. Maximum moisture absorption: 0.20 percent by volume.
4. Minimum density: 1.0 lb/cu. ft. (16 kg/m^3).

B. Vapor Barrier Jacket:
1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.
b. White Faced: PSK (polypropylene-scrim-kraft) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.

D. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

E. Tie Wire: Annealed steel, 16 ga (1.5 mm).

2.3 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket. Supplied in board form.
1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum moisture absorption: 1.0 percent by volume.
4. Density: 3.0 lb/cu. ft. (48 kg/cu m).

B. Vapor Barrier Jacket:
1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
a. Aluminum Faced: FSK (foil-scrim-kraft) construction

b. White Faced: ASJ (all-service jacket) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure sensitive tape.

C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.

D. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, [black] [white] color.

2.4 GLASS FIBER, SEMI-RIGID

A. Insulation: ASTM C612; semi-rigid, noncombustible blanket, with fibers oriented perpendicular to insulation surface to provide compressive strength while maintaining flexibility. Supplied in roll form, suitable for application on rounded shapes such as pipes, tanks, ducts, vessels, and other similar round and irregular shapes.
1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum moisture absorption: 1.0 percent by volume.
4. Density: 2.5 lb/cu. ft. (40 kg/cu m).

B. Vapor Barrier Jacket:
1. ASTM C1136, kraft paper with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
a. Aluminum Faced: FSK (foil-scrim-kraft) construction
b. White Faced: ASJ (all-service jacket) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.

D. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, [black] [white] color.

2.5 GLASS FIBER, PREFORMED PIPE COVERING

A. Insulation: ASTM C547; rigid molded, noncombustible.
1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft-°F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
2. Maximum service temperature: 850 degrees F (454 degrees C).
3. Maximum moisture absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket:
1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.

2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Vapor Barrier Tape: Provide self-adhesive butt strips furnished by the insulation manufacturer, with finish to match the insulation outer finish.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449/C449M.

2.6 GLASS FIBER INSULATION SEALING TAPE

A. Self-adhesive tape with integral vapor barrier, pressure sensitive acrylic-based or rubber-based adhesive, and release liner strip. Width 3 inch (76 mm) nominal.

B. Manufactured by VentureTape, by the insulation manufacturer, or by one of the other tape manufacturers listed in the article “Manufacturers” in this Section.

C. Types:
1. For rigid and semi-rigid insulations, tape shall be reinforced type. For flexible “duct wrap” insulation, tape shall be either reinforced or non-reinforced.
2. White or aluminum outer surface to match the insulation.
3. Reinforced: Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier layer.
   a. Aluminum Finish with FSK: VentureTape 1525CW.
   b. White Finish with ASJ: VentureTape 1540CW
   c. White Finish with PSK: VentureTape 1531CW.
4. Non-Reinforced: Foil insulation tape. Dead-soft temper 2 mil (0.05 mm) thick aluminum foil, without reinforcement. Hand-tearable.
   a. Venture Tape 3520CW.
5. Performance:
   a. Peel Adhesion: PSTC-101 with 20 minute dwell, 45 oz/in. (12.5 N / 25 mm).
   b. Shear Adhesion: PSTC-107, 2.2 psi (15.2 kPa) after 24 hours.
   c. Tensile Strength: PSTC-131:
      1) Reinforced Types: 40 lb/in. (180.8 N / 25 mm).
      2) Non-reinforced Types: 21 lb/in. (94.9 N / 25 mm).
   d. Elongation: PSTC 131, 6 percent maximum.

e. Service Temperature: -40 to 240 degrees F (-40 to 116 degrees C).
f. UL 723 listed or classified (flame/smoke rating).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Division 01 Section “Project Management and Coordination”: Verification of existing conditions before starting work.

B. Verify that ductwork has been tested before applying insulation materials.

C. Verify that surfaces are clean, foreign material removed, and dry.

D. Verify that insulation materials are clean and dry. Discard any materials that exhibit signs of moisture damage, contamination, mold, mildew, or other biological growth. Discard any materials used in the air handling airstream if they have been exposed to water.

3.2 INSTALLATION

A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. In addition to new ductwork, provide insulation for surfaces of existing ductwork that is uninsulated. Field-verify scope of existing ductwork.

D. Provide insulation for surfaces of ductwork, as indicated and specified. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.

E. Insulated Ductwork Conveying Air below Ambient Temperature:
1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

F. Insulated Ductwork Conveying Air above Ambient Temperature:
1. Provide with standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

G. Ductwork Exposed below 10 feet (3 meters) above finished floor in Mechanical Equipment Rooms or below 8 feet (2.4 meters) above finished floor in Finished Spaces: Provide glass fiber rigid insulation with vapor barrier jacket.

H. Do not insulate exposed heating or cooling supply ductwork in the conditioned spaces which it serves, unless otherwise specified or indicated on the Drawings.

I. Wherever exposed ductwork for air conditioned systems passes through non air conditioned

spaces, insulate ductwork with glass fiber rigid insulation with vapor barrier, to prevent condensation.

J. Where rigid glass fiber insulation is scheduled, semi-rigid glass fiber insulation may be used on round and flat oval ducts and irregular shapes, and preformed pipe insulation may be used on small diameter round ducts.

K. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

L. Inspection Plates and Test Holes: Provide, where required, in ductwork or casings for balance measurements. Test holes shall be factory fabricated, airtight, and noncorrosive with screw cap and gasket. Extend cap through insulation.

M. Install insulation after ductwork and equipment have been tested and approved.

N. Ensure that surface is clean and dry prior to installation. Ensure that insulation is dry before and during application. Finish with system at operating conditions.

O. Ensure that insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.

P. Finish insulation neatly at hangers, supports and other protrusions.

Q. Locate insulation or cover seams in least visible locations.

R. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

S. Standing seams, supporting angles and flanges on insulated ductwork shall be insulated with thickness equal to the duct and edges shall be finished and vapor sealed.

T. For supply or return ductwork which is required to be insulated, insulation shall be continuous and shall include the insulating of register, grille and diffuser connection plenums/boots.

U. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.

3.3 FIELD INSPECTION

A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
DUCTWORK INSULATION MATERIAL AND WALL THICKNESS

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Supply ductwork (unless exposed in a conditioned space)	Glass Fiber, Flexible	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)
Exposed supply ductwork in mechanical or equipment rooms	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)

END OF SECTION 230713

SECTION 230716 – HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Covering.

C. Shields, Inserts, and Saddles.

1.2 RELATED SECTIONS

A. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Placement of hangers and hanger inserts.

B. Division 23 Section “Identification for HVAC Piping and Equipment.”

C. Division 23 Section “Hydronic Piping”: Placement of hangers and hanger inserts.

D. Division 23 Section “Refrigerant Piping”: Placement of inserts.

1.3 REFERENCES

A. Division 01 Section “References”: Requirements for references and standards.

B. ASTM

C. NAIMA National Insulation Standards.

D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Division 01 Section “Submittal Procedures.”

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years’ experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).

B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 01 Section “Product Requirements”: Environmental conditions affecting products on site.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

C. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Elastomeric Foam Products:
1. Armacell LLC.
2. K-Flex USA.
3. No substitutions.

B. Glass and Mineral Fiber Products:
1. Knauf Insulation.
2. Certainteed Corporation.
3. Johns Manville.
4. Owens Corning.
5. No substitutions.

C. Removable, Reusable Insulation Covers:
1. Advance Thermal Corp.
2. Pacor, Inc.
3. Thermal Science Technologies.
4. Thermaxx LLC.
5. No substitutions.

D. Glass Fiber Insulation Sealing Tapes:
   1. Venture Tape Corporation.
   2. 3M Company.
   3. Ideal Tape Co., division of American Biltrite Inc.
   4. Nashua Tape Products, division of Berry Plastics Corp.
   5. No substitutions.

E. Accessories:
   1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
   2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
   3. Johns Manville (products: Super-Seal acrylic polymer coatings).
   4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
   5. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).

2.2 ELASTOMERIC FOAM

A. Products:
   1. Armacell, AP Armaflex and AP Armaflex FS pipe and sheet insulation.
   2. K-Flex USA: Insul-Tube or K-Flex LS pipe insulation, and Insul-Sheet S2S or K-Flex LS sheet insulation.
   3. No substitutions.

B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
   1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(h-ft2-degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
   2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -40 degrees F (-40 degrees C)).
   3. Maximum service temperature: 220 degrees F (104 degrees C).
   4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
   5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
   6. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.3 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible.
   1. 'K' (KSI) Value: ASTM C177 or ASTM C518, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   2. Maximum Service Temperature: 450 degrees F (232 degrees C).
   3. Maximum Moisture Absorption: 0.2 percent by volume.
   4. Density: 1.5 lb/cu. ft. (24 kg/cu m).

B. Vapor Barrier Jacket:
   1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
      a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.

b. White Faced: PSK (polypropylene-scrim-kraft) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

C. Vapor Barrier Lap Adhesive: Compatible with insulation.

D. Vapor Barrier Tape: See article "Glass Fiber Insulation Sealing Tape" in this Section.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

2.4 GLASS FIBER, RIGID

A. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
1. 'K' (KSI) Value: ASTM C177 or ASTM C518, 0.24 at 75 degrees F (0.035 at 24 degrees C).
2. Maximum Service Temperature: 850 degrees F (454 degrees C).
3. Maximum Moisture Absorption: 0.1 percent by volume.
4. Density: 3.0 lb/cu. ft. (48 kg/cu m).

B. Vapor Barrier Jacket:
1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
a. Aluminum Faced: FSK (foil-scrim-kraft) construction
b. White Faced: ASJ (all-service jacket) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure sensitive tape.

C. Facing: 1 inch (25 mm) galvanized steel hexagonal wire mesh stitched on one face of insulation.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Vapor Barrier Tape: See article "Glass Fiber Insulation Sealing Tape" in this Section.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.5 GLASS FIBER, SEMI-RIGID

A. Insulation: ASTM C612; semi-rigid, noncombustible blanket, with fibers oriented perpendicular to insulation surface to provide compressive strength while maintaining flexibility. Supplied in roll form, suitable for application on rounded shapes such as pipes, tanks, ducts, vessels, and other similar round and irregular shapes.
   1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
   2. Maximum service temperature: 450 degrees F (232 degrees C).
   3. Maximum moisture absorption: 1.0 percent by volume.
   4. Density: 2.5 lb/cu. ft. (40 kg/cu m).

B. Vapor Barrier Jacket:
   1. ASTM C1136, kraft paper with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
      a. Aluminum Faced: FSK (foil-scrim-kraft) construction
      b. White Faced: ASJ (all-service jacket) construction.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.
   3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
   4. Overlap longitudinal laps and butt strips.
   5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.

D. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
   2. Vinyl emulsion type acrylic, compatible with insulation, [black] [white] color.

2.6 GLASS FIBER, PREFORMED PIPE COVERING

A. Insulation: ASTM C547; rigid molded, noncombustible.
   1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
   2. Maximum service temperature: 850 degrees F (454 degrees C).
   3. Maximum moisture absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket:
   1. ASTM C1136, ASJ (all-service jacket) construction, white kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Vapor Barrier Tape: Provide self-adhesive butt strips furnished by the insulation manufacturer, with finish to match the insulation outer finish.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

G. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, white color.

H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

J. Insulating Cement: ASTM C449/C449M.

2.7 GLASS FIBER INSULATION SEALING TAPE

A. Self-adhesive tape with integral vapor barrier, pressure sensitive acrylic-based or rubber-based adhesive, and release liner strip. Width 3 inch (76 mm) nominal.

B. Manufactured by VentureTape, by the insulation manufacturer, or by one of the other tape manufacturers listed in the article "Manufacturers" in this Section.

C. Types:
   1. For rigid and semi-rigid insulations, tape shall be reinforced type. For flexible "duct wrap" insulation, tape shall be either reinforced or non-reinforced.
   2. White or aluminum outer surface to match the insulation.
   3. Reinforced: Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier layer.
      a. Aluminum Finish with FSK: VentureTape 1525CW.
      b. White Finish with ASJ: VentureTape 1540CW
      c. White Finish with PSK: VentureTape 1531CW.
   4. Non-Reinforced: Foil insulation tape. Dead-soft temper 2 mil (0.05 mm) thick aluminum foil, without reinforcement. Hand-tearable.
      a. Venture Tape 3520CW.
   5. Performance:
      a. Peel Adhesion: PSTC-101 with 20 minute dwell, 45 oz/in. (12.5 N / 25 mm).
      b. Shear Adhesion: PSTC-107, 2.2 psi (15.2 kPa) after 24 hours.
      c. Tensile Strength: PSTC-131:
         1) Reinforced Types: 40 lb/in. (180.8 N / 25 mm).
         2) Non-reinforced Types: 21 lb/in. (94.9 N / 25 mm).
      d. Elongation: PSTC 131, 6 percent maximum.
      e. Service Temperature: -40 to 240 degrees F (-40 to 116 degrees C).
      f. UL 723 listed or classified (flame/smoke rating).

2.8 REMOVABLE, REUSABLE INSULATION COVERS

A. Jacket:
   1. PTFE-fiberglass composite jacketing, industrial grade, 13.5 oz/sq. yd (458 g/m2) minimum. Room-side surface in well-vented indoor locations, or cold-equipment-side surface of jacketing may be either PTFE-fiberglass or silicone-fiberglass.
   2. Breather vents and drain orifices, brass or stainless steel.
   3. Stitching: Double-sewn lock stitching with non-melting thread.
   4. Insulation shall be sewn integral to jacket to prevent shifting.

5. Insulating mat shall be placed in overlapping pattern to minimize convection currents.
6. Jacket shall completely encapsulate insulation.
7. Cut jacket material edges shall be folded under and concealed.
8. Provide a permanently attached Aluminum or stainless steel nameplate on each jacket to identify its location, size and tag number.

B. Fastening:
1. Jackets shall be fastened using hook and loop ("Velcro" type) straps and 1-inch (25 mm) slide buckles. Hog rings, staples, wires, and other devices are not acceptable.
2. Jacket pieces which match mating seams shall include an extended 2-inch (50 mm) flap constructed from the exterior fabric and shall be secured using hook and loop closure parallel to the seam.

C. Service Rating: Maximum equipment temperature 700 degrees F (371 degrees C).

D. Warranty: 5-year materials and labor.

2.9 JACKETS

A. PVC Plastic:
1. Jacket: ASTM D1784, Sheet material, off-white color.
a. Minimum Service Temperature: -40 degrees F (-40 degrees C).
b. Maximum Service Temperature: 150 degrees F (66 degrees C).
c. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
d. Thickness: 20 mil (0.50 mm).
e. Connections: Brush on welding adhesive.
2. Covering Adhesive Mastic: Compatible with insulation.

B. Canvas Jacket: UL listed.
1. Fabric: 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.
2. Lagging Adhesive: Compatible with insulation.

C. Fibrous Glass Fabric:
1. Cloth: Heat treated to remove most organic binders. May be factory-impregnated with an inorganic fire-retardant rewettable adhesive, at Contractor's option.
2. Weight: 9 oz/sq yd (305 g/sq m) minimum.
3. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
4. Weave: 10x20 per inch (390x780 per meter).
5. Service Temperature: 1000 degrees F (538 degrees C).

2.10 SHIELDS, INSERTS, AND SADDLES:

A. Shields: Galvanized steel formed in at least a 90 degree arc. Minimum 18 gauge (1.2 mm) thickness. Minimum 12 inches (300 mm) long.

B. Inserts:
1. Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

C. Saddles:
   1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches (300 mm) and larger.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards where applicable.

C. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.

D. Factory Insulated Equipment: Do not insulate.

E. Exposed Equipment: Locate insulation and cover seams in least visible locations.

F. Where rigid glass fiber insulation is scheduled, semi-rigid glass fiber insulation may be used on round and flat oval and irregular shapes, and preformed pipe insulation may be used on small diameter round items.

G. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

H. For hot equipment containing fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

I. For hot equipment containing fluids over 140 degrees F (60 degrees C), insulate flanges and unions with removable sections and jackets.

J. Fiber glass insulated equipment containing fluids below ambient temperature: Provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

K. Fiber glass insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

L. Shields, Inserts, and Saddles:
   1. Application: Provide shields at hangers. Provide inserts for equipment 1-1/2 inches (40 mm) diameter or larger. Provide saddles for equipment 6 inches (150 mm) and larger.

2. Shield location: Between insulation jacket and hanger.
3. Insert location: Between support shield and equipment and under the finish jacket.
4. Saddle location: Between support shield and equipment.
5. Tack-weld saddles to the equipment. Fill air spaces within the saddle with insulation material.
6. Glue shields to outside of insulation after system is filled and run at operating temperature.
7. Align mid-length of shields, inserts, and saddles with the hanger centerline.

M. Finish insulation at supports, protrusions, and interruptions.

N. Equipment Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.

O. Exterior Applications:
1. Provide vapor barrier jacket. Insulate to 1-inch (25 mm) thicker than Table I thickness, and finish with glass-mesh-reinforced vapor barrier cement.
2. Other Equipment: Cover with PVC jacket with seams located on bottom side of horizontal piping.

P. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

Q. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

R. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

S. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

T. Insulate equipment after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust and scale, and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction with valve handles, safety reliefs, and other components requiring movement. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
1. Nameplate labels.
2. Valve hand wheels.
3. ASME stamps.

U. Equipment Insulation:
1. General Procedures: Apply equipment insulation suitable for temperature and service in rigid block or semi-rigid board or flexible form to fit as closely as possible to equipment. Groove or score insulation where necessary to fit the contours of equipment. Stagger end joints where possible. Bevel the edges of the insulation for cylindrical surfaces to

provide tight joints. Bevel insulation around name plates, ASME Stamp, and access plates. For insulation on equipment that must be opened periodically for inspection, cleaning, or repair, construct insulation to be removable and replaceable without damage. Protect exposed insulation corners with corner angles under wires and bands.

2. Fill mineral fiber joints with insulating cement conforming to ASTM C195.
3. Join sections of cellular glass insulation with bedding compound. After the cellular glass insulation is in place on areas to be insulated, except where metal-encased, fill joints, seams, chipped edges, or depressions with bedding compound to form a smooth surface.

V. Cold Equipment (except Pumps):
1. Secure insulation with 16-gauge galvanized steel or copper clad wire or with 3/4 inch (19 mm) wide 20 gauge stainless steel bands spaced on 12-inch (305 mm) centers. Seal joints with joint sealer. Cover non-removable irregular surfaces such as corner angles with a smoothing coat of insulating cement. Apply two coats of vapor barrier coating with a layer of glass cloth embedded between coats. The dry film thickness of the finish shall be 1/32 inch (0.79 mm) minimum.
2. Provide removable heat exchanger head covers with a male-female shiplap type joint.

W. Removable Reusable Equipment Covers:
1. Provide on equipment requiring periodic or frequent service, including but not limited to shell-and-tube heat exchangers and steam converters, plate-and-frame heat exchangers, steam pressure-reducing station PRVs and related valves, pumps, steam condensate traps, steam and condensate meters, … […], and large valves and fittings as referenced in Division 23 Section "HVAC Piping Insulation."
2. Equipment Nameplates: It is acceptable to insulate over nameplates with this type cover.
3. Field-verify installed dimensions prior to ordering covers.

X. For equipment which may operate at a range of temperatures (for example, heat recovery and heat exchange equipment), provide insulation and vapor barriers as are suitable for the entire range of operation.

Y. Insulate equipment and accessories as specified in Table I. In outside locations, provide insulation one inch thicker than that specified in Table I. In addition, comply with the other requirements of this Section.

3.3 PAINTING AND IDENTIFICATION

A. Paint in accordance with Division 09 Section "Painting."

3.4 FIELD INSPECTION

A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
EQUIPMENT INSULATION MATERIAL AND WALL THICKNESS

EQUIPMENT	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Heat Exchangers with fluids at or below room temperature	Glass Fiber, Rigid	Yes	2inch (51 mm)
	Elastomeric Foam	N/A	2inch (51 mm)
Expansion Tanks With fluids at or below room temperature	Glass Fiber, Rigid	Yes	2 inch (51 mm)
	Elastomeric Foam	N/A	2 inch (51 mm)
Air Separators with fluids at or below room temperature	Glass Fiber, Rigid	Yes	2 inch (51 mm)
	Elastomeric Foam	N/A	2 inch (51 mm)
Chilled Water Pumps	Elastomeric Foam	N/A	2 inch (51 mm)
Chilled Water Duct Mounted Coils	Elastomeric Foam	Yes	2 inch (51 mm)
Drain Pans for Chilled Water Systems	Elastomeric Foam	N/A	2 inch (51 mm)

END OF SECTION 230716

This Page Intentionally Left Blank

SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

C. Shields, Inserts, and Saddles.

1.2 RELATED SECTIONS

A. Division 07 Section “Through Penetration Firestop Systems.”

B. Division 09 Section “Painting”: Painting insulation jacket.

C. Division 23 Section “Identification for HVAC Piping and Equipment.”

D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Placement of hangers and hanger inserts

E. Division 23 Section “HVAC Equipment Insulation”: Removable, reusable insulation covers.

F. Division 23 Section “Hydronic Piping”: Placement of hangers and hanger inserts.

G. Division 23 Section “Refrigerant Piping.”: Placement of inserts.

1.3 REFERENCES

A. Division 01 Section “References”: Requirements for references and standards.

B. ASTM

C. NAIMA National Insulation Standards.

D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures”.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in

this Section with minimum 3 years' experience.

B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).

B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Division 01 Section "Product Requirements": Transport, handle, store, and protect products.

B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Division 01 Section "Product Requirements": Environmental conditions affecting products on site.

B. Maintain ambient conditions required by manufacturers of each product.

C. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Elastomeric Foam Products:
1. Armacell LLC.
2. K-Flex USA.
3. No substitutions.

B. Glass and Mineral Fiber Products:
1. Knauf Insulation.
2. Certainteed Corporation.
3. Johns Manville.
4. Owens Corning.
5. No substitutions.

C. Accessories:
1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket

systems).
4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
5. Pittsburgh Corning (product: cellular glass insulation for high-density inserts).
6. Proto Corporation (product: plastic jacket systems).
7. Vac Systems International (product: Tough Coat acrylic polymer mechanical insulation repair coating).

2.2 ELASTOMERIC FOAM

A. Products:
1. Armacell: AP Armaflex and AP Armaflex FS pipe and sheet insulation.
2. K-Flex USA: Insul-Tube and K-Flex LS pipe insulation, and Insul-Sheet S2S and K-Flex LS sheet insulation.
3. No substitutions.

B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -20 degrees F (-29 degrees C)).
3. Maximum service temperature: 220 degrees F (104 degrees C).
4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
6. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

D. Insulated Hanger Inserts: At Contractor’s option, Armacell Armafix IPH insulated pipe hanger inserts may be used at hanger locations.
1. Engineered from Armaflex insulation, with inserts of CFC-free PPUR/PIR polyurethane foam insulation bearing segments.
2. Outer shell of 30 mils (0.76 mm) -thick painted aluminum.
3. Self-adhesive closure strip.
4. Provide Armaflex insulation tape, wrapped around the IPH prior to placing in the hanger.

2.3 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.
1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
2. Maximum service temperature: 850 degrees F (454 degrees C).
3. Maximum moisture absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket:
1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

G. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

H. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

I. Insulating Cement: ASTM C449/C449M.

2.4 JACKETS

A. PVC Plastic.
1. Jacket: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
a. Minimum service temperature: 0 degrees F (-18 degrees C).
b. Maximum service temperature: 150 degrees F (66 degrees C).
c. Moisture vapor transmission: ASTM E96; 0.002 perm-inches.
d. Thickness: 15 mil (0.38 mm) for indoor use, 30 mil (0.76 mm) for outdoor use
e. Connections: Brush on welding adhesive, tacks (for heating systems only) or pressure sensitive color matching vinyl tape.
2. Covering Adhesive Mastic: Compatible with insulation.

B. ABS Plastic:
1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
a. Minimum service temperature: -40 degrees F (-40 degrees C).
b. Maximum service temperature of 180 degrees F (82 degrees C).
c. Moisture vapor transmission: ASTM E96; 0.012 perm-inches.
d. Thickness: 30 mil (0.76 mm).
e. Connections: Brush on welding adhesive.

2.5 SHIELDS, INSERTS, AND SADDLES

A. Shields:
1. Carpenter and Paterson Figure 265GS, or equal.
2. Galvanized or electro-galvanized steel, minimum 12 inch length, minimum 120-degree arc, minimum 18 ga.
3. Provide contact adhesive to glue shields to the insulation.

B. Snap-On Shields:
1. Cooper B-Line "Snap-N Shield".
2. Snap-N Shield is an acceptable substitute for metal shields when installed with strut trapeze hangers on horizontal piping.
3. Paintable polypropylene plastic 12 inch long preformed shields, snap-on design for attachment to strut.

4. Gluing is not required with Snap-N Shield.
5. Provide black or white color to match the insulation in areas exposed to public view.

C. Inserts:
1. Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

D. Saddles:
1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches (300 mm) and larger.

2.6 MANUFACTURER'S STAMP OR LABEL

A. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use shall have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be asbestos-free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Division 01 Section "Quality Requirements": Manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards where applicable.

C. Provide insulation for surfaces of new piping, as indicated and specified.

D. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
1. International Energy Conservation Code (IECC): Chapter 5 of the Code allows the use of ASHRAE 90.1 insulation thicknesses instead of the Minimum Pipe Insulation table which is in Chapter 5 of the IECC. This Specification does not reference the table in IECC.

E. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed in Table I herein. For piping not listed in Table 1, insulate to meet Code requirements, using suitable specified materials, subject to Architect's approval. Except for flexible unicellular insulation, insulation thicknesses as specified in Table I shall be one inch (25 mm) greater for insulated piping systems located outside the building and in unconditioned

spaces. Unless otherwise specified, insulate fittings, flanges, and valves, except valve stems, hand wheels, and operators. Use factory pre-molded, precut, or field-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be factory cleanable, grease resistant, non-flaking, and non-peeling.

F. Exposed Piping: Locate insulation and cover seams in least visible locations.

G. Insulated Pipes Conveying Fluids Below Ambient Temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

H. Glass Fiber Insulated Pipes Conveying Fluids below Ambient Temperature:
1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

I. Glass Fiber Insulated Pipes Conveying Fluids above Ambient Temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

J. Large Valve Bodies and Other Fittings: Large valves and other fittings requiring service access may be insulated with removable, reusable equipment covers with "Velcro" closures. Refer to Division 23 Section "HVAC Equipment Insulation."

K. Branches to Expansion Tanks: For chilled water systems, insulate completely.

L. Branches to Gauges, Sensors, Drains, and Vents: Insulate branches to gauges, sensors, drains, and vents as for active sections of piping. For piping with operating temperatures above ambient, insulate to at least 6 inches (150 mm) from the active main. For temperature devices, insulate to include the sensing bulb or other element.

M. Shields, Inserts, and Saddles:
1. Application: Provide shields at hangers. Provide inserts for piping 2 in. (50 mm) nominal size or larger. Provide saddles for piping 6 in. (150 mm) nominal size and larger and for generator exhaust piping and muffler.
2. Shield location: Between insulation jacket and hanger.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Saddle location: Between support shield and piping.
5. Tack-weld saddles to the pipe or muffler. Fill air spaces within the saddle with insulation material.
6. Glue shields to outside of insulation after system is filled and run at operating temperature.
7. Align mid-length of shields, inserts, and saddles with the hanger centerline.

N. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Division 07.

O. Pipe Exposed in Mechanical Equipment Rooms 10 feet (3 meters) or Less Above Finished Floor:
   1. Other Piping: Finish with PVC or ABS jacket and fitting covers.

P. Pipe Exposed in Finished Spaces 10 feet (3 meters) or Less Above Finished Floor: Finish with PVC or ABS jacket and fitting covers.

Q. Exterior Applications:
   1. Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass-mesh-reinforced vapor barrier cement.
   2. Other Piping: Cover with PVC jacket and fitting covers with seams located on bottom side of horizontal piping.

3.3 UNIFORM INSTALLATION

A. Systems shall use a single insulation type throughout the installation.

3.4 PREPARATION

A. Insulate piping after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust, and scale and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction of valve handles, safety reliefs, and other components requiring movement. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer’s recommended coverage per gallon. Individually insulate piping. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
   1. Piping in radiation enclosures, or within cabinets of unit heaters.
   2. Valve hand wheels.
   3. Vibration isolating connections.
   4. Adjacent insulation.
   5. ASME stamps.

3.5 PIPING INSULATION

A. Pipe Insulation (Except Elastomeric Insulation): Place sections of insulation around the pipe and joints tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with fire resistant adhesive, factory applied self sealing lap. Cover circumferential joints with butt strips, not less than 3-inches (76 mm) wide, of material identical to the jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches (38 mm). Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. When a vapor barrier jacket is required, as indicated in Table I, or on the ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, use a vapor-barrier coating conforming to manufacturer's weatherproof coating for outside service. Apply this vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, and coating as specified for butt strips. Extend

the patch not less than l-l/2 inches (38 mm) past the break in both directions. At penetrations by pressure gauges and thermometers, fill the voids with the vapor barrier coating for outside service. Seal with a brush coat of the same coating. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with the vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the exterior metal jacket 2 inches (51 mm) down beyond the end of the insulation. Seal the flashing and counterflashing underneath with the vapor barrier coating.

B. Elastomeric Foam Insulation: Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide mineral-fiber insulation inserts and sheetmetal sleeves. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two coats of vinyl lacquer finish to elastomeric foam insulation before applying PVC jacket in outside locations.

C. Seal surfaces of fibrous insulation to prevent release of fibers.

D. Sleeves and Wall Chases: Where penetrating interior walls, extend a metal jacket 2 inches (51 mm) out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches (254 mm) above the floor with one band at the floor and one not more than one inch from end of metal jacket. Where penetrating exterior walls, extend the metal jackets through the sleeve to a point 2 inches (51 mm) beyond the interior surface of the wall.

3.6 PAINTING AND IDENTIFICATION

A. Piping identification shall be as specified in other sections.

3.7 FIELD INSPECTION

A. Visually inspect to ensure that materials used conform to specifications. Inspect installations progressively for compliance with requirements.

TABLE I
PIPING INSULATION MATERIAL AND WALL THICKNESS

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Air Conditioning Condensate Drain Located Inside Building	Elastomeric Foam	N/A	0.75 inches	0.75 inches	1 inch	1.5 inches	1.5 inches
	Glass Fiber	Yes	0.75 inches	0.75 inches	1 inch	1.5 inches	1.5 inches

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Cooling Systems (Chilled Water)							
Fluid Design Operating Temperature Range							
40 degrees F to 60 deg. F	Elastomeric Foam	N/A	0.5 inch	1 inch	1 inch	1.5 inches	2 inches
	Glass Fiber	Yes	0.5 inch	1 inch	1 inch	1.5 inches	2 inches
Refrigerant Suction and Liquid Piping							
Operating Temperature							
40 degrees F to 60 deg. F	Elastomeric Foam	N/A	0.75 inch	1 inch	1 inch	1.5 inches	2 inches
Below 40 degrees F	Elastomeric Foam	N/A	1 inch	1 inch	1 inch	1.5 inches	2 inches

END OF SECTION 230719

SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings For:
   1. Chilled water piping system.
   2. Equipment drains and overflows.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Access Doors.

1.3 RELATED SECTIONS

A. Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”

B. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

C. Division 23 Section “Identification for HVAC Piping and Equipment.”

D. Division 23 Section “HVAC Piping Insulation.”

E. Division 23 Section “Hydronic Specialties.”

F. Division 23 Section “HVAC Water Treatment”: Pipe cleaning.

1.4 REFERENCES

A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

E. ASME B31.5 - Refrigeration Piping.

F. ASME B31.9 - Building Services Piping.

G. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

I. ASTM B32 - Solder Metal.

J. ASTM B88 - Seamless Copper Water Tube.

K. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

L. AWS A5.8 - Brazing Filler Metal.

M. AWS D1.1 - Structural Welding Code.

N. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

O. MSS SP69 - Pipe Hangers and Supports - Selection and Application.

P. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide Manufacturers catalogue information. Indicate valve data and ratings.

C. Welders Certificate: Include welder’s certification of compliance with ASME SEC 9 and AWS D1.1.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section “Closeout Procedures.”

B. Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.

B. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.

C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.

D. Pressed Pipe Fittings: Submit documentation of fitting-manufacturer training of installers or their on-site supervisors, with names of individuals.

1.9 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53, Schedule 40 for sizes less than 12 inch (300 mm), 0.375 inch (10 mm) wall for sizes 12 inch (300 mm) and over], black.
   1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type.
   2. Joints: Threaded for pipe sizes 2 inch (50.8 mm) and smaller or AWS D1.1 welded for pipe sizes over 2 inch (50.8 mm).
   3. Grooved and Shouldered Pipe End Couplings: As specified in this Section, with grooved steel pipe, is an acceptable alternate to the above for water service operating at temperatures from -30 to 230 degrees F (-30 to 110 degrees C), utilizing grade E, EPDM gasket compound.

B. Copper Tubing: ASTM B88, Type L hard drawn.
   1. Allowed only for pipe sizes 2 inch (50.8 mm) and smaller.
   2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
   3. Joints: Solder or braze, or press fittings.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.
   1. Fittings: Galvanized cast iron, or ASTM B16.3 malleable iron.
   2. Joints: Threaded, or grooved mechanical couplings.

B. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
2. Joints: Solder or braze, or press fittings.

2.3 BRAZING MATERIALS – 15 percent Silver for copper, brass, and bronze

A. Manufacturers:
1. Harris (Product: Stay-Silv 15).
2. Lucas-Milhaupt (Product: Sil-Fos 15).
3. Wolverine (Product: Silvaloy 15).
4. No substitutions.

B. Nominal Composition: 5.0 percent phosphorus, 15.0 percent silver, 0.15 percent other elements (total), remainder copper. Cadmium-free.

C. Physical Properties:

1.	Color:	Yellow/Gray
2.	Solidus:	1190 degrees F (643 degrees C)
3.	Liquidus:	1480 degrees F (802 degrees C)
4.	Brazing Range:	1300 – 1500 degrees F (704-816 degrees C)
5.	Electrical Conductivity:	9.9 percent IACS
6.	Electrical Resistivity:	17.40 Microhm-cm

D. Specification Compliance:
1. ANSI/AWS A5.8, class BCuP-5
2. ASME SFA5.8, class BCuP-5
3. Optional:
   a. QQB 650C, class BCuP-5
   b. QQB 654A, class BCuP-5
   c. QQB 654, class BCuP-5

E. Flux:
1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS – 35 percent Silver for brazing to ferrous metals (steel)

A. Manufacturers:
1. Harris (Product: Safety-Silv 35).
2. Lucas-Milhaupt (Product: Braze 351).
3. Wolverine (Product: Silvaloy A-35).
4. No substitutions.

B. Nominal Composition: 35.0 percent silver, 33 percent Zinc, 0.15 percent other elements (total), remainder copper. Cadmium-free.

C. Physical Properties:

1.	Color:	Yellow/Gray
2.	Solidus:	1250 degrees F (677 degrees C)
3.	Liquidus:	1410 degrees F (732 degrees C)
4.	Electrical Conductivity:	19.8 percent IACS
5.	Electrical Resistivity:	8.2 Microhm-cm

D. Specification Compliance:
   1. ANSI/AWS A5.8, class BAg-5
   2. ASME SFA5.8, class BCuP-5

E. Flux:
   1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

A. Manufacturers:
   1. Harris (Product: Stay-Brite).
   2. Lucas-Milhaupt (Product: Clean ‘n Brite).
   3. Wolverine (Product: Silvabrite).
   4. No substitutions.

B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.

C. Physical Properties:

1.	Color:	Bright Silver
2.	Solidus:	430 degrees F (221 degrees C)
3.	Liquidus:	430 degrees F (221 degrees C)
4.	Electrical Conductivity:	16.4 percent IACS
5.	Shear Strength:	10,600 psi (73 MPa)
6.	Tensile Strength:	14,000 psi (96 MPa)
7.	Elongation:	48 percent

D. Specification Compliance:
   1. NSF 51
   2. ASTM B32-89, Alloy Grade Sn96
   3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
   4. J-STD-006, Sn96Ag04A

E. Flux:
   1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inch or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
   2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 inch (50 mm) and Under:
   1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inch (50 mm):
   1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene or EPDM, reinforced as required for the system operating pressure, up to relief valve setting.

C. Grooved and Shouldered Pipe End Couplings:
   1. Approved Manufacturers:
      a. Victaulic Company.
      b. Anvil International (division of Mueller Water Products, Inc.) - Gruvlok product line. Grinnell Mechanical Products (division of Tyco Fire Suppression & Building Products Co.).
      c. No Substitutions.
   2. Products:
      a. Housing Clamps: Malleable iron to engage and lock, designed to permit some angular deflection, contraction, and expansion.
      b. Sealing Gasket: C-shape EPDM elastomer composition for operating temperature range from -30 degrees F (-34 degrees C) to 230 degrees F (110 degrees C). This is the standard gasket material suitable for water and glycol service. For other services, verify material.
      c. Accessories: Steel bolts, nuts, and washers with zinc plating.
   3. Note: Grooved couplings are not allowed where concealed above hard ceilings.

D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.7 PRESS FITTINGS PIPING SYSTEMS

A. Approved Manufacturers:
   1. Viega LLC, Wichita, KS - ProPress System with Smart Connect feature.
   2. No substitutions.

B. Fitting and Valve Products:
   1. Wrought copper and cast copper alloy (brass or bronze) fittings and valves for copper piping.
   2. Stainless steel Type 304 or Type 316 fittings and valves for stainless steel piping.
   3. Adapter fittings for transition connections to threaded fittings and dissimilar materials.
   4. Available sizes: 1/2 inch to 4 inch (12.7 mm to 101 mm).

C. Features:
   1. Seals: O-ring type, factory installed in a fitting bead. Seals in larger sizes shall include a separator ring and a stainless steel grip ring.
   2. Seal Materials: EPDM (color shiny black) in copper for hydronic, and drain systems.
   3. Colored Identification Dots:
      a. Copper Fittings:
         1) Green for EPDM seal.
   4. Smart Connect feature provides a leakage path to allow water and air to leak past any unpressed connection, for quick identification during pressure testing.

D. Temperature/Pressure ratings (with appropriate type seals):
   1. Hydronic Systems: 0 to 250 degrees F (-17 to 121 degrees C) up to 200 psig (1723 kPa), at up to 100 percent maximum concentration of ethylene or propylene glycol.

E. Accessories:
   1. Pressing: Use pressing tools, actuator jaws, and pressing rings, Ridgid brand manufactured by Ridge Tool Company, as recommended by the fitting manufacturer for each type of fitting.

2. Lubricants: Do not use. Not recommended by fitting manufacturer.
3. Cutting Tools: For copper or stainless steel pipe, use wheeled cutting tool, or cutting tool approved by the fitting manufacturer. Use deburring tool or reamer after cutting.

2.8 SLEEVES

A. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

E. After completion, fill, clean, and treat systems. Refer to Division 23 Section "HVAC Water Treatment."

3.2 INSTALLATION

A. Install in accordance with Manufacturer's instructions.

B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems."

C. Install heating water, glycol, condenser water, and engine exhaust piping to ASME B31.9. Install chilled water piping to ASME B31.5.

D. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.

E. Minimum pipe size allowed for hydronic piping shall be 3/4 inch (19 mm). Piping less that 3/4 inch (19 mm) shall not be allowed for these piping systems.

F. Route piping in orderly manner, parallel to building structure, and maintain gradient.

G. Install piping to conserve building space, and not interfere with use of space.

H. Group piping whenever practical at common elevations.

I. Erect piping to provide for the easy passage and noiseless circulation of water under working conditions.

J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top

of pipe level. Slope water piping 1 inch in 40 feet (1:480) and arrange to drain at low points. Slope piping up in direction of water flow.

K. On closed systems, equip low points with 3/4 inch (19 mm) drain valves and hose nipples. Provide, at high points of mains, collecting chambers and high capacity float operated automatic air vents, with ball valves on their inlets to valve off after initial system startup. Provide, at high points of branches, manual air vents with air chambers.

L. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least 1 pipe size larger than the branch for up to 6 inch (152 mm) mains and if main is at least 2 pipe sizes larger than branch for 8 inch (203 mm) and larger mains. Do not project branch pipes inside the main pipe.

M. Caulking of threads will not be allowed on any piping.

N. Pipe joint compound shall be put on male threads only.

O. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

P. Dissimilar Metals: Use non-conducting dielectric connections whenever jointing dissimilar metals. Cast red-brass (not yellow brass) or bronze-bodied fittings such as valves and couplings may be used when joining steel to copper, steel to stainless steel, or copper to stainless steel. Steel and stainless steel may connect directly to iron, but copper may not connect directly to iron.

Q. Where welded joints are required, steel piping shall be installed by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory fabricated tees, elbows, reducers, caps, and accessories. Branch outlets 2 inch (50.8 mm) and smaller shall be made by the use of approved welding type half-couplings, "Weldolet" or "Threadolet" fittings.
   1. Piping smaller than 2 inch (50.8 mm) may be installed at the Contractor's option with welding type, or threaded type fittings, except that piping regardless of size concealed in trenches or inaccessible building construction (for example, concealed behind sheetrock walls or concealed above sheetrock ceilings) shall be welded.
   2. Offsets shall be installed with long radius welding elbows.
   3. Welding shall be executed only by certified welding mechanics in accordance with the best practice of the trade.

R. Grooved Mechanical Couplings:
   1. Use grooved mechanical couplings and fasteners in accessible locations only. Grooved mechanical couplings are not allowed in areas such as behind gypsum wallboard walls and above gypsum wallboard or wood ceilings.
   2. Install in strict accordance with manufacturer's instructions. Nothing in this Specification is intended to supersede manufacturer's instructions and recommendations.
   3. Prepare pipe ends properly, and check again before coupling installation.
   4. Lubricate gaskets as recommended. Check gasket before installation.
   5. Do not lubricate coupling mating surfaces (bolt pads) or bolt threads, because this might affect torque readings.

6. Verify that pipe-end separation (all couplings) and deflection from centerline (flexible couplings only) do not exceed manufacturer's specifications. For piping which will operate at a colder temperature than installation temperature (for example, chilled water systems), butt pipes together to provide maximum contraction capability. For piping which will operate at a warmer temperature (for example, heating systems), separate pipe ends the maximum allowed amount to provide maximum expansion capability. Some systems operate at mixed temperatures (for example, cooling tower condenser water systems) and may require different spacing for different sections of the system, and/or a spacing somewhere between minimum and maximum in proportion to the need for expansion and contraction.
7. NOTE: Tighten nuts evenly by alternating sides until tightened to recommended torque. Make sure the housings' keys completely engage the grooves. Make sure the offsets are equal at the bolt pads, during tightening and when fully tightened. NOTE: It is important to tighten nuts evenly to prevent gasket pinching.
    a. Victaulic Couplings: On rigid couplings with angled bolt pads, pads will be offset when tightened. On flexible couplings, bolt pads will be in contact and aligned when tightened.
    b. Anvil and Grinnell Couplings: On rigid couplings, bolt pads will have up to 1/16-inch (1.59 mm) gap when tightened. On flexible couplings, bolt pads will be in contact when tightened.
8. If an impact wrench or other power tool is used to tighten, use extra care. NOTE: Anvil International does not recommend use of impact wrenches with their Gruvlok products.
9. For couplings with manufacturer torque specifications, verify torque on each bolt. Do not exceed torque specification by more than 25 percent.

S. Sleeve pipe passing through partitions, walls and floors:
1. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."
2. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
3. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 in. (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 in. (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
4. Where piping passes through floor, ceiling or wall, close off space between pipe sleeve and construction with non-combustible insulation or with approved firestopping material when penetrating fire rated floors, ceilings or walls. Provide tight fitting metal escutcheons on both ends of sleeves to prevent movement of sleeve during piping expansion. Escutcheons shall be sized slightly larger than outside diameter of piping and smaller than diameter of sleeve. Escutcheons shall be rigidly secured to walls.
5. Where piping passes through fire rated floors, ceilings or walls, close off space between pipe insulation and sleeve with approved firestopping material
6. Install chrome-plated escutcheons where piping passes through finished surfaces.

T. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."

U. In the erection of mains, use special care in the support, working into place without springing or forcing, and proper allowance made for expansion.

V. Pipes shall be anchored, guided, and otherwise supported, where necessary, to prevent vibration or to control expansion.

W. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.

X. Take branch lines off bottom of mains or at 45 degree bottom angle, as space permits.

Y. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

Z. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs.

AA. Install concealed pipes close to building structure to keep furring to a minimum.

BB. Provide access where valves and fittings are not exposed.

CC. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

DD. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09 Section "Painting."

3.3 CLEANING

A. After satisfactory completion of pressure tests, before permanently connecting equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.

B. Fill, vent and circulate the system with approved solution in accordance with equipment (boiler, piping, coils, and others) manufacturer's recommendation, allowing it to reach design or operating temperatures. After circulating for 6 hours, drain the system completely and remove and clean strainer screens. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.

C. Fill and vent system as required.

D. Manually vent heat transfer units and high points of the system.

E. Adjust the pressure reducing valve to provide minimum of 5 psig (35 kPa) pressure at the highest point of the system.

F. After system has been completely filled, start zone pumps and circulate cold water for a short time to dislodge small air bubbles, and return them to air extraction device.

G. Stop pump and vent radiation and high points of the system. Normal operation may now be started at any time.

3.4 TESTING

A. No joint or section of piping shall be left untested.

B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, and other parts which are not designed to stand test pressures.

C. Test piping for leaks under 100 psig (689 kPa) air pressure with soap suds prior to hydrostatic testing.

D. Test piping hydrostatically to 1-1/2 times the maximum systems operating pressure, but in no case to less than 75 psig (517 kPa), for at least 4 consecutive hours, during which time pressure shall remain constant without pumping.

E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

END OF SECTION 232113

This Page Intentionally Left Blank

SECTION 232118 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Valves:
   1. Gate valves.
   2. Globe or angle valves.
   3. Ball valves.
   4. Plug valves.
   5. Butterfly valves.
   6. Check valves.

B. Expansion tanks.

C. Air vents.

D. Air separators.

E. Strainers.

F. Combination fittings.

G. Flow indicators, controls, meters.

H. Pressure reducing valves for cold water makeup.

I. Combination valve assemblies.

J. Relief valves.

1.2 RELATED SECTIONS

A. Division 23 Section “Meters and Gauges for HVAC Piping”: Test Ports.

B. Division 23 Section “Hydronic Piping.”

C. Division 23 Section “HVAC Water Treatment”: Pipe cleaning, and bypass (pot) feeder.

1.3 REFERENCES

A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

C. Submit inspection certificates for pressure vessels from authority having jurisdiction.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section "Closeout Procedures."

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."

B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.1 VALVES

A. Manufacturers:
1. Nibco.
2. Apollo.
3. Crane
4. Hammond.
5. Milwaukee.
6. Victaulic Company.

7. Watts.
8. Wheatley.
9. No substitutions.

B. Ball Valves:
1. Up To and Including 2 inch (50 mm):
a. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
b. 150 lb S.W.P., 600 lb W.O.G.
2. Over 2 Inch (50 mm):
a. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.
b. 150 lb S.W.P., 285 lb W.O.G.
3. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.
4. Ball valves used in chilled water systems shall be furnished with factory installed insulated handles and stems, equal to Nibco NIB-SEAL. For valves that exceed maximum available factory pre-insulated valve sizes, provide valves with extended stems to allow for continuous field installed vapor barrier insulation to prevent condensation.

C. Butterfly Valves:
1. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
2. Disc: Aluminum bronze or chrome plated ductile iron.
3. Operator: 10 position lever handle for shut-off service, infinite position lever handle with memory stop for throttling service, handwheel and gear drive for sizes 8" (203 mm) and larger.
4. Pressure rating shall be 150 psi at 225 degrees F (1034 kPa at 107 degrees C).

D. Swing Check Valves:
1. Up To and Including 2 inch (50 mm): Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
2. Over 2 inch (50 mm): Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.2 EXPANSION TANKS, BLADDER TYPE

A. Manufacturers:
1. Taco.
2. Bell & Gossett.
3. Flo-Fab.
4. John Wood.
5. Watts.
6. Wessels.
7. Wheatley.

B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with removable and replaceable flexible butyl or EPDM bladder, full or partial acceptance type as indicated on the Drawings, and integral steel support stand.

C. Accessories: Schraeder-type air-charging fitting and protective heavy steel cap, drain fitting with plug, and field-furnished pressure gauge.

2.3 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.

2.4 AIR SEPARATORS

A. In-line Combination Air/Dirt Separators, 2 inches (50 mm) and Larger Line Size:
   1. Manufacturers:
      a. Taco, Inc. - 4900DR and 4900DHR Series with removable cover.
      b. Spirotherm - VDN and VHN Series.
   2. Provide removable cover for cleaning.
   3. Steel body, with brass-or-cast-iron-body venting mechanism with components of stainless steel, EPDM, viton, brass, and engineered plastics. Tested and stamped in accordance with ASME SEC 8-D; for 125 psig (860 kPa) operating pressure, 270 degrees F (132 degrees C) maximum temperature, straight-through inlet and outlet connections, top fitting for air vent, bottom fitting for drain, side fitting with ball valve with hose-thread outlet for skimming and purge, with internal stainless steel or copper coalescing medium. Fittings 3-inch (76 mm) and under shall be NPT threaded or flanged, larger fittings shall be flanged. Primer paint finish.
   4. Separator shall function on the coalescing principle. Manufacturer shall furnish documentation demonstrating that separator removes air microbubbles as small as 18 microns.
   5. Provide a top-mounted automatic air vent with hose-clamp or pipe-thread outlet. Vent shall be serviceable and replaceable. Provide integral or separate valve allowing the vent to be manually closed for its protection during startup and purging.
   6. Dirt and debris separation shall include a deep settling area below the level of the main piping connections. Dirt separation shall be effective down to 35 micron particle size, and at least 90 percent efficient down to 90 microns in 100 passes or fewer. Provide a factory-installed blowdown ball valve at base of unit.
   7. Provide welded steel base support ring for floor mounting on line sizes 8 inches (203 mm) and larger.

2.5 STRAINERS

A. Manufacturers:
   1. Sarco.
   2. Armstrong.
   3. Barnes and Jones.
   4. Bell & Gossett.
   5. Flo-Fab.
   6. Keckley Co.
   7. Muesco.
   8. Wheatley.

B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

D. Size 5 inch (125 mm) and Larger: Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.6 BALANCING VALVES AND COMBINATION BALANCING/SHUT-OFF VALVES.

A. Manufacturers:
1. Bell & Gossett.
2. Armstrong.
3. Flow Design, Inc.
4. Gerand.
5. Griswold Controls.
6. Mepco.
7. Nexus Valve.
8. Taco.
9. Tour and Andersson.
10. Watts.
11. Wheatley.

B. Valves shall conform to one of the following:
1. Fixed-Orifice Manual Balancing Valve: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer with memory stop. Readout valves measure the pressure differential across the fixed orifice plate or venturi. Valve shall be designed for positive shut-off.

C. Size balancing valves to allow a reading of 2 to 5 ft wg (6 to 15 kPa) pressure drop at design flow rates. Submittals shall include a chart of valve selections, indicating room number, terminal heating device tag, flow rate, pressure drop, and differential pressure reading.

D. Insulation: Valves may be furnished with prefabricated thermal insulation. Flame spread reading shall be 25 or less per ASTM E84. R-value shall be 4 hr-sq.ft- F/Btu (0.704 K·m²/W) or greater. Install in accordance with Division 23 Section “HVAC Piping Insulation.”

E. close-out.

2.7 PRESSURE REDUCING VALVES FOR COLD WATER MAKEUP

A. Manufacturers:
1. Watts.
2. Bell & Gossett.
3. Caleffi.
4. Spence.
5. Taco.
6. Wheatley.

B. Pressure Reducing Valve (PRV): Bronze body. Stainless steel, EPDM, and plastic internals. Maximum temperature rating 160 degrees F (71 degrees C). Maximum inlet pressure rating 200 psig (1378 kPa). Reduced pressure range suitable for the project. Provide inlet union,

integral to the valve or furnished separately. Valve may include an integral inlet strainer. Valve may include a bypass lever or button. Valve internals shall be serviceable and replaceable without removing the body from the piping. Valve shall be line size unless otherwise indicated.

C. Set pressure reducing valve to achieve 5 psi (34.5 kPa) gauge pressure at high point of system. Provide pressure gauge at high point of system, per Division 23 Section "Meters and Gauges for HVAC Piping." Set pressure reducing valve when the temperature of the water in the system is less than 80 degrees F (27 degrees C).

D. Provide bypass line with full-port ball valve for fast system fill, sized as indicated. Reducing valve may include fast-fill lever, but this is not a substitute for the bypass line and valve.

2.8 RELIEF VALVES

A. Manufacturers:
1. Bell & Gossett.
2. Spence.
3. Taco.
4. Watts.
5. Wheatley.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

C. Factory set to relieve pressure at field verified setting in psig.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Valve Type Selection:
1. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
2. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.
3. Use Butterfly Valves in chilled water and condenser water piping for general shut-off service at equipment connections 2 inch (50.8 mm) and larger.
4. Use Bronze Ball Valves for general shut-off service in heating and cooling system piping 2 inch (50.8 mm) and smaller.
5. Use Combination Balancing, Flow Measuring and Tight Shut-off Valves at terminal heating and cooling units, zone branches and as indicated.
6. Use Bronze Ball Valves for drain valves with hose connections. Provide valve of size indicated; if size isn't indicated, provide at least 3/4 inch (19 mm) valve size. Provide outlet fitting for standard "garden hose" with 3/4 inch (19 mm) hose threads. Provide brass cap with retainer chain. Compression-type "boiler drain valves" are not allowed.

B. With the exception of valves which must be properly sized to ensure design flow rates (such as balancing valves), valves shall be line sized.

C. For valves located more than 7 feet (2.1 m) above finished floor in equipment room areas, provide chain operated sheaves. Extend chains to 5 feet (1.5 m) above finished floor and hook

to clips arranged to clear walking aisles.

D. For isolation valves, control valves and balancing valves located above suspended ceilings and in areas that are not visible to building occupants (for example, mechanical rooms), provide yellow colored surveyors tape. Permanently attach tape to valve handles and run tape down to 10 inches (254 mm) above ceiling or 12 inches (305 mm) below valve handle where ceilings do not exist (for example, mechanical rooms).

E. Standard details for cooling coils are based on single coil arrangements. For cooling coils that are supplied in a split coil arrangement, with 2 or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.

F. Install valves with stems upright or horizontal, not inverted.

G. Install specialties in accordance with manufacturer's instructions.

H. Where large air quantities can accumulate, provide enlarged air collection standpipes.

I. Provide manual air vents at system high points and as indicated.

J. Provide air separator on suction side of system circulation pump and connect to expansion tank.

K. Provide valved drain and hose connection on strainer blow down connection.

L. Support pump fittings with floor mounted pipe and flange supports.

M. Ensure that balancing valves are installed with minimum upstream length of straight pipe as recommended by the manufacturer.

N. Ensure that balancing valves are installed with the readout valves fully accessible, including space required for insertion of metering probes.

O. Expansion Tanks : Provide pressure gauge per Division 23 Section “Meters and Gauges for HVAC Piping” near point where expansion tank is connected to system, for determining required pre-charge pressure for air side of expansion tank. Isolate expansion tank from system and pre-charge air side of tank to same pressure as static head of system at point where expansion tank is connected to system. Measure static head of system after pressure reducing valve at cold water make-up has been properly set in accordance with this Section. Pre-charge air side of expansion tank only when the temperature of the water in the system is less than 80 degrees F (27 degrees C). Provide drain valve with hose end connection at point of connection to expansion tank to allow for periodic removal of system pressure in order to check expansion tank’s pre-charge air pressure. Drain valve shall be located closest to expansion tank, isolation valve shall be immediately upstream of drain valve and pressure gauge shall be within sight upstream of isolation valve.

P. Relief Valves:
   1. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
   2. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to not exceed maximum pressure

rating of connected equipment.

3. Pipe relief valve outlet to nearest floor drain.
4. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 232118

SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vertical in-line pumps.

1.2 RELATED SECTIONS

A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”

B. Division 23 Section “HVAC Piping Insulation.”

C. Division 23 Section “HVAC Equipment Insulation”

D. Division 23 Section “Hydronic Piping.”

E. Division 23 Section “Hydronic Specialties”

F. Division 26 “Electrical” Electrical characteristics and wiring connections.

1.3 REFERENCES

A. UL 778 - Motor Operated Water Pumps.

B. NFPA 70 - National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading throughout the entire operating range in parallel or individual operation, and operate within 25percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

D. Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

B. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing, assembly, and field performance of pumps with minimum 3 years' experience.

B. Alignment: Base mounted pumps shall be aligned by a qualified millwright.

1.8 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cartridge Circulators with Integral Speed Controller:
1. Grundfos.

B. No Substitutions.

2.2 GENERAL

A. Statically and dynamically balance rotating parts.

B. Construction shall permit complete servicing without breaking piping or motor connections.

C. Pumps shall operate at 1750 rpm unless indicated or specified otherwise.

D. Pump connections shall be flanged.

E. Wetted parts shall be compatible with circulated fluid.

2.3 CARTRIDGE CIRCULATORS WITH INTEGRAL SPEED CONTROLLER

A. Grundfos Magna series, with pump-mounted speed controller.

B. Type: Cartridge type circulator, in-line mounting,

C. Working Conditions:
1. Working Pressure: 145 psig (10 bar) maximum.
2. Minimum Inlet Pressure: 6.5 psig (0.45 bar) at 194 degrees F (90 degrees C).
3. Fluid Temperature: 230 degrees F (110 degrees C) maximum for short periods, 203 degrees F (95 degrees C) maximum for continuous operation.
4. Ambient Temperature: 32 to 104 degrees F (0 to 40 degrees C).

D. Casing: Cast iron or stainless steel with flanged pump connections. Wet-varnished finish.

E. Impeller: Stainless steel, or non-metallic composite.

F. Shaft: Stainless steel, tungsten carbide, or aluminum oxide.

G. Bearings: Carbon, with aluminum oxide outer bearing ring, aluminum oxide or silicon carbide inner bearing ring, and stainless steel bearing plate.

H. Stator Housing: Aluminum, with EPDM O-rings.

I. Rotor: Permanent-magnet rotor, with leak-proof stainless steel rotor can.

J. Motor: Variable speed, electronically commutated, synchronous permanent magnet motor, with 3-lead Alpha snap-lock power plug at pump, and flexible power cord for field connection to junction box. Integral motor protection.

K. Speed Controller: Integral pump-mounted frequency converter. Differential pressure control with "Auto-Adapt" function. Pump speed calculated via a built-in induction coil on the stator winding. Differential-pressure and temperature sensor located inside the pump housing. User interface with LED indicators of relative flow and head, operating mode, on-off status, and fault. Pushbuttons for speed settings and power on-off pushbutton. External start/stop input dry contact. 5 selectable operating modes. Infrared remote control receiver.

L. Remote Control: Wireless remote control Model R100. Communicates to pump controller via infrared light.

M. LON Module: Provide module using LonTalk protocol for LONWorks networks, for interface to the building automation system. Module shall provide access to controller information and alarms, allow remote adjustment of setpoints, and allow remote inputs such as start/stop signals. Coordinate requirements with Division 23 Section "Instrumentation and Control for Mechanical Systems."

N. Insulation Shell: Provide Grundfos Magna insulation shell, factory-molded to the shape of the pump body. Insulation shall be suitable for chilled water service..

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

C. Decrease piping from line size with long radius reducing elbows or reducers.

D. Pump inlet conditions shall be as recommended by the pump manufacturer to eliminate system effects.
   1. Provide proper straight lengths of inlet piping and long-radius elbows at pump inlets.

E. Support piping adjacent to pump such that no weight is carried on pump casings. Provide necessary brackets or hanger supports as required to relieve the stress on the pumps and piping. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.

F. Provide line sized shut-off valve and strainer on pump suction, and properly sized soft seat check valve and balancing/flow-measuring/shutoff valve on pump discharge.

G. Install pumps with a pressure gauge piped to suction and discharge, with shutoff valves.

H. Lubricate pumps before start-up.

I. Provide labor and materials required to ensure that pump impellers are adequately sized to provide flow rates as indicated. This shall include, but not be limited to, trimming impellers.

END OF SECTION 232123

SECTION 232300 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and Liquid Indicators.

D. Valves.

E. Strainers.

F. Check Valves.

G. Pressure Relief Valves.

H. Filter-Driers.

I. Solenoid Valves.

J. Expansion Valves.

K. Receivers.

L. Flexible Connections.

1.2 RELATED SECTIONS

A. Division 08 Section “Access Doors and Frames.”

B. Division 09 Section “Painting.”

C. Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”

D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

E. Division 23 Section “HVAC Piping Insulation.”

F. Division 23 Section “HVAC Equipment Insulation.”

G. Division 23 Section “Packaged Compressor and Condenser Units.”

H. Division 23 Section “Air-Cooled Refrigerant Condensers.”

I. Division 23 Section “Air Coils.”

J. Division 23 Section “Instrumentation and Controls for Mechanical Systems.”

K. Division 26 “Electrical.”

1.3 REFERENCES

A. ARI 495 - Refrigerant Liquid Receivers.

B. ARI 710 - Liquid Line Dryers.

C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers

D. ARI 750 - Thermostatic Refrigerant Expansion Valves.

E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.

F. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

G. ASHRAE 34 - Number Designation of Refrigerants.

H. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.

I. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

J. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.

K. ASME B31.5 - Refrigeration Piping.

L. ASME B31.9 - Building Services Piping.

M. ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.

N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

O. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

P. ASTM B88 - Seamless Copper Water Tube.

Q. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

R. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.

S. ASTM F667 - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.

T. ASTM F708 - Design and Installation of Rigid Pipe Hangers.

U. AWS A5.8 - Brazing Filler Metal.

V. AWS D1.1 - Structural Welding Code, Steel.

W. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

X. MSS SP69 - Pipe Hangers and Supports - Selection and Application.

Y. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

Z. UL 429 - Electrically Operated Valves.

1.4 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with MSS SP69 unless indicated otherwise.

C. Liquid Indicators:
1. Use line size liquid indicators in main liquid line leaving condenser.
2. If receiver is provided, install in liquid line leaving receiver.
3. Use line size on leaving side of liquid solenoid valves.

D. Valves:
1. Use service valves on suction and discharge of compressors.
2. Use gauge taps at compressor inlet and outlet.
3. Use gauge taps at hot gas bypass regulators and at filters and filter driers, inlet and outlet.
4. Use check valves on compressor discharge.
5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
1. Use line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
3. On steel piping systems, use strainer in suction line.
4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and on compressors converted to higher pressure refrigerant. Pipe field-installed valves and valves furnished with equipment to outdoors as required by ASHRAE Standard 15 and where directed.

H. Replaceable Cartridge Filter-Driers:
1. Use vertically in liquid line adjacent to receivers.
2. Use with filter elements in suction line. Provide temporary wax removal filter-drier core in low temperature systems and systems where motor failure has occurred.
3. Use filter-driers for each solenoid valve.

I. Solenoid Valves:
1. Use in liquid line of systems operating with single pump-out or pump-down compressor

control.
2. Use in liquid line of single or multiple evaporator systems.
3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:
1. Use on systems 5 tons (18 kW) and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 Section "Submittal Procedures."

B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

C. Product Data: Provide general assembly of specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.

D. Pipe Sizing Recommendations of Equipment Manufacturers:
1. Verify indicated pipe sizes with the manufacturers of the associated equipment. If manufacturer's recommendations differ from the sizes indicated on the Drawings, submit recommendations to the Architect. The Architect will make the final determination of pipe sizes. Provide sizes per final determination at no additional cost to the Owner. In sizing piping, include modifications as required to affected items including but not limited to piping, valves, filters, other pipeline accessories, insulation, supports, sleeves, conduits, building openings, and building enclosures.
2. Submission of manufacturer's recommendations, and equipment performance related to pipe sizing, is the Contractor's responsibility.
3. Verify sizing prior to any preparation for piping installation.

E. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

F. Test Reports: Indicate results of leak test, acid test.

G. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

H. Submit welders' certifications of compliance with AWS D1.1., and their assigned identification letters, numbers or symbols.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section "Closeout Procedures."

B. Record exact locations of equipment and refrigeration accessories on record drawings.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

B. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.8 QUALIFICATIONS

A. Installer: Company specializing in performing the work of this Section with minimum 3 years’ experience.

B. Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the Project is located.

1.9 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

C. Welders Certification: In accordance with AWS D1.1. and state and local requirements.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

E. Refrigerant Safety: Conform with ASHRAE 15, state and local codes and manufacturer’s requirements for safe handling to avoid exposure to workers or to occupants.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 Section “Product Requirements.”

B. Deliver and store piping and specialties in shipping containers with labeling in place.

C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Division 01 Section “Closeout Procedures.”

B. Provide 2 refrigeration oil test kits, each containing everything required to conduct 1 test.

C. Provide 2 filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn, degreased, nitrogen charged and sealed. Annealed (soft) tubing may be used only for underfloor or below grade runs or for short (6 feet (1.8 m) or less) above-grade connections to valves and equipment.
   1. Fittings: ASME B16.22 wrought copper.
      a. Fittings shall be packaged and labeled for ACR use.
      b. Elbows: Use long-radius elbows wherever possible. Do not use 45-degree elbows, because they are more likely to break at their inner surface in refrigeration service.
   2. Joints:
      a. Braze, 15 percent silver for copper, brass, and bronze.
      b. Braze, 35 percent silver, for brazing to ferrous metals (steel).
      c. Solder (for use only at equipment and valve connections where required by the equipment manufacturer).
      d. Other: If a valve or equipment manufacturer recommends a joint material other than those specified, submit it for approval.
      e. Flux: Use as recommended by alloy manufacturer. Should not be needed for copper-to-copper brazed joints.

B. Copper Tubing to 7/8 inch (22 mm) OD: ASTM B88, Type K, annealed.
   1. Fittings: ASME B16.26 cast copper.
   2. Joints: Flared.

C. Steel Pipe: ASTM A53, Schedule 40, 0.365 inch (10 mm) wall for sizes 12 inch (300 mm) and over, black.
   1. Fittings: ASTM A234, forged steel welding type.
   2. Joints: AWS D1.1, welded.

2.2 PIPE SLEEVES

A. See Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”

2.3 BRAZING MATERIALS - 15% Silver

A. Manufacturers:
   1. Harris (Product: Stay-Silv 15).
   2. Lucas-Milhaupt (Product: Sil-Fos 15).
   3. Wolverine (Product: Silvaloy 15).
   4. No substitutions.

B. Nominal Composition: 5.0 percent phosphorus, 15.0 percent silver, 0.15 percent other elements (total), remainder copper. Cadmium-free.

C. Physical Properties:

1.	Color:	Yellow/Gray
2.	Solidus:	1190 degrees F (643 degrees C)
3.	Liquidus:	1480 degrees F (802 degrees C)
4.	Brazing Range:	1300–1500 degrees F (704-816 degrees C)

5. Electrical Conductivity: 9.9 percent IACS
6. Electrical Resistivity: 17.40 microhm-cm

D. Specification Compliance:
1. ANSI/AWS A5.8, class BCuP-5
2. ASME SFA5.8, class BCuP-5
3. Optional:
   a. QQB 650C, class BCuP-5
   b. QQB 654A, class BCuP-5
   c. QQB 654, class BCuP-5

E. Flux:
1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.4 BRAZING MATERIALS – 35 percent Silver

A. Manufacturers:
1. Harris (Product: Safety-Silv 35).
2. Lucas-Milhaupt (Product: Braze 351).
3. Wolverine (Product: Silvaloy A-35).
4. No substitutions.

B. Nominal Composition: 35.0 percent silver, 33 percent Zinc, 0.15 percent other elements (total), remainder copper. Cadmium-free.

C. Physical Properties:
1. Color: Yellow/Gray
2. Solidus: 1250 degrees F (677 degrees C)
3. Liquidus: 1410 degrees F (732 degrees C)
4. Electrical Conductivity: 19.8 percent IACS
5. Electrical Resistivity: 8.2 microhm-cm

D. Specification Compliance:
1. ANSI/AWS A5.8, class BAg-5
2. ASME SFA5.8, class BCuP-5

E. Flux:
1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.5 SOLDER MATERIALS:

A. Manufacturers:
1. Harris (Product: Stay-Brite).
2. Lucas-Milhaupt (Product: Clean ‘n Brite).
3. Wolverine (Product: Silvabrite).
4. No substitutions.

B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.

C. Physical Properties:

1.	Color:	Bright Silver
2.	Solidus:	430 degrees F (221 degrees C)
3.	Liquidus:	430 degrees F (221 degrees C)
4.	Electrical Conductivity:	16.4 percent IACS
5.	Shear Strength:	10,600 psi (73 MPa)
6.	Tensile Strength:	14,000 psi (96 MPa)
7.	Elongation:	48 percent

D. Specification Compliance:
1. NSF 51
2. ASTM B32-89, Alloy Grade Sn96
3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
4. J-STD-006, Sn96Ag04A

E. Flux:
1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inches or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.6 REFRIGERANTS AND LUBRICANTS

A. Refrigerant: ASHRAE 34;
1. R-22: Monochlorodifluoromethane. HCFC; no new equipment after 2009.
2. R-32: Difluoromethane. Component of blends.
3. R-123: Dichlorotrifluoroethane. HCFC; EPA phase-out in 2030.
4. R-125: Pentafluoroethane. Component of blends.
5. R-134a: Tetrafluoroethane. Suitable for new equipment and retrofits.
6. R-407a: Blend of R-32/125/134a. Suitable for food-storage systems.
7. R-407c: Blend of R-32/125/134a. Suitable for retrofits.
8. R-410a: Blend of R-32/125. Suitable for new equipment.

B. Oils and Other Lubricants: Provide as required by the refrigerant manufacturer and the equipment manufacturer(s).

2.7 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:
1. Sporlan Valve Co, Model “See-All”.
2. Emerson Climate Technologies.
3. Henry Technologies.
4. Mueller.

B. Indicators: Double port type, UL listed, with steel body, flared or copper plated solder ends, leak proof fused sight glass, replaceable color coded paper moisture indicator and plastic cap; for maximum working pressure of 500 psig (3450 kPa) for connection sizes 1-1/8 inch (29 mm) O.D. and smaller, 430 psig (2960 kPa) for sizes 1-3/8 inch (35 mm) O.D. and larger, and maximum temperature of 200 degrees F (93 degrees C). Synthetic gaskets are not allowed.

2.8 VALVES

A. Diaphragm Packless Valves:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.
   2. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

B. Packed Angle Valves:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.
   2. Forged brass (or brass and copper), forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

C. Ball Valves:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.
   2. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 325 degrees F (163 degrees C).

D. Service Valves:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.
   2. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig (3450 kPa).

2.9 CHECK VALVES

A. Globe Type:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.
   2. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).

B. Straight Through Type:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
      c. Superior.

C. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 250 degrees F (121 degrees C).

2.10 EXPANSION VALVES

A. Manufacturers:
   1. Sporlan.
   2. Henry Technologies.
   3. Parker Hannifin.

B. Angle or Straight Through Type: ARI 750; balanced port or two-port design suitable for refrigerant, brass body, flare or solder connections, internal or external equalizer, resealable bleed hole, adjustable superheat setting, replaceable inlet strainer, with replaceable thermostatic power element with capillary tube and remote sensing bulb. Joints to the body at the removable power element and at the strainer shall be knife-edge type not requiring a synthetic seal.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load. Select thermostatic charge for the particular application.

2.11 ELECTRONIC EXPANSION VALVES

A. Manufacturers:
   1. Sporlan.
   2. Henry Technologies.
   3. Parker Hannifin.

B. Valve:
   1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
   2. Capacity: To meet the load of the equipment served.
   3. Electrical Characteristics: Compatible with the control system.

C. Evaporation Control System:
   1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.
   2. Electrical Characteristics: Compatible with the control system.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.12 PRESSURE REGULATORS

A. Manufacturers:
   1. Sporlan.
   2. Parker Hannifin.

B. Brass body, stainless steel diaphragm, pilot operated with internal pressure pilot, adjustable over 0 to 100 psig (0 to 690 kPa) range, for maximum working pressure of 450 psig (3100 kPa).

2.13 PRESSURE RELIEF VALVES

A. Manufacturers:
   1. Henry Technologies.
   2. Mueller.
   3. Superior.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard setting; selected to ASHRAE 15.

2.14 SOLENOID VALVES

A. Manufacturers:
   1. Sporlan.
   2. Henry Technologies.
   3. Parker Hannifin.

B. Valve: ARI 760, pilot operated, brass or steel body and internal parts, teflon seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig (3450 kPa). Stem shall have a knife-edge joint to the body and shall permit manual operation in case of coil failure.

C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

D. Electrical Characteristics: 10 to 15 watts, voltage compatible with control system, single phase, 60 Hz.

2.15 FILTER-DRIERS

A. Replaceable Cartridge Angle Type:
   1. Manufacturers:
      a. Sporlan, Model CW Catch-All.
      b. Emerson Climate Technologies.
   2. Shell: ARI 710, UL listed, steel with epoxy paint finish, copper sweat fittings, removable cap with zinc-plated fasteners, for maximum working pressure of 500 psig (3450 kPa), size as recommended by manufacturer.
   3. Suction Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for capacity of the equipment served.
   4. Filter/Dryer Cartridge: Pleated media with solid core molecular sieve with activated alumina, ARI 730 rating for capacity of the equipment served.

5. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, with filter surface area, desiccant volume and ARI 710 moisture rating as recommended by the manufacturer based on line size and refrigeration system horsepower (kW).

B. Permanent Straight Through Type:
   1. Manufacturers:
      a. Sporlan, Model CW Catch-All.
      b. Emerson Climate Technologies.
   2. ARI 710, UL listed, steel shell with copper plated steel sweat or flare fittings, molded molecular sieve/activated alumina desiccant filter core, for maximum working pressure of 500 psig (3450 kPa).
   3. Rating: ARI 730 flow capacity of the equipment served.

2.16 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Metraflex.
   2. Mason Industries.
   3. Keflex.

B. Corrugated bronze hose with single layer of exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure 500 psig (3450 kPa).

2.17 RECEIVERS

A. Manufacturers:
   1. Henry Technologies.
   2. Refrigeration Research Inc.
   3. Sporlan.
   4. Standard Refrigeration Co.

B. Internal Diameter 6 inch (150 mm) and Smaller: ARI 495, UL listed, steel, brazed; 400 psig (2760 kPa) maximum pressure rating, with tappings for inlet, outlet, liquid level gauge, sight glasses and pressure relief valve. Provide at least 2 bullseye liquid level sight glasses. Size receiver to hold at least 120 percent of fully charged system.

C. Internal Diameter Over 6 inch (150 mm): ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, sight glasses and magnetic liquid level indicator. Provide at least 2 bullseye liquid level sight glasses. Size receiver to hold at least 120 percent of fully charged system.

2.18 STRAINERS

A. Straight Line or Angle Line Type:
   1. Manufacturers:
      a. Henry Technologies.
      b. Sporlan.
      c. Superior.
   2. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of

stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig (2960 kPa).

B. Straight Line, Non-Cleanable Type:
   1. Manufacturers:
      a. Henry Technologies.
      b. Mueller.
   2. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 430 psig (2960 kPa).

C. Screens: 80 mesh (0.007 in. (0.18 mm) square openings) in most uses, 60 mesh (0.010 in. (0.25 mm) square openings) in line sizes above 1-1/8 inch (29 mm), and 40 mesh (0.015 in. (0.38 mm) square openings) for use in suction lines.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.

B. Comply with Federal, State, and local Codes and regulations regarding the handling and disposal of refrigerants and oil. Provide documentation of quantities installed in the system. Document handling and disposal; see “Project Closeout” in this Section.

C. Install refrigeration specialties in accordance with manufacturer's instructions.

D. Flood piping system with nitrogen when brazing.

E. Route piping in orderly manner, parallel or perpendicular to building structure, and maintain gradient.

F. Install annealed piping free of kinks, and with bends only as necessary.

G. Install piping to conserve building space and not interfere with use of space.

H. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

J. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide

double risers as required.

K. Provide liquid line replaceable cartridge (unless sealed type is indicated) filter-driers, with isolation valves and valved bypass. On low temperature systems, or after a hermetic motor burnout, provide wax removal cores. Provide upstream and downstream pressure-testing access valves.

L. Provide suction line replaceable cartridge filters, with isolation valves and valved bypass. Provide upstream and downstream pressure testing access valves. On low temperature systems, or after a hermetic motor burnout, provide temporary wax removal cores. After cleanup of the system, replace cores with filter elements for lower pressure drop.

M. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

N. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

O. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

P. Pipe Sleeves and Escutcheons:
1. See **Division 23 Section "Sleeves and Escutcheons for HVAC Piping.**"
2. Provide sleeves, sized to fit outside the pipe insulation with at least 1/4 inch (6 mm) clearance, at penetrations of building assemblies. Interrupt insulation where required by fire ratings.
3. Extend floor sleeves to 2 inches (50 mm) above finished floor and seal watertight.
4. For below-grade penetrations and where indicated, provide watertight link-type pipe seals.
5. Secure sleeves in place, and caulk, grout or firestop into the building assembly.
6. Provide split chrome or painted escutcheons where exposed to occupancy.

Q. Provide clearance for installation of insulation and access to valves and fittings.

R. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Division 08 Section "Access Doors and Frames."

S. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

T. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to **Division 09 Section "Painting.**"

U. Insulate piping and equipment; refer to Division 23 Sections "HVAC Piping Insulation" and "HVAC Equipment Insulation"

V. Fully charge completed system with refrigerant after testing.

W. Provide electrical connection to solenoid valves. Refer to Division 26 - Electrical.

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Division 01 Section “Quality Requirements.”

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psig (1470 kPa). Perform final tests at 27 inches of mercury (92 kPa) vacuum and 200 psig (1470 kPa) pressure using electronic leak detector. Test to no leakage.

D. Evacuate the system as required by Codes and by equipment manufacturer, including a vacuum test at 0.02 inches of mercury (500 microns). The system shall be valved off and tested for 2 hours with a pressure rise of no more than 0.002 inches of mercury (50 microns).

3.4 SYSTEM STARTUP

A. Lubricate motors and other moving parts as necessary before operating them.

B. Charge the system with liquid refrigerant into the low pressure side of the system, where the liquid will evaporate. Expel air from the system. Operate the compressor, condenser, water cooling pumps and evaporator fans during charging. Monitor compressor discharge pressure. Monitor oil levels for a period of 24 hours.

C. Coordinate control setpoints and wiring prior to startup.

D. Change suction filter elements if the pressure drop exceeds 1 Psi (6.9 kPa) after the initial 24 hours of operation. Change suction wax removal cores to filter elements after system cleanup.

E. Adjust expansion valve superheat using a thermistor or thermocouple temperature sensor at the bulb location and a pressure gauge at the external equalizer line (or the compressor). Adjust under full system load, and again when the system stabilizes.

F. Check the system again after seven full days of operation.

G. Periodically clean strainers until no more accumulation occurs.

3.5 PROJECT CLOSEOUT

A. Indicate exact locations of buried piping conduits on As-Built Drawings.

B. Submit records of handling and disposal of refrigerant and oil to verify compliance with Federal, State, and local Codes and regulations.

C. Submit records of installed quantities of refrigerants and oils in each system. Submit manufacturer’s product sheets, MSDS, and instructions in the Operation and Maintenance Manuals.

END OF SECTION 232300

SECTION 232500 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleaning of piping systems.

B. Chemical feeder equipment.

C. Chemical treatment.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Division 23 Section “Hydronic Piping”: Placement of water coupon rack, by-pass (pot) feeder.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Division 01 Section “Summary”: Owner-furnished treatment equipment and chemicals.

1.4 RELATED SECTIONS

A. Division 23 Section “Instrumentation and Controls For Mechanical Systems.”

B. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.5 REFERENCES

A. NFPA 70 - National Electrical Code.

1.6 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

D. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

B. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience and approved by manufacturer.

1.9 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.

B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.10 MAINTENANCE SERVICE

A. Furnish service and maintenance of treatment systems for 1-year from Date of Substantial Completion.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.

C. Provide laboratory and technical assistance services during this maintenance period.

D. Include 2-hour training course for Owner's operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Schedule the course at Owner's convenience after start-up of systems.

E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.11 MAINTENANCE MATERIALS

A. Provide maintenance materials under provisions of Division 01 Section "Product Requirements."

B. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Chemical Treatment Systems Products, and Services:
   1. Barclay Water Management, Inc., Watertown, MA office.
   2. Nalco Company, Windham, ME office.

B. Chemical Treatment Products:
   1. Nu-Calgon.
   2. Culligan.
   3. H-O-H Water Technology, Inc.
   4. Wesco Chemicals, Inc.

2.2 MATERIALS

A. System Cleaner:
   1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
   2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

B. Closed System Treatment (Water):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
   2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
   3. Conductivity enhancers; phosphates or phosphonates.

2.3 BY-PASS (POT) FEEDER

A. Manufacturers:
   1. Neptune Chemical Pump Co.: Model DBF-5HP.
   2. General Treatment Products, Inc.: Model DB5-QC-AR.
   3. Griswold Water Sytems: Model DB-5-GE-CS-Z-230.
   4. Wheatley - a division of Global Flow Products: Model VFT-005-0.
   5. No substitutions.

B. 5.0 gal (18.9 l), with quick opening cap (coarse threaded or Victaulic grooved coupling type), domed (convex) top and bottom, for working pressure of 200 psig (1370 kPa) at 200 degrees F (93 degrees C), fittings as required for piping configuration indicated on the Drawings, minimum of 3/4 inch (19 mm) FPT inlet, outlet, and bottom drain.

C. Provide fitting for air vent ball valve, either on the feeder or on piping, to allow release of pressure before opening the cap.

D. Plug any unused openings.

E. Open fill funnel is not desired. If a fill funnel is provided, provide a lockable ball valve, and padlock with 3 keys, to prevent tampering. If more than one lock is provided, they shall be keyed alike. Furnish keys to the Owner.

F. Install above the floor with legs or pedestal. For feeders which don't have integral legs or pedestal, provide additional support or concrete housekeeping pad.

PART 3 - EXECUTION

3.1 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

A. Concentration:
   1. As recommended by manufacturer.
   2. 1 pound per 100 gallons (1 kg per 1000 L) of water contained in the system.
   3. 1 pound per 100 gallons (1 kg per 1000 L) of water for hot systems and 1 pound per 50 gallons (1 kg per 500 L) of water for cold systems.
   4. Fill steam boilers only with cleaner and water.

B. Chilled Water Systems:
   1. Circulate for 48 hours, then drain systems as quickly as possible.
   2. Refill with clean water, circulate for 24 hours, then drain.
   3. Refill with clean water and repeat until system cleaner is removed.

C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.

D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

E. Remove, clean, and replace strainer screens.

F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

END OF SECTION 232500

SECTION 233013 – HVAC AIR DUCT CLEANING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air duct cleaning to include site preparation, source removal of dirt and debris, chemical surface treatment, duct openings, sealing and repair of duct insulation.

1.2 QUALITY ASSURANCE

A. The publications listed below form a part of this Specification to the extent referenced.

B. The publications are referred to in the text by the basic designation only.

C. NADCA Standard ACR 2013 for Assessment, Cleaning, and Restoration of HVAC Systems.

D. SMACNA Standards, HVAC Duct Construction Standards - Metal and Flexible (HVACDCS).

1.3 AIR DUCT CLEANING CONTRACTOR

A. Obtain the services of a qualified HVAC system cleaning Subcontractor to perform the air system cleaning as specified herein. Prior to commencing work under this Section of the Specifications, the testing organization shall have been approved by the Engineer. The criteria for determining qualifications shall be recent experience with similar projects done in accordance with National Air Duct Cleaners Association (NADCA) Standard ACR 2013.

1.4 SUBMITTALS

A. Submit experience list of similar projects.

B. Submit cleaning methodologies and material safety data sheets (MSDS) for chemicals to be used.

PART 2 - PRODUCTS

2.1 APPROVED DUCT CLEANING AGENCIES

A. Air Duct Klean, a division of Kitchen Klean, Inc., Epsom, NH - Tel # 800-736-4484

B. Cochrane Ventilation, Inc., Wilmington, MA - Tel # 800-974-9055

C. Haley’s Metal Shop, Inc., Biddeford, ME - Tel # 207-284-8571

D. Or approved equal.

2.2 PROCEDURES FOR AIR DUCT CLEANING

A. Perform work in accordance with NADCA Standard ACR 2013.

B. Supply materials for cleaning, repairing and inspection work including HEPA filtered collection systems, rotary brushes, air lances, mechanical agitators, fiber optic borescopes, vacuums, or other equipment and materials necessary to perform work specified. Furnish materials and equipment that are of a reputable manufacturer. Submit Material Safety Data Sheets for chemicals utilized in this project prior to product usage.

C. Access points shall be constructed of metal or plastic. Points shall be installed in a hole that is a minimum of 1 inch in diameter. Access points shall be reusable by Owner's maintenance staff. If external insulation is removed during the installation process, repair the open edges with a similar color repair tape (to the best extent possible).

D. Access doors shall consist of 3 layers of precision stamped 0.030-inch (23 gauge) (0.78 mm) electro-galvanized zinc-plated steel. The inside door shall consist of 2 layers of metal which are spot-welded together at the rim, encapsulating high density fiberglass insulation - UL classified FHC 25/50. The inside surface shall be smooth to reduce friction. The gasket which seals the door from the inside to the duct shall consist of a closed cell neoprene gasket which is UL 94 HF-1 listed with a service temperature of (ASTM D746) 70 to 220 degrees F (21 to 104 degrees C). The gasket shall be permanently bonded to the inside of the door to eliminate leakage. Conical springs shall be installed over the bolts, between the inner and outer door, to facilitate opening. Access shall be accomplished by use of high impact polypropylene molded knobs that have threaded brass inserts to eliminate thread stripping. Knobs shall be easy to turn by hand without wrenches. Door shall be tested to 20 in. WG (4.9 kPa) with no leakage noted. The installed access door shall be a permanent reusable access system that can be utilized for further inspections and/or repair.

E. Clean outdoor air plenums thoroughly. Vacuum or scrape inlet louvers, bird screens, dampers, turning vanes, moisture deflectors and other irregular surfaces, if necessary.

F. Vacuum the interior surfaces of the mixing chamber, removing gross debris. Sanitize the plenum, drains, and dampers with an EPA registered sanitizing agent.

G. Remove filters from the rack and prepare the area for cleaning. If filters are to be reused, clean and store in a dry area. Scrape debris from the filter rack area. Vacuum clean and/or pressure wash the filter rack system (ensure proper drainage is available before cleaning). Sanitize the filter rack system.

H. Remove standing water from the condensate pans or base of the plenum. Clear the drains associated with each pan, ensuring proper operation before cleaning. If fins are bent prior to cleaning, straighten fins utilizing a coil combing system after the cleaning process. High-pressure-water clean the coil section. First apply a biodegradable cleaning solution to penetrate into the coil section (follow manufacturer's guidelines). Repeat process on the other side of the coil section. Rinse each side. Continue process until clear water can penetrate coil section on entire coil face. After cleaning, sanitize coil section with an approved biocide-utilizing atomizing system. Report existing damage to the coil section or improper drainage in writing to the Architect.

I. Vacuum clean the fan housing and motors to remove debris. Hand scrape fan impellers and remove loose debris from the internal surfaces of the fan housing. Take precautions not to damage the impellers, alter blade shape or weight, or affect impeller balance.

J. Vacuum the internal surfaces of the plenums associated with the air handler. Remove gross

debris and other debris or excess equipment that may be present. In severe cases, the internal plenum surface may be high-pressure-water cleaned to remove grease, dirt, and debris. After interior surfaces and equipment are cleaned, sanitize the unit with an approved sanitizer utilizing an atomizing system.

PART 3 - EXECUTION

3.1 DUCTWORK CLEANING PROCESS

A. Equipment used shall be portable and sized to enter these areas. Coordinate electrical requirements through the Owner's electrical or maintenance department, as appropriate. Modifications to accommodate electrical requirements will be at the Contractor's expense.

B. Address each main duct section by first securing debris collection equipment to diffuser branch ducts or to an isolated section of main trunk ductwork.

C. Collectors shall be fan powered, high velocity dust and particle collection systems which will be utilized in areas where debris is being removed from the system. Equip collection systems with HEPA filtration (99.97 percent collection efficiency for 0.3 micron size). The collection systems shall be self-contained, with appropriate components to adequately prevent dirt and debris loosened from upstream duct mains and branches during cleaning operations from entering the diffuser plenums by capturing this debris within the collection device. The components of the collector that connect the base collection unit to the duct or diffuser plenum shall be air-tight and reusable from area to area.

D. Agitate the loose debris on the interior surfaces to introduce the debris into the air flow produced and controlled by the collection systems. Collection systems shall be able to produce a minimum of 0.42 in. WG (104 Pa) in the targeted section of duct to be cleaned. Debris shall travel through the ductwork to the point of collection.

E. Ductwork shall be cleaned by inserting air powered brush systems, air powered extended whip sections, electric rotary brush systems, skipper balls, or air sweeps through the installed access. Utilize equipment that will best contact surfaces of the duct regardless of shape or size.

F. Where duct is large enough and able to support the weight of a worker, hand tools and vacuums may be used. Install collection equipment in the section of duct to be cleaned by hand as a precautionary measure to catch any residual debris.

G. Whenever the grilles, registers, or diffusers are removable, they shall be removed, washed, rinsed, dried, and then replaced. If for any reason they are not removable, they shall be vacuumed in place. Contractor is not responsible for existing improperly installed grilles, registers, and diffusers; for example, grilles, registers, or diffusers screwed directly into porous ceiling tiles. Whenever possible, reinstall grilles, registers, and diffusers that were originally improperly installed to the best of the Contractor's ability in a timely manner. Report inability to reinstall grilles, registers, and diffusers in a proper manner in writing to the Architect.

H. Perform sanitizing of the air distribution system as required using an air sprayer or fogging device to cover the interior surfaces of the ductwork. Make certain that surfaces are kept wet for at least 10 minutes. Sanitizing fluid shall be registered with the Environmental Protection Agency. Sanitizing shall be accomplished through installed access doors and access points.

I. Perform duct cleaning and sanitizing only at a time when the targeted air distribution systems can be shut down and the facility cleared of occupants. Schedule the duct cleaning for an appropriate time. Note: "Occupants" does not include maintenance or supervisory personnel who take proper precautions.

J. Replace, at no additional cost to the Owner, any ceiling tiles or gridwork that is/are damaged during the ductwork cleaning process.

K. De-activate and re-activate duct smoke detectors during the duct cleaning process. Coordinate with and receive approval from the local Fire Department and/or local Code Enforcement Officials prior to the de-activation and re-activation of smoke detectors.

3.2 PROJECT ASSESSMENT

A. Provide inspection access to the Architect any time during or immediately after the cleaning of the air delivery system or systems. Inspection shall be visual in nature by means of installed access doors and points with the benefit of a fiber optic borescope where necessary. Meet the guidelines set down in the NADCA Standard ACR 2013 for Assessment, Cleaning, and Restoration of HVAC Systems.

B. Perform the NADCA vacuum test and submit report for approval.

C. Show exact locations of access doors installed as part of the cleaning process on the Record Drawings.

END OF SECTION 233013

SECTION 233113 – HVAC DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Metal Ductwork.

1.2 RELATED SECTIONS

A. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Sleeves.

B. Division 23 Section “Duct Insulation”: External insulation and duct liner.

C. Division 23 Section “HVAC Air Duct Cleaning.”

D. Division 23 Section “Air Duct Accessories”

E. Division 23 Section “Air Outlets and Inlets.”

1.3 REFERENCES

A. ASTM

B. AWS D9.1 - Welding of Sheet Metal.

C. NBS PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.

D. NFPA

E. SMACNA

F. UL.

1.4 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes is permitted except by written permission from the Architect. Size proposed substitutions of round ducts in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures”.

B. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration. Submit prior to start of work.

C. Product Data: Provide data for duct materials, duct liner and duct connectors.

D. Test Reports: Submit testing apparatus, procedures, and preliminary forms prior to performing

tests. On final reports, indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section "Closeout Procedures."

B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Indicate additional fittings used.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA HVACDCS.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.9 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Flexible Ducts:
   1. Flexible Technologies Group - Thermaflex product line.
   2. Buckley Associates - Flexmaster Triple-Lock Buck Duct product line.
   3. No substitutions.

B. Plastic Drawbands:
   1. Panduit.
   2. Thomas and Betts.
   3. Tyton.

C. Tape for Flexible Ducts:
   1. Ideal Tape Co., division of American Biltrite Inc.
   2. 3M Company.
   3. Nashua Tape Products, division of Berry Plastics Corp.

4. Venture Tape Corporation.
5. No substitutions.

D. Manufactured Ductwork - Round and Flat Oval:
1. McGill AirFlow LLC, a subsidiary of United McGill Corporation.
2. Aero Heating & Ventilating, Inc.; Portland, ME.
3. Air Purchases, Inc.; Manchester, NH – spiral duct lengths.
4. Atlantic Air Products LLC; Bow, NH.
5. Hahnel Brothers; Bangor and Lewiston, ME.
6. Hranec Corporation; Uniontown, PA.
7. Lindab, Inc. – duct fittings only.
8. Macy Industries, Inc.; Hookset, NH. [http://www.macyindustries.com/]
9. Monroe Metal Mfg. Inc.; Monroe, NC.
10. Northeastern Sheet Metal Inc.; Goffstown, NH.
11. Semco Inc., division of the Flakt Woods Group.
12. S.G. Torrice Co.; Wilmington, MA – spiral duct lengths.
13. Sheet Metal Connectors Inc.; Minneapolis, MN.
14. Spiral Manufacturing Co. Inc.; Minneapolis, MN.
15. Total Air Supply; Nashua, NH – spiral duct lengths.
16. No substitutions.

E. Manufactured Ductwork - Transverse Duct Connection System:
1. Ductmate.
2. HFC Enterprises; Baldwin Park, CA – Dura Flange product line, for round and flat oval ducts only.

F. Sealants:
1. Hardcast, a division of Carlisle Corporation.
2. 3M Company.
3. Ductmate.
4. Foster.
5. McGill AirSeal LLC, a subsidiary of United McGill Corporation.
6. Mon-Eco Industries, Inc - Eco product line.
7. Polymer Adhesive Sealant Systems.

2.2 MATERIALS

A. Galvanized Steel Ducts:
1. Steel sheet metal components of galvanized ductwork in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating (G90 minimum for outdoor or moist applications) conforming to ASTM A653 rating system and tested in accordance with ASTM A90.
2. Provide paint-grip exterior surfaces for exposed ducts, where available.
3. Sheet metal gauge shall be not less than 26 gauge (0.56 mm).

2.3 FLEXIBLE DUCTS

A. Insulated Flexible Ducts:
1. Fabric-Core Flexible Ductwork:
a. Thermaflex Model M-KC.
b. Greenguard certified.

c. UL 181, Class 1, heavy fiberglass cloth fabric supported by helically wound spring steel wire; fiberglass insulation; reinforced metalized vapor barrier film.
d. Pressure Rating: 10 inches WG (2.5 kPa) positive and 2.0 inches WG (500 Pa) negative.
e. Maximum Velocity: 6000 fpm (30.4 m/sec).
f. Temperature Range: -20 to 250 degrees F (-28 to 121 degrees C).

B. Non-Insulated Flexible Ducts:
1. Semi-Rigid Flexible Aluminum Ductwork:
a. Flexmaster Triple-Lock Buck Duct - Bare.
b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
c. Pressure Rating: 12 inches WG (2988 Pa) positive for all sizes, 12 inches WG (2988 Pa) negative for sizes thru 16 in. diameter (406 mm), 8 inches WG (1992 Pa) negative for sizes 18 in. (457 mm) and 20 in. (508 mm) diameter.
d. Maximum Velocity: 5500 fpm (27.9 m/sec).
e. Inside bend radius: Minimum one diameter.
f. Temperature Range: -40 to 250 degrees F (-40 to 121 degrees C).
g. UL 181, Class 0 air duct.
h. Meets NFPA 90A and 90B standards.

C. Return and Exhaust: Use either semi-rigid flexible aluminum type (insulated or bare), or fabric-core type (insulated). Non-insulated fabric-core type does not have adequate negative pressure rating.

2.4 ACCESSORIES

A. Drawbands for Flexible Ducts:
1. Stainless Steel: ½ inch (13 mm) wide with screw-driven worm gear.
2. Plastic: Panduit PLT5H or PLT8H; Thomas and Betts Dukt-Rap, VAL-26-50, or VAL-275X-25; or Tyton T150L or LX. Install with manufacturer's lever-action tightening tool.

B. Tape for Flexible Ducts: Ideal-Seal 587A/B, UL 181B-FX listed, aluminum foil with pressure-sensitive acrylic adhesive, -20 to 250 degrees F (-28 to 121 degrees C) temperature range, 25.0 lb/in. width (109.4 N/25.4 mm width) tensile strength.

C. Fasteners: Rivets, bolts, or sheet metal screws.

D. Sealants: See Duct Sealant portion of this Specification.

E. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.5 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVACDCS, as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

B. SMACNA Duct Construction Manuals:
   1. The SMACNA recommendations shall be considered as mandatory requirements.
   2. Substitute the word "shall" for the word "should" in these manuals.
   3. Where the Contract Specifications differ from SMACNA recommendations, the more stringent requirements (as determined by the Architect) shall take precedence.
   4. Details on the Contract Drawings take precedence over SMACNA standards.

C. Sheet metal shall be galvanized steel as specified in Part 2 paragraph “Materials” in this Section, unless otherwise indicated or specified.

D. Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
   1. Where space is too restricted for full-radius elbows, provide mitered (square-throat) elbows with single wall turning vanes. Do not use air foil turning vanes.
   2. Mitered elbows in round or flat-oval ductwork shall be factory-manufactured.
   3. Radiused elbows with throat radius 1/2 times width of duct (centerline radius 1 width of duct) may be used instead of mitered elbows, but only where space is too restricted for full radius.
   4. Fittings not conforming to these requirements will be ordered removed and replaced with proper fittings.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence or convergence (per side) wherever possible; maximum 30 degrees divergence (per side) upstream of equipment and 45 degrees convergence (per side) downstream.

F. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.

G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. Longitudinal locks or seams known as “button-punch-snap-lock” and other “snap-lock” types will not be permitted in rectangular duct. Snap-lock longitudinal seams may be used on round ducts up to 8 inches diameter, with screws provided to secure the seams at 24 inches (609 mm) on center maximum spacing.

I. Exposed Ducts: Select and handle materials with care for a neat appearance. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable.

2.6 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufactured ductwork and fittings listed below are acceptable alternatives to standard ductwork systems. For exposed round and flat oval ductwork, factory-manufactured ductwork and fittings are required.

B. Manufacture in accordance with SMACNA HVACDCS, and as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

C. Exposed Round and Flat Oval Ductwork: Shall be manufactured ductwork by one of the listed

manufacturers.

1. Spiral Ductwork Acceptable Products:
    a. McGill Airflow: Standard Uni-Seal product line (smooth surface between spiral lockseams) or Uni-Rib product line (one standing seam reinforcement between each pair of spiral lockseams).
    b. Monroe Metal Inc.: Standard spiral product line (smooth surface between spiral lockseams). V-Rib product line is not allowed.
    c. Other Manufacturers: Standard spiral product line (smooth surface between spiral lockseams).
    d. Ductwork and fittings shall be products of a single manufacturer.

D. Exposed Ducts:
1. Select and handle materials with care for a neat appearance.
2. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable. Joint connections on flat oval ducts 42 inches (1.07 m) and wider shall be flanged type to ensure tight fit and good appearance.
3. Provide exterior reinforcing only where required, with prior approval from the Architect.
4. External reinforcement of flat-oval ducts shall be full-perimeter angle rings. Straight angles along flat sides only are not allowed.

E. Galvanized and stainless steel sheet metal used in fabrication shall be not less than 26 gauge (0.551 mm) thickness. Aluminum shall be not less than 0.025 in. (0.635 mm) nominal thickness. This requirement supersedes SMACNA requirements.

F. Round and Flat Oval Duct and Fittings:
1. Shall be suitable for at least 4 in. WG (996 Pa) positive pressure and 2 in. WG (498 Pa) negative pressure in accordance with SMACNA HVACDCS standards. This is a minimum; provide higher ratings where required.
2. Fittings shall be fabricated of sheet metal at least one gauge heavier than straight duct of the same size.
3. Fittings shall be factory-sealed so that no field sealing of joints between gores or segments is required. Acceptable methods of construction are fully welded, spot-welded with inner sealant, or standing-seam crimped joints.

G. Radiused Elbows in Round and Flat Oval:
1. In exposed ductwork shall be non-adjustable type, factory-sealed.
2. In concealed ductwork may be adjustable type, with full long radius as detailed on the Drawings. Short-radius elbows are not allowed.
3. Shall be constructed of the following minimum number of segments or gores: 90-degree: 4 gores; 60-degree: 3 gores; 45-degree: 3 gores; 30-degree: 2 gores; 22-1/2-degree: 2 gores.
4. 1-piece stamped elbows are acceptable up to 12 inches (305 mm) diameter. Pleated elbows are acceptable up to 10 inches (254 mm) diameter.

H. Mitered Elbows in Round and Flat Oval:
1. Available in both 90-degree and 45-degree elbows.
2. Shall have minimum number of welded single-wall vanes as follows (size is duct width in plane of bend):
    a. 3 to 9 inch (76 to 229 mm): 2.
    b. 10 to 14 inch (254 to 356 mm): 3.
    c. 15 to 19 inch (381 to 483 mm): 4.

d. 20 to 60 inch (508 to 1524 mm): 5.
e. Larger Sizes: 12-inch (305 mm) maximum spacing.

I. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.

J. Transverse Duct Connection System: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips. Product shall be Ductmate factory-manufactured connectors, or field-formed flanges using a specialized machine.

2.7 PRESSURE CLASSIFICATION

A. Ratings as indicated on the Drawings or as specified. See Ductwork Pressure Class Schedule in Part 3 of this Section.

B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus 25 percent.
1. If 4 dampers (of any type) or fewer can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fans.

2.8 DUCT SEALING

A. Seal ductwork as outlined in the SMACNA HVACDCS. Seal ductwork to a minimum of class A (transverse joints, longitudinal seams, and duct wall penetrations), regardless of pressure class.

B. Seal ductwork systems as required to ensure that maximum duct leakage does not exceed that allowed by the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual. Allow sealant to dry in accordance with manufacturer’s requirements of time and environmental conditions before ductwork systems are pressurized.

C. Existing Ductwork: Seal existing ductwork served by, and/or connected to, the equipment furnished under Division 23, and ductwork as indicated on the Drawings. Contractor shall be responsible to field-verify quantities and sizes. Provide access to existing ductwork as required for complete sealing. Remove existing finishes and loose existing sealants as required for proper adhesion of sealant.

D. Duct sealing materials used shall be non-flammable and non-combustible in both liquid and solid states.

E. Seal Pittsburgh hammered lockseams by flooding the joint with sealant prior to assembly.

F. Seal exposed ducts by applying mastic-type or gasket-type sealer just before the joint or seam is made; remove excess sealant for a neat appearance.

G. Fill (with matching duct material such as sheet metal) any gaps in duct which exceed the recommendations of the sealant manufacturer, and in no case shall liquid or mastic sealant be used to fill gaps or openings which exceed 1/8 inch (3.2 mm) in any direction. Verify that system air pressure acting on a wide gap will not exert enough force to damage or loosen the sealant.

H. Materials for Sealing:
   1. Hardcast: Flex-Grip 550 or Iron-Grip 601 mastic.
   2. Hardcast: gypsum-based tape and mastic, waterproof type when used on moist-air exhaust or in humid or outdoor locations.
   3. Ductmate: Flanged lateral joints with gaskets.
   4. Ductmate: PROseal.
   5. Foster: Duct-Fas or Safetee mastic sealant. Duct-Fas is UV resistant and recommended for applications exposed to sunlight.
   6. Mon-Eco: Eco-Duct Seal 4450 (red color) or 4452 (grey color). Use grey color where ducts will be unpainted and exposed to public view.
   7. Polymer Adhesives Sealant Systems: Airseal No. 11 premium sealant.

2.9 UNIFORMITY OF MATERIALS

A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section “Instrumentation and Control for Mechanical Systems”; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.

C. Install ducts in accordance with SMACNA HVACDCS.

D. Duct Hangers and Supports: SMACNA HVACDCS, Section 4. Hang ducts up to and including 36 inches (914 mm) in width by a minimum of 1 in x 16 ga (25 mm x 1.61 mm) flat straps on each side of the duct on 4 ft (1.22 m) centers, bent under bottom of duct a minimum of 2 inches (50 mm) and securely fastened to duct. Hang ducts larger than 36 inches (914 mm) in width by 3/8 inch (9.5 mm) steel rods and 2 x 2 x 1/4-inch (50x50x6.3 mm) steel angle trapeze hangers, spaced 4 ft (1.22 mm) on center. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements.
   1. Ducts with Extra Weight Such As Lead Lining or Lagging: Include the extra weight in determination of suitable hangers and supports.

E. Attach supports only to structural framing members and non-metal deck concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.

F. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

G. “Fishmouth” duct connections are not allowed.

H. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.

I. Exposed Ducts:
   1. Handle with care for a neat appearance. Repair or replace dented or damaged ductwork as required by the Architect. Select hangers for appearance, and to prevent sagging or distortion of duct.
   2. Remove labels attached to ducts before receiving paint.

J. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

K. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

L. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.

M. Use double nuts and lock washers on threaded rod supports. Strap hangers shall be minimum 16 gauge (1.50 mm) x 1 inch (25 mm) galvanized straps. Hanger and support components including but not limited to "unistrut" shall be galvanized steel except that where other duct materials are used, the hanger materials shall be compatible and non-corrosive to the duct. Wire hangers are not acceptable.

N. Flexible Ducts:
   1. Connect diffusers or light troffer boots to low pressure supply ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
   2. Minimum bend radius shall be one and one half times the duct diameter. Support the bend to maintain this radius.
   3. Bends shall not exceed 45 degrees.
   4. Connect flexible ducts to metal ducts with 2 turns of duct tape and metal draw bands. Plastic drawbands may be used if they are installed using the band manufacturer's lever-action tightening tool. On insulated flexible ducts, provide an additional seal of tape and drawband on the insulation's vapor barrier.

O. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

P. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Do not start ducted air moving equipment until construction is completed to a stage where airborne construction dust is no longer present. At the time of substantial completion, the entire air distribution system shall be turned over to the Owner clear of construction dust and debris. If the interior surfaces of any ducted air moving equipment or the interior surfaces of any portion of the ductwork distribution system are found, as determined by the Architect, to contain significant construction dust and debris, the entire air distribution system shall be cleaned in accordance with Division 23. If proper precautions are taken to prevent construction dust and debris from entering the ductwork during construction and if the Architect finds all ductwork to be free from such dust and debris, air duct cleaning shall not be required.

Q. For fresh air intake and exhaust plenums connected to louvers or brick or block vents, pitch bottom of plenums down to bottom of louver at minimum 1/4 inch per foot (2 percent). Seal connections and joints on bottom of plenums watertight with mastic. Connect bottom of plenum to top-inside edge of bottom louver blade or waterstop as detailed on the Drawings, to ensure positive drainage. Provide ¾" drain connection at the lowest point upstream of pitched duct connection to louver. Pipe to nearest floor drain.

R. Install duct-mounted components furnished under other Sections of this Specification, such as smoke dampers, control dampers, control sensors, and smoke detectors. Install with straight lengths of duct as required for proper operation. Provide access at such components as required. Install in accessible locations for maintenance; notify the Architect if a location indicated or selected requires addition of access by other trades.

END OF SECTION 233113

SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Dampers:
   1. Volume Control Dampers.

B. Drip Pans.

C. Duct Access Doors.

D. Duct Sleeves, Prepared Openings and Closure Collars.

E. Duct Test Holes.

F. Flexible Duct Connections.

G. Turning Vanes.

1.2 RELATED SECTIONS

A. Division 23 Section “Common Work Results for HVAC”

B. Division 23 Section “Identification for HVAC Piping and Equipment.”

C. Division 23 Section “Instrumentation and Control for Mechanical Systems.”

D. Division 23 Section “Metal Ducts.”

E. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.3 REFERENCES

A. ASTM C423-02a - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

B. ASTM E477-99 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

D. NFPA 92A - Smoke Control Systems.

E. NFPA 70 - National Electrical Code.

F. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.

G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible, Third Edition - 2005

(HVACDCS).

H. SMACNA - Seismic Restraint Manual - Guidelines for Mechanical Systems (SRMGMS).

I. UL 33 - Heat Responsive Links for Fire-Protection Service.

J. UL 94 - Safety of Flammability of Plastic Materials for Parts in Devices and Appliances Testing.

K. UL 555 - Fire Dampers and Ceiling Dampers.

L. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

M. UL 1995 - Heating and Cooling Systems.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

C. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section “Closeout Procedures.”

B. Record actual locations of access doors and test holes.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 Section “Product Requirements.”

B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL

A. Steel sheet metal components of accessories in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating conforming to ASTM A653 rating system and tested in accordance with ASTM A90. Provide paint-grip exterior surfaces for exposed ducts, where available.

2.2 DAMPERS

A. Manufacturers:
   1. Ruskin.
   2. Air Balance, Inc.
   3. Arrow.
   4. Cesco.
   5. Greenheck.
   6. NCA.
   7. Tamco.
   8. Ventex.
   9. Vent Products, Inc.
   10. No substitutions.

B. Volume Control Dampers:
   1. Factory-fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
   2. Shop fabrication is permitted for single blade dampers only.
   3. Height is the dimension perpendicular to the blade rod or shaft. Width is the dimension parallel to the blade rod.
   4. Single Blade Dampers: For duct sizes (height x width) up to 7 x 30 inch (175 x 760 mm). When height or width exceeds its respective maximum, provide multi-blade damper.
   5. Multi-Blade Damper: Opposed blade pattern with maximum blade sizes (height x width) 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
   6. End Bearings: Except in round ductwork 6 inches (150 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide retainer clips or other devices to prevent bearings from pulling out. For single-blade dampers, plastic bearings are allowed.
      a) Manufacturers:
         1) Duro Dyne.
         2) Elgen Manufacturing.
         3) Rossi.
         4) Ventfabrics.
      b) Snap-in Plastic Bearings for Single-Blade Dampers: Designed to push into hole in sheet metal, with retaining tabs. Flame Retardant, Glass Reinforced, “Zytel” polymer by Dupont, conforming to UL 1995 and UL 94 with the required flammability rating of 5VA or lower. Acceptable materials include Polyamide 66 (PA66) (glass-reinforced Dupont Zytel), nylon and acetyl. Submit manufacturer’s verification of the suitability of these bearings for the application, including operating pressures and temperatures.

7. Quadrants:
    a) Manufacturers:
        1) Duro-Dyne.
        2) Elgen Manufacturing.
        3) Rossi.
        4) Ventfabrics.
    b) Duro-Dyne Specline SR and SRH series; Quadline series; or Stampline dial regulators and wedge-loc regulators. Or equal by Elgen, Rossi, or Ventfabrics. Factory-manufactured dampers shall have damper manufacturer's choice of quadrant equal to the Duro-Dyne products specified.
    c) Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulators shall include lever handle, locking wing nut and graduated indicator dial. Provide shaft seals, bushings, or gaskets for duct penetrations. Quadrants without these features are not allowed.
        1) Rossi Everlock Regulators: Locking lever handle of Polyamide 66 (PA66) (glass-reinforced Dupont Zytel) plastic, thumb trigger with stainless steel spring, with at least 9 latching positions in a 90 degree rotation.
    d) On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters, with open space to run insulation through.
    e) Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends, with a single rod so that either regulator will control the entire damper.
8. Provide required operating wrenches for balancing, and furnish to the Owner at project completion.

2.3 DUCT ACCESS DOORS

A. Manufacturers:
1. Standard Doors:
    a) Ruskin.
    b) Air Balance, Inc.
    c) Arrow.
    d) Buckley Associates.
    e) Cesco.
    f) DuctMate.
    g) Greenheck.
    h) Nailor.
    i) Vent Products, Inc.
    j) Shop fabricated.
2. Medium and High-Pressure Doors:
    a) Ruskin.
    b) DuctMate.
    c) Greenheck.
    d) Nailor.
    e) No substitutions.

B. Fabricated in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings. Standard access doors and access doors for grease ducts may be shop-fabricated. Pressure rating shall be equal to the rating of the associated ductwork; see Part 3 Division 23 Section "Metal Ducts" for schedule of pressure classes.

C. Standard Doors: Removable, with retainer chain. Rigid and close-fitting with sealing gaskets

and quick fastening locking devices. For insulated ductwork, install minimum 1 inch (25 mm) thick insulation with galvanized steel sheet metal airstream-side cover.

1. 16 inches (406 mm) Square and Smaller: Secure with two sash locks.
2. Over 16 inches (406 mm), up to 24 inches (610 mm) Square: Provide four sash locks.
3. Larger Sizes: Hinges and two compression latches with outside and inside handles.
4. Clamping-type doors with knob handles, as manufactured by Ductmate, may be substituted for standard sizes.
5. Material: Galvanized steel in galvanized steel ductwork. Stainless steel in stainless steel ductwork. Aluminum as manufactured by Arrow in aluminum ductwork.
6. Provide in negative-pressure systems, and in positive-pressure systems with specified pressure class at or below 2 in. WG (498 Pa).

D. Medium- and High-Pressure Positive-Pressure Ducts:

1. Ruskin ADHP-3 high pressure access door rated up to 12 in. WG (2985 Pa), with spring latches to allow the door to open temporarily to relieve negative pressures.
2. Provide in positive-pressure systems with specified pressure class above 2 in. WG (498 Pa).

2.4 DUCT SLEEVES, PREPARED OPENINGS AND CLOSURE COLLARS

A. Duct Sleeves and Closure Collars: Fabricate from minimum 20 ga (1.0 mm) galvanized steel or equivalent thickness of aluminum, select material to match duct material. Where sleeves are installed in bearing walls, provide structural steel sleeves.

B. Prepared Openings: Provide 1 inch (25.4 mm) clearance between the duct and the sleeve.

2.5 DUCT TEST HOLES

A. Manufacturers:

1. Ductmate.
2. Carlyle Corporation.
3. Duro-Dyne.
4. Ventfabrics.

B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

C. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.6 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Ductmate.
2. Ventfabrics.
3. Duro-Dyne.
4. No substitutions.

B. Fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.

C. Connector: Fabric crimped into metal edging strip.
   1. Connectors shall be Ductmate PROFLEX Commercial series.
   2. Fabric: UL listed coated woven glass fiber fabric meeting the requirements of NFPA 90A and NFPA 701. Resistant to weather and most chemicals, fat, grease, and oil.
      a) Supply Ducts: Neoprene coated, minimum density 30 oz per sq yd (1.0 kg/sq m). Fire-retardant coating. Black color. Temperature range -40 to 200 degrees F (-40 to 93 degrees C).
      b) Exhaust Ducts Serving Fume Hoods: Hypalon coated, minimum density 24 oz per sq yd (0.8 kg/sq m). Flame proof coating. White color. UV and ozone resistant. Temperature range -40 to 250 degrees F (-40 to 121 degrees C).
   3. Net Fabric Width: Approximately 3 inches (75 mm) wide.
   4. Metal: 3 inch (75 mm) wide, 24 ga (0.6 mm thick).
      a) Supply Ducts: G-60 galvanized steel.
      b) Exhaust Ducts Serving Fume Hoods: Type 316 stainless steel.
   5. Connectors shall have double fold seams. Single fold seams (metal folded once only) shall not be accepted.

2.7 TURNING VANES

A. Manufacturers for Turning Vanes and Vane Rails:
   1. Ductmate Industries - PROrail 2 inch Turning Vane Rail.
   2. Duro Dyne - Junior Vane Rail.
   3. Hardcast, a division of Carlisle Corporation - Dyn-O-Rail Jr.

B. Factory-fabricated and factory-or-field-assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single thickness vanes for mitered elbows with change in direction of 45 degrees or greater, conforming to SMACNA HVACDCS single vane schedule for small vanes. Each vane shall form a 90 degree arc. Fill the entire duct cross-section with vanes. Orient leading edge of vanes parallel to the side of the duct (directed straight into the entering airstream).

C. Turning vanes shall be minimum 16 gauge (1.61 mm), regardless of gauges that are recommended by SMACNA. Double thickness turning vanes are not allowed.

D. Turning vanes in rectangular ductwork and shop-fabricated round ductwork shall conform with details on the Drawings. If not detailed, the SMACNA detail for small-radius small-spacing single-thickness vanes shall be used.

E. Turning vanes in manufactured round and flat oval duct elbows shall be the duct manufacturer's standard size, spacing, and gauge, but must be single-wall and not less than 16 gauge (1.61 mm).

F. Material for vanes shall be the same as the duct sheet metal.

G. Factory-fabricated turning vane rails shall be a minimum of 24 ga (0.7 mm) and shall be the same material as the duct sheet metal.

2.8 UNIFORMITY OF MATERIALS

A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be

fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVACDCS. Refer to Division 23 Section “Metal Ducts” for duct construction and pressure class.

B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section “Instrumentation and Control for Mechanical Systems”; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.

C. Duct Hangers and Supports: SMACNA HVACDCS, Section 4.
   1. Flexible Ducts: Support ducts by hangers every 3 feet (0.9 m), unless supported by ceiling construction. Stretch flexible air ducts to smooth out corrugations, and long radius elbows, where possible, using a minimum length to make connections.
   2. Flexible Connectors: Provide flexible connectors between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc-coated steel clinch-type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.

D. Attach supports only to structural framing members and non-metal deck concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.

E. Access Doors:
   1. Provide duct access doors in horizontal return air, exhaust air and fresh air intake ductwork to facilitate the removal of accumulations of dust and combustible materials in accordance with NFPA 90A. Install access doors at maximum 20 foot (6 m) intervals and at the base of each vertical riser.
   2. Provide duct access doors for inspection, servicing, and cleaning before filters, before and after coils, before and after fans, before automatic dampers, at fire dampers, at smoke dampers, at combination fire and smoke dampers, at smoke detector sampling tubes (upstream of the sampling tube), at multiple blade volume dampers, at backdraft and counterbalanced dampers, and elsewhere as specified or as indicated on the Drawings. Provide at changes in direction of kitchen exhaust ductwork and as otherwise required for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as specified or as indicated on the Drawings. Review locations prior to fabrication.
   3. Access doors installed for access to fire dampers and fire/smoke dampers shall have one

side at least 12 inches long to allow two hand access. Provide identification with letters of minimum 1/2 inch (13 mm) height to indicate the presence of fire protection devices within. Conform with NFPA 90A and applicable Codes. Refer to Division 23 Section "Identification for HVAC Piping and Equipment" for labeling materials specifications.

F. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

G. Provide balancing dampers on high velocity systems where indicated. Refer to Division 23 Section "Air Terminal Units"

H. Provide balancing dampers on duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly. Where branch duct is completely above non-accessible wallboard ceiling and the Architect has not approved the use of access doors, duct mounted balancing dampers shall not be required.

I. For volume dampers located above suspended ceilings and in areas that are not visible to building occupants (e.g. mechanical rooms), provide fluorescent orange colored surveyor's tape. Permanently attach tape to damper handles and run tape down to 10 in. (254 mm) above ceiling or 12 in. (304 mm) below damper handle where ceilings do not exist (e.g. mechanical rooms).

J. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and support by vibration isolators. Staple and seal connections airtight. [For fans developing static pressures of 5.0 in. w.g. (1250 Pa) and over, cover connections with leaded vinyl sheet, held in place with metal straps.]

K. Duct Sleeves and Prepared Openings: Install for ducts passing through roofs, ceilings, walls and floors. Field determine the proper size and location of sleeves and prepared openings.
   1. Duct Sleeves: Allow one-inch (25 mm) clearance between duct and sleeve or one-inch (25 mm) clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
   2. Prepared Openings: Allow one-inch (25 mm) clearance between duct and opening or one-inch (25 mm) clearance between insulation and opening for insulated ducts, except at grilles, registers, and diffusers.

L. Closure Collars:
   1. Provide not less than 4 inches (100 mm) wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts. Grind smooth edges of collar to prevent tearing or puncturing insulation covering or vapor barrier.
   2. Where insulated ducts penetrate non-fire-rated walls, insulation shall be continuous through the closure collars and the closure collars shall be installed tight to the insulation.
   3. Where insulated ducts penetrate fire rated walls, insulate ducts on both sides of closure collars and seal points of contact between closure collar and insulation with vapor proof adhesive.
   4. Where ducts penetrate fire rated walls, provide fire proof sealant at closure collar. Refer to Division 07 Section "Through Penetration Firestop Systems," for fire proof sealant requirements.
   5. Secure closure collars to ducts with sheet metal screws at maximum 6 inch (152 mm) centers and secure closure collars to walls or floors with sheetrock screws, nails or other

appropriate fastener at maximum 6 inch (152 mm) centers.

6. Packing: Pack with non-combustible glass fiber insulation in spaces between sleeve/opening and duct/duct insulation. Cover or seal edges of packing to contain loose fibers.

M. Drain Connections, and Drain Lines: Provide coils with drain and drain connections. Where coils are sectionalized, with one section above the other, provide intermediate drain pans. There shall be no entrainment of water in air stream. Drain condensate from drain pans to the nearest floor drains or disposal points as specified or as indicated on the Drawings. Equip drain lines with U-traps and a seal height one-inch greater than the maximum static pressure rating of the fan system. Insure pans drain completely under operating conditions.

N. Provide duct test holes where indicated and required for testing and balancing purposes.

O. Provide interconnecting power and control wiring as required, in accordance with Division 26.

END OF SECTION 233300

This Page Intentionally Left Blank

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers/Grilles.

1.2 REFERENCES

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.

B. ADC 1062 - Certification, Rating and Test Manual.

C. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

D. AMCA 511 - Certified Ratings Program for Air Control Devices

E. ARI 650 - Air Outlets and Inlets.

F. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

G. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

H. ASTM E413 - Classification for Rating Sound Insulation.

I. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

J. NFPA 70 - National Electrical Code.

K. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittal Procedures.”

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets indicating type, size, application, rated airflow, noise level, pressure drop, and throw distance as applicable. Submit both manufacturer’s standard performance tables and graphs, AND tabulated selection data specific to this project. NOTE: Submittals without complete and sufficient information, to verify the performance specified and scheduled on the Drawings, shall be rejected.

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 Section “Closeout Procedures.”

B. Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate louver performance in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Diffusers, Registers, Grilles, and Drum Louvers:
1. Titus.
2. Anemostat.
3. Krueger.
4. Metalaire.
5. Price.

B. No substitutions.

2.2 RECTANGULAR CEILING DIFFUSERS

A. Type: Square and rectangular, multi-louvered directional diffuser to discharge air in pattern as indicated. Removable and interchangeable core for cleaning and changing patterns without tools.

B. Frame: Surface mount, inverted T-bar, snap-in, or spline type, as indicated and as required to be compatible with ceiling. In plaster ceilings, provide plaster frame and ceiling frame.

C. Fabrication: Steel or aluminum with baked enamel finish with color as schedule.

D. Accessories: Opposed blade damper and multi-louvered equalizing grid, with damper adjustable from diffuser face when schedule.

2.3 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch (13 x 13 x 13 mm) vanes in square grid pattern.

B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting. For suspended grid ceilings, provide channel lay-in frame for suspended grid ceilings.

C. Fabrication: Aluminum with factory enamel finish color as scheduled.

D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

C. Install outlets and inlets to ductwork with air tight connection.

D. Slope ducts or plenums at louvers, and at brick or block vents, to drain outward, and seal bottoms watertight.

E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

F. Paint ductwork visible behind air outlets and inlets matte black.

G. Surfaces exposed to view shall be clean, and free of stains, smudges, and scratches.

END OF SECTION 233700

This Page Intentionally Left Blank

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER GENERAL

1.1 SECTION INCLUDES

A. Condensing unit package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Refrigerant piping connections.

E. Motor starters.

F. Electrical power connections.

1.2 RELATED SECTIONS

A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”

B. Division 23 Section “Refrigerant Piping.”

C. Division 23 Section “Air Coils.”

D. Division 23 Section “Instrumentation and Controls for Mechanical Systems” - Sequence of Operation.

E. Division 26 “Electrical.”

1.3 REFERENCES

A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

C. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

D. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.

E. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

F. ASHRAE 90A - Energy Conservation in new Building Design.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

H. NEMA MG 1 - Motors and Generators.

I. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.

J. UL 303 - Refrigeration and Air-Conditioning Condensing, and Air-Source Heat Pump Equipment.

1.4 SUBMITTALS

A. Division 01 Section “Submittal Procedures”: Procedures for submittals.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections.

C. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Submit under provisions of Division 01 Section “Closeout Procedures”: Procedures for submittals.

B. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

A. Division 01 Section “Product Requirements”: Transport, handle, store, and protect products.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

C. Protect units on site from physical damage. Protect coils.

1.9 WARRANTY

A. Provide a 5 year warranty to include coverage for refrigerant compressors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Trane.

B. Daikin Applied (formerly McQuay).

C. Carrier.

D. York.

2.2 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver and screens.

B. Construction and Ratings: In accordance with ARI 210/240, ARI 365 and UL 207 and UL 303. Testing shall be in accordance with ASHRAE 14.

C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90A.

2.3 CASING

A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.

B. Mount starters and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.4 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 kPa), and dehydrate.

B. Coil Guard: PVC coat steel wire.

2.5 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection.

C. Motors as indicated, in compliance with Division 23 Section “Common Motor Requirements for HVAC Equipment.”

2.6 COMPRESSORS

A. Compressor: Hermetic scroll type.

B. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators. Internally isolate hermetic units on springs.

C. Lubrication System: Centrifugal oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.

D. Motor: Constant speed 3600 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.

E. Capacity Reduction Equipment: Suction valve unloaders, with lifting mechanism operated by electrically actuated solenoid valve, with unloaded compressor start; controlled from suction pressure.

F. Sump Oil Heater: Evaporates refrigerant returning to sump during shut down. Energize heater thermostatically when compressor is not operating.

2.7 REFRIGERANT CIRCUIT

A. Provide each unit with one refrigerant circuit piped to remote chiller evaporator. Refer to Division 23 Section "Refrigerant Piping."

B. For Each Refrigerant Circuit, Provide:
1. Filter dryer replaceable core type.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve for maximum operating pressure.
4. Insulated suction line.
5. Suction and liquid line service valves and gage ports.
6. Liquid line solenoid valve.
7. Charging valve.
8. Discharge line check valve.
9. Compressor discharge service valve.
10. Condenser pressure relief valve.

2.8 PLATE TYPE HEAT EXCHANGERS – BRAZED TYPE
1. Plates: Embossed with a specific heat transfer surface. Stainless steel Type 316.
2. Nozzles: Male NPT thread, stainless steel Type 316. [**Marine Stainless Alloy is available (for Steam, Sea Water and Ground Water)]
3. Mounting Studs: Threaded stainless steel Type 316, brazed or welded to outer plate.
4. Maximum Working Pressures and Temperatures: [As scheduled on the Drawings.
5. Temperature: 350 degrees F (176 degrees C).
6. U.L. Listed. ASME Certified with permanent metal ASME stamp or nameplate.

2.9 CONTROLS

A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, factory wired with single point power connection.

B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide Safety Controls Arranged So Any One Will Shut down Machine:
1. High discharge pressure switch (manual reset) [for each compressor].
2. Low suction pressure switch ([automatic] [manual] reset) [for each compressor].
3. Oil Pressure switch (manual reset).

D. Provide the Following Operating Controls:
   1. Five minute off timer prevents compressor from short cycling.
   2. Periodic pump-out timer to pump down on high evaporator refrigerant pressure.
   3. Low ambient temperature controls.
   4. Hot gas bypass sized for minimum compressor loading bypasses hot refrigerant gas to evaporator.
   5. Lead-lag switch to alternate compressor operation.
   6. Low ambient thermostat to lock out compressor at low ambient temperatures.

E. Provide Controls to Permit Operation down to 0ºF Ambient Temperature:
   1. Thermostat to cycle fan motors in response to outdoor ambient temperature.
   2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
   3. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
   4. Electronic control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.

F. Gages: Prepiped for suction and discharge refrigerant pressures and oil pressure for each compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

C. Provide for connection to electrical service. Refer to Division 26.

D. Install units on vibration isolation. Refer to Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

E. Install units on concrete base as indicated. Refer to Division 01 Section “Submittal Procedures.”

F. Provide connection to refrigeration piping system and evaporators. Refer to Division 23 Section “Refrigerant Piping.” Comply with ASHRAE 15.

G. Furnish charge of refrigerant and oil.

3.2 DEMONSTRATION AND INSTRUCTIONS

A. Division 01 Section “Closeout Procedures”: Demonstrating installed work.

B. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

C. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

D. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

E. Provide cooling season start-up, and winter season shut-down for first year of operation.

END OF SECTION 236200

SECTION 238216 - AIR COILS GENERAL

1.1 SECTION INCLUDES

A. Water Coils.

1.2 REFERENCES

A. ANSI/ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. ANSI/NFPA 70 - National Electrical Code.

C. SMACNA - HVAC Duct Construction Standards, Metal and Flexible (HVACDCS).

D. ANSI/UL 1995 - Heating and Cooling Equipment.

1.3 SUBMITTALS

A. Submit under provisions of Division 01 Section “Submittals”. Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

B. Submit manufacturer's installation instructions under provisions of Division 01 Section “Submittal Procedures”.

C. Submit manufacturer's certificate, under provisions of Division 01 Section “Quality Requirements”, that coils are tested and rated in accordance with ANSI/ARI 410.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01.

B. Store and protect products under provisions of Division 01.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.

D. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Hydronic Coils:
   1. Equipment manufacturer.
      a. Trane
      b. Daikin Applied (formerly McQuay).

c. Aerofin Corporation.
d. Coil Company, LLC.
e. Enviro-Tec.
f. Heatcraft.
g. Super Radiator Coils.
h. USA Coil.
i. York.

2.2 FABRICATION - HYDRONIC COILS

A. Fins: Aluminum continuous plate type with full fin collars or individual helical finned tube type wound under tension.

B. Casing: Die formed channel frame of 16 ga (1.8 mm) galvanized steel with 3/8 inch (9.5 mm) mounting holes on 6 inch (150 mm) centers. Provide tube supports for coils longer than 36 inches (0.9 m).

2.3 WATER COOLING COILS

A. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.

B. Tubes: 5/8 inch (16 mm) OD seamless copper arranged in parallel or staggered pattern, expanded into fins, brazed joints.

C. Testing: Air test under water to 200 psig (1380 kPa) for working pressure of 200 psig (1380 kPa) and 220 degrees F (104 degrees C).

D. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install with air filters mounted upstream of coil and downstream of any entering airstream, so that no unfiltered air reaches the coil.

C. Install in ducts and casings in accordance with SMACNA HVACDCS.

D. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Provide frames for a maximum of 3 coil sections. Arrange supports to avoid piercing drain pans.

E. Provide airtight seal between coil and duct or casing.

F. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

G. Install coils level. Install cleanable tube coils with 1:50 pitch.

H. Make connections to coils with unions and flanges.

I. Locate water supply at bottom of supply header and return water connection at top. Provide manual air vents at high points complete with stop valve. Ensure water coils are drainable and provide drain connection at low points.

J. On water chilled water cooling coils, connect water supply to leaving air side of coil (counterflow arrangement).

K. Provide drain pan and drain connection for cooling coils. Fabricate drain pan from 20 gage (0.90 mm) stainless steel. Extend 3 inches (75 mm) from face of coil entering air side, 6 inches (150 mm) from face of coil leaving air side. Pipe drain pans individually to floor drain with water seal trap.

L. Insulate headers located outside air flow as specified for piping.

END OF SECTION 238216

This Page Intentionally Left Blank

SECTION 260100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to all Division 26 Sections.

B. Intent Is to Provide and Install Complete Electrical Systems, as Required to Accommodate the Building renovations.

C. Access Panels: Where required by NFPA 70 (N.E.C.)

D. Seismic Requirements.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section. Examine all contract documents for requirements affecting the work.

1.3 DEFINITIONS

A. As used in this section, "provide" shall mean, "furnish and install". "Furnish" shall mean "to purchase and deliver to the project site complete with every necessary appurtenance and support", and "Install" shall mean "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project".

1.4 SUBSTITUTIONS AND PRODUCT OPTIONS

A. Refer to Division 01.

1.5 REFERENCES

A. NEMA Standards.

B. NECA "Standard of Installation."

C. NFPA 70 (N.E.C.) latest edition.

D. NFPA 101 Life Safety Code

E. U.L. Standards.

F. ANSI Standards.

1.6 SUBMITTAL PROCEDURES

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

B. Include products specified in Division 26 individual sections.

C. Submit Shop Drawings and product data grouped by individual Sections to include complete submittals of related systems, products, and accessories. Label each with Section number and title. Partial Section submittals will not be reviewed.

D. Include access panels.

E. Include fire-stop seals and fillers.

1.7 PROJECT RECORD DRAWINGS

A. Keep a marked set of Drawings at the site as a record set indicating all revisions in the work as the work progresses. At the completion of the work, mark the Drawings "As-Built Drawings" with the Contractor's name and date, and deliver to the Architect.

1.8 PERFORMANCE REQUIREMENTS

A. Conform to requirements of the latest edition of ANSI/NFPA 70 National Electrical Code (N.E.C.).

B. Conform to requirements of all local, State and Federal laws and regulations, plus local electric utility company's rules, and the Fire Underwriters' requirements.

C. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.

D. Secure and pay for all permits and certificates as required by local, State and Federal laws.

E. Request inspections from authority having jurisdiction.

F. Run separate circuits for lighting and receptacle outlets as indicated.
   1. Circuits shall be balanced and loads and capacities shall be in accordance with requirements of local electric light company and National Board of Fire Underwriters.
   2. Do not share neutral on branch circuits.

G. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.

H. The Drawings indicate only diagrammatically the extent, layout and the general location and arrangement of equipment, conduit and wiring. Become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible.
   1. Lighting and Devices shown with same panel and circuit designation with no home run symbol may share same home runs to panelboards provided that the furthest device on the circuit does not exceed 2-1/2% voltage drop.

2. Where home run symbols are shown, use separate run to panelboard for each symbol, and do not share home run with other devices having same panel and circuit designation.

1.9 PROJECT/SITE CONDITIONS

A. Coordinate with all other trades to ensure proper access and space requirements.

B. Where project conditions occur necessitating departures from the drawings, submit for approval the details of and reasons for departures prior to implementing any change.

1.10 SEQUENCING AND SCHEDULING

A. Construct Work in sequence under provisions of Division 01.

B. Schedule and coordinate all work with Division 02. Demolition and removal of electrical items are included as part of Division 26.

1.11 TEMPORARY LIGHT AND POWER

A. "Temporary Light and Power" specified under Division 01.

B. If permanent light fixtures are used for lighting during the construction phase to achieve the required lighting level, fixtures shall be re-lamped with correct lamps prior to building turnover to Owner."

1.12 SEISMIC DESIGN

A. This project requires special provisions for the support and restraint of equipment components of the Life-safety system. Complements of this system shall continue to function after an earthquake. These provisions shall be incorporated in accordance with the following:
   1. The requirements of this Section are complementary and additional to requirements listed elsewhere for the fastening and support equipment and components.
   2. Life-safety systems shall be adequately supported and restrained to resist seismic forces in accordance with the International Building Code and associated supplements as adopted.
   3. Seismic Restraints for Equipment:
      a. Engage the services of a professional engineer (hereinafter known as the Engineering Specialist) with experience in the field of equipment support and seismic restraints. The Engineering Specialist shall select and coordinate the restraints and supports based on the final coordinated drawings showing exact locations of equipment and shall coordinate with the project Structural Engineer to ascertain that the connections to the structure will resist the horizontal forces to which they might be subjected. Submit details and calculations from the Engineering Specialist as required to demonstrate compliance. Equipment that shall be considered in the Engineering Specialist's seismic design shall include, but not be limited to all components of the Electrical Life-safety systems:
         1) Feeder and branch circuits
         2) Panelboards.
         3) Lighting fixtures that serve the life-safety lighting system.
         4) Fire Alarm distribution

5) Other components as may be required to ensure proper operation of the building electrical life-safety systems.

4. Refer to Structural Drawings for exposure group and performance category.
5. Provide floor-mounted equipment with approved seismic control devices as required to prevent overturning or movement. Seismic devices shall be capable of keeping equipment captive under seismic loads.
6. Provide suspended equipment with approved seismic control devices as required to maintain the equipment in a captive attitude under seismic loads.

1.13 SAFETY PRECAUTIONS

A. Furnish, place and maintain proper guards for the prevention of accidents and any other necessary construction required to secure the safety of life and property

B. Where removal of electrical equipment is included within the scope of work, the Division 26 Contractor shall determine whether any such equipment contains PCBs or any other hazardous materials and shall be responsible for having same removed from the site and properly disposed of.

C. All PCB-contaminated materials shall be incinerated pursuant to the U.S. Environmental Protection Agency Final Rules 40 CFR 761.70. All uncontaminated (less than 50 ppm PCBs) metal components of the ballast shall be recycled, recovered or reclaimed by an approved company. Contractor shall provide a manifest and certificate of destruction pursuant to 40 CFR 761 Subpart K. Contractor disposing of PCB ballasts shall have at least $5 million of pollution liability insurance and a fully funded closure plan pursuant to 40 CFR 761.65 © (7) (ii), and a Hazard Communication Program pursuant to 29 CFR 1910.1200.

D. All lamps, HID and fluorescent, being removed from the job site shall be disposed of properly by an approved company. Contractor shall provide a manifest and certificate of destruction to the owner's representative. Contractor disposing of lamps shall have at least $5 million of pollution liability insurance and a fully funded closure plan, and a Hazard Communication Program.

1.14 CONTINUITY OF SERVICE

A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted services for the buildings, or any of its sections or portions of the Campus.
   1. Services Include but Not Limited to: Power, lighting, fire alarm, paging/intercom, telephone, computer, and life safety systems as required to maintain occupancy.
   2. If necessary, install temporary work to provide for this condition. Authorization for interrupting services for any building or portions of the campus shall be obtained, in writing, from the Owner.
   3. Costs for overtime work and temporary work shall be included in the bid.

1.15 ALTERATIONS AND DEMOLITION

A. The Contractor shall study all Drawings and Specifications and visit the site and acquaint himself with the existing conditions, and the requirements of the Plans and Specifications. No claim will be recognized for extra compensation due to failure of Contractor to familiarize him/her self with the conditions and extent of the proposed work.

B. The Contractor shall execute all alterations, additions, removals, relocations, or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the Drawings and Specifications.

C. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Owner's satisfaction.

D. All new materials shall conform to the Specifications for the new work.

E. Contractor shall assure all circuits in existing buildings are re-energized where existing panelboards are replaced, or existing wiring is rerouted, disconnected, disturbed or re-used. Existing circuits shall not be loaded beyond 75% of their ampacities.

F. All existing equipment, fixtures, wiring and devices disconnected and not reused shall be removed and shall remain the property of the Contractor, except as noted. All items removed and not reused or turned over to the owner shall be properly disposed of with all required paperwork.

G. Where new fixtures, outlets, switches, etc., are indicated, the Contractor shall provide and install new wiring complete from branch circuit panel to final outlets. Existing conduit raceways may be reused at the option of the Contractor, if adaptable. Where existing raceways are reused, the existing wiring shall be removed and new wiring in accordance with Specification requirements shall be installed.

H. Discontinued wiring shall be removed.

I. Remove existing ceiling and wall boxes, where equipment is removed and not reused.

J. Provide finished blank plates on all existing ceiling and wall boxes which can not be removed.

PART 2 - PRODUCTS

2.1 PAINTING

A. Refer to Division 09 Section "Painting".

2.2 ACCESS PANELS

A. Access panels required for items furnished under Division 26 shall be provided under this Division and installed under Divisions 08.

B. Standard panels: 12" x 16" except as indicated. Doors: flush type 14-gauge steel, hinged to 16-gauge frame. Latch: Flush face screw. All factory primed and painted to match in the field.
   1. Same U.L. fire rating as wall, floor, or ceiling in which they are installed.
   2. Equal To: Inryco/Milcor style "M" and Miami-Carey "HM".

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

A. Execute all work in a neat manner acceptable to the Local and State Electrical Inspector. Follow manufacturer's installation recommendations.

B. All electrical components and their attachments shall be properly supported and where required shall be designed for seismic forces.

C. Lighting fixtures shall be supported from structure.

D. Perform all electrical work by licensed electricians well skilled in the trade and supervised by a Master Electrician.

E. Replace or repair to new condition, defective equipment and equipment damaged during installation or testing.

F. Position isolated electrical equipment so that it is free standing and does not come in rigid contact with the building structure or other systems.

3.2 TESTING AND ADJUSTING

A. The entire installation shall be free from short circuits and improper grounds. Test in the presence of the Architects or their representatives.

B. Test each individual branch circuit at the panel. In testing for insulation resistance to ground, the power equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code and the manufacturer's recommendations. Correct failure in a manner satisfactory to the Architect and Engineers.

C. Completely test and adjust each system specified under Division 26 for proper operation.

END OF SECTION 260100

SECTION 260111 – CONDUIT

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Metal Conduit.

B. Flexible Metal Conduit.

C. Liquidtight Flexible Metal Conduit.

D. Electrical Metallic Tubing (EMT).

E. Non-Metallic Conduit.

F. Flexible Nonmetallic Conduit.

G. Fittings and Conduit Bodies.

1.2 RELATED SECTIONS

A. Division 01.

B. Division 26 Section “Basic Electrical Requirements”.

C. Division 26 Section “Wire and Cable”.

D. Division 26 Section “Boxes”.

E. Division 26 Section “Grounding and Bonding”.

F. Division 26 Section “Electrical Identification”.

1.3 REFERENCES

A. NECA "Standard of Installation."

B. NEMA Standards.

C. NFPA 70 N.E.C. latest edition.

D. U.L. Standards.

1.4 DESIGN REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (N.E.C.)

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

C. Conduit Size: ANSI/NFPA 70 (N.E.C.) for conductors indicated. Increase size as required to include bonding conductors specified.

1.5 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

B. Include expansion fittings for all conduit types used on the project.

C. Include fire-stop seals and fillers.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01.

B. Accurately record actual routing of conduits larger than 2 inches.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Division 01.

B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

1.8 PROJECT CONDITIONS

A. Verify that field measurements are as shown on Drawings.

B. Verify routing and termination locations of conduit prior to rough-in.

C. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to meet project conditions.

D. Where conduit routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in minimum size 3/4 inch conduit.

B. Underground Installations:
   1. More than Five Feet from Foundation Wall: Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80, thinwall nonmetallic conduit PVC-40 encased in concrete where indicated.
   2. Within Five Feet from Foundation Wall: Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80, thinwall nonmetallic conduit PVC-40.
   3. In or Under Slab on Grade:
      a. Use rigid galvanized steel conduit, intermediate metal conduit, plastic coated steel conduit, thickwall nonmetallic conduit PVC-80 and thinwall nonmetallic conduit PVC-40.
      b. Rise through slab in rigid galvanized steel conduit.
      c. Conduit larger than 3/4" shall run below slab.
   4. Minimum Size: 3/4 inch.
   5. Under paved areas: rigid galvanized steel conduit or concrete encased PVC-40.
   6. Metallic conduits buried in soil: Coated with Bitumastic #50.

C. Outdoor Locations, Above Grade: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit.

D. In Slab Above Grade:
   1. Use rigid galvanized steel conduit, intermediate metal conduit, electrical metallic tubing with water tight connectors.
   2. Maximum Size Conduit in Slab: 3/4 inch.
   3. Rise through slab in rigid galvanized steel conduit.

E. Interior Wet and Damp Locations: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit.

F. Dry Locations:
   1. Concealed: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
   2. Concealed/ Accessible: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
   3. Exposed: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing.
      a. Exposed conduit: Not allowed in finished areas except as specifically noted.

G. Panel Feeders: Use rigid galvanized steel and aluminum conduit, intermediate metal conduit, electrical metallic tubing in accordance with locations herein specified.

H. Couplings and connectors for electrical metallic tubing up to 2" shall be steel set screw. Set-screw connection shall be used for all tubing sizes with a minimum of four set-screws for coupling and two

set-screws for connectors and fittings for sizes 1-1/4" and larger. EMT used in damp or wet location shall be compression type fittings. Diecast fittings are not allowed.

I. Couplings and connectors for rigid and intermediate metal conduit shall be threaded.

J. Termination for all conduit and tubing shall have insulated bushings or insulated throat connectors in accordance with code requirements.

K. Permanent Connection to Motors: Dry locations, use flexible metal conduit. Damp or wet locations, use flexible liquidtight Type UA conduit with approved liquidtight fittings. Maximum length two feet (2').

PART 3 - EXECUTION

3.1 INSTALLATION

A. In general, all raceways shall be concealed above ceilings and within finished walls - securely supported in accordance with code requirements. Wiring in areas with no finished ceilings (exposed construction) shall be exposed overhead such that all raceways are parallel or perpendicular to joists, columns or beams and all drops to wall devices shall be concealed in walls.

B. Install exposed only where specifically indicated.

C. Aluminum conduits shall not be installed below grade or in poured concrete or masonry.

D. Install conduit in accordance with NECA "Standard of Installation."

E. Install nonmetallic conduit in accordance with manufacturer's instructions.

F. Arrange supports to prevent misalignment during wiring installation.

G. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

H. Group Related Conduits:
1. Support using conduit rack of Power-Strut, or approved equal.
2. Parallel runs shall be neatly clustered with all bends and offsets of uniform pattern
3. Provide space on each for 25 percent additional conduit.

I. Substantially support with approved clips or hangers spaced not to exceed ten feet (10') on centers except 1/2" rigid conduit and 1/2" and 3/4" electrical metallic tubing shall have supports spaced not to exceed six feet (6').

J. Fasten conduit supports to building structure.
1. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
2. Do not attach conduit to ceiling support wires.
3. Conduits larger than 2@ shall be supported from top cord of joists.

K. Arrange conduit to maintain headroom and present neat appearance.

L. Route conduit parallel and perpendicular to walls.

M. Route conduit in and under slab from point-to-point.
   1. Install only where specifically indicated or required.
   2. Obtain approval from the Architect before installation.

N. Do not cross conduits in slab.

O. Maintain adequate clearance between conduit and piping.

P. Maintain 6 inch clearance between conduit and surfaces with temperatures exceeding 104°F.

Q. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

R. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

S. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction. Use factory elbows or hydraulic one-shot bender to fabricate bends in metal conduit 2 inches or larger in size.

T. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.

U. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.

V. Provide suitable labeled nylon pull string in each empty conduit.

W. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

X. Use sleeves when passing through floors and walls.

Y. When serving roof top equipment, conduit shall enter within the weather-proof curbing. Maintain water tight roofing system.

Z. Ground and bond conduit under provisions of Division 26 Section “Grounding and Bonding”.

AA. Identify conduit under provisions of Division 26 Section “Electrical Identification”.

BB. All elbows in nonmetallic conduit runs shall be rigid galvanized steel to eliminate "burn through" when pulling in conductors.

3.2 FIELD QUALITY CONTROL

A. No wire shall be installed until work which might cause damage to wires or conduits has been completed.

B. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire-resistance rating of partitions and other elements, using approved seals, fillers and materials.

SECTION 260123 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire and cable.

B. Branch circuit cable.

C. Wiring connectors and connections.

1.2 RELATED SECTIONS

A. Division 26 Section “Conduit.”

B. Division 26 Section “Basic Electrical Requirements.”

C. Division 26 Section “Boxes.”

D. Division 26 Section “Electrical Identification.”

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 N.E.C. Latest Edition.

C. U.L. Standards.

1.4 DESIGN REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.

C. Conductors shall be Copper.

D. Manufacturer's name, wire size and insulation type shall be clearly marked on the insulation or jacket.

1.5 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

B. Include MC manufacturer's specification sheets indicating construction, diameter, ampacity and bending radius.

C. Include the following only if aluminum wire option is used: Indicate type, size, length, ampacity and impedance comparisons, termination methods and locations used. Comparison shall be in chart form listed by feeder/pnl name with all data CU vs AL for each feeder length.

D. Not submitting aluminum wire for approval is confirmation that only copper wiring will be used.

1.6 PROJECT CONDITIONS

A. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.

B. Where wire and cable routing is not shown, and destination or circuit number only is indicated, determine exact routing and lengths required.

1.7 COORDINATION

A. Locate such that outlets are readily accessible.

B. Determine required separation between cable and other work.

C. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cable 600 volts and below:
   1. General Wire and Cable.
   2. Triangle Wire and Cable.
   3. Southwire Company.

B. MC cable - Galvanized steel:
   1. AFC Cable systems
   2. Service Wire.

2.2 WIRE AND CABLE

A. Description: Single conductor insulated wire.

B. Conductors: Stranded Copper.

C. Aluminum Conductors: NOT Allowed.

D. Insulation Voltage Rating: 600 volts.

E. Insulation: ANSI/NFPA 70 (N.E.C.), Type THHN/THWN, rated 90 degrees C.

2.3 METAL CLAD CABLE (allowed for lighting fixture whips where concealed).

A. Description: ANSI/NFPA 70 (N.E.C.), Type MC with separate insulated ground.

B. Conductor: Copper, minimum #12 and maximum # 10 AWG.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 90°C.

E. Armor Material: Full wall Galvanized Steel.

F. Jacket: None.

2.4 WIRING CONNECTORS

A. Use The Following Types As Herein Specified:
1. Split bolt connectors.
2. Solderless pressure connectors.
3. Spring wire connectors.
4. Compression connectors.
5. Insulation piercing connectors.

2.5 NONMETALLIC-SHEATHED CABLE

A. Not Allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that mechanical work likely to damage wire and cable has been completed.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRING METHODS

A. Concealed Dry Interior Locations: Use only wire Type THHN/THWN insulation, in raceway (conduit).

B. Where concealed metal clad cable is allowed only for a six foot whip supported per code from a junction box to a light fixture.

C. Accessible Dry Interior Locations (such as above acoustical ceilings): Use only wire Type THHN/THWN insulation, in raceway.

D. Exposed Dry Interior Locations:
   1. Exposed wiring is not allowed.

E. Wet or Damp Interior Locations: Use only building wire Type THWN insulation, in raceway.

F. Exterior Locations: Use only building wire Type THWN insulation, in raceway.

G. Use other wiring methods only as specifically indicated on Drawings.

3.4 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in raceways.

C. All wire in raceways and cable whips shall be concealed above ceilings and within finished walls, securely supported in accordance with code requirements. Wiring in areas with no finished ceilings (exposed construction) shall be raceways exposed overhead such that all raceways are parallel or perpendicular to joists, columns or beams and concealed in walls.

D. Use stranded conductors for #10 AWG and smaller with vinyl insulated support crimp-on fork terminals for all screw head terminations. Barrel lugs and screw activated compression clamps on back wired devices shall not require crimp-on terminals.

E. Use stranded conductor for feeders and branch circuits.

F. Use stranded conductors for control circuits.

G. Minimum Size Conductors for Power and Lighting Circuits #12 AWG Except as Follows:
   1. Minimum #10 AWG for 120 volt circuits more than 100 feet long.
   2. Sizes shall be not less than indicated.
   3. Sizes shall limit voltage drop for branch circuits to 3% for power circuits and 3% for lighting and combination lighting and power circuits.
   4. Note: Wire sizes indicated on drawings and schedules are minimum requirements and shall be adjusted to meet the above criteria.

H. Use conductor not smaller than #14 AWG for control circuits with fusing sized accordingly.

I. Pull all conductors into raceway at same time.

J. Use suitable wire pulling lubricant for building wire #4 AWG and larger.

K. Support cables above accessible ceiling, using spring metal clips or approved cable ties to support cables from structure. Do not support from ceiling suspension system. Do not rest cable on ceiling panels. Do not drape over ductwork or between bar joists. Wiring shall not be run diagonally and shall be cabled neatly.

L. Use approved cable fittings and connectors.

M. Neatly train and lace wiring inside boxes, equipment, and panelboards.

N. Clean conductor surfaces before installing lugs and connectors.

O. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

P. Use split bolt connectors, insulation piercing connectors or U.L. approved insulated connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

Q. Use solderless pressure connectors with insulating covers or “Skotch-loks” for copper conductor splices and taps, #8 AWG and smaller.

R. Loading of 20 amp branch circuits shall not exceed 80 percent.

S. In general all electrical devices shall be connected so that the removal of a device (pig tails) shall not interrupt conductor continuity.

T. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

U. Wiring in sleeves passing through fire-rated barriers shall be sealed/filled with approved material to maintain the fire rating.

3.5 INTERFACE WITH OTHER PRODUCTS

A. Identify wire and cable under provisions of Division 26 Section "Electrical Identification."

B. Identify each conductor with its circuit number or other designation indicated on Drawings.

3.6 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

D. Verify proper operation of each circuit.

END OF SECTION 260123

This Page Left Intentionally Blank

SECTION 260130 – BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall and Ceiling Outlet Boxes.

B. Pull and Junction Boxes.

C. Hinged Cover Cabinet Enclosures.

1.2 RELATED SECTIONS

A. Division 26 Section “Conduit.”

B. Division 26 Section “Basic Electrical Requirements.”

C. Division 26 Section “Wiring Devices.”

D. Division 26 Section “Grounding and Bonding.”

E. Division 26 Section “Equipment Wiring.”

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 N.E.C. Latest Edition.

C. U.L. Standards.

1.4 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

B. Include product data for floor boxes, boxes larger than 12x12x6 inches, boxes with hinged covers.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01.

B. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12x12x6 inches and boxes used for panel feeders.

1.6 PERFORMANCE REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.

C. Size per N.E.C. Art. 314.

1.7 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.

B. Verify locations of wall boxes and outlets in kitchen areas prior to rough-in.

C. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose and meet all applicable codes.

D. Generally pull boxes are not shown on Drawings. Provide as required.

1.8 COORDINATION

A. Locate such that outlets are readily accessible and does not interference with other work.

B. Provide for access panel where required.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: Standard type galvanized steel, minimum four inch square or octagon by 2-1/8 inch deep.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type, three and four inch deep or depth as to coordinate with concrete slab.
   3. Single Wall Type: Minimum size, four inch square by 1-1/2 inch deep, except as noted. Provide dry wall plaster rings raised as required to insure flush finish mounting.
   4. Ganged Wall Type: Minimum depth 3 inches except as noted, ganged as required under common plate to contain device shown.

B. Cast Boxes: Type FD deep aluminum or cast feralloy.
   1. Provide number of threaded hubs as required.
   2. Use in all exterior, damp or exposed in mechanical space.
   3. Provide gasketed cover and accessories by box manufacturer for complete weatherproofing.

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: Standard type galvanized steel, minimum four inch square or octagon by 2-1/8 inch deep.
   1. Sizes up to 12x12x6 inch: Provide screw-type or hinged covers.
   2. Sizes greater than 12x12x6 inch: Provide hinged covers.

B. Exterior Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box.
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

2.3 CABINET ENCLOSURES

A. Covers: Continuous hinge, held closed by flush latch operable by screwdriver; finish in gray baked enamel.

B. Boxes: Galvanized steel minimum 12"x12"x6" deep or as noted. Provide 3/4 inch (19 mm) thick plywood backboard painted matte white, for mounting terminal blocks.

C. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.

D. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   1. Except where specifically noted, boxes on finished surfaces shall be flush mounted with finished cover plate.
   2. Consult Architect prior to installing in finished areas.

B. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

D. In Non-accessible Ceiling Areas: Install outlet and junction boxes no more than 12 inches from ceiling access panels or from removable recessed luminaires such that they are accessible.

E. In accessible Ceiling Areas: Install outlet and junction boxes such that they are accessible from ceiling access panels or from removable recessed luminaires.

F. Align Wall Boxes for Switches, Receptacles, Thermostats, Telephone, and Similar Devices with Each Other as Follows:
   1. Horizontally for outlets with same mounting height.
   2. Vertically for outlets shown in similar locations with different mounting heights.

G. Do not install flush mounted boxes back-to-back in walls; provide minimum 6 inch separation. Provide minimum 24 inches separation in acoustic and fire rated walls.

H. Accurately position flush mounted wall boxes to allow for surface finish thickness.
   1. Box shall be flush with finished surface.
   2. Use wall box support brackets that span two studs.
   3. Single stud support will be allowed only if used with E-Z Mount Brackets or equal product to support side opposite the stud.

I. Install flush mounting box without damaging wall insulation and vapor barrier or reducing its effectiveness.

J. Use adjustable steel channel fasteners for hung ceiling outlet box.

K. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

L. Use gang box where more than one device is mounted together. Do not use sectional box.

M. Use 4" square box with plaster ring for single device outlets.

N. Use cast outlet box in exterior locations, exposed to the weather, and wet locations.

O. All devices, light fixtures, etc., shall employ tamper-proof screws.

P. Large Pull Boxes: Boxes larger than 100 cubic inches in volume or 12 inches in any dimension.
   1. Interior Dry Locations: Use hinged covers.
   2. Other Locations: Use surface-mounted cast metal box.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations and sizes of required doors with Division 08.

B. Locate flush mounting box in masonry wall to require cutting of only one masonry unit. Coordinate masonry cutting to achieve neat opening.

C. Coordinate mounting heights and locations of outlets mounted above counters, and backsplashes.

D. Position outlet boxes to locate luminaires as shown on reflected ceiling plan.

END OF SECTION 260130

SECTION 260141 - WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wall Switches.

B. Receptacles.

C. Lighting Occupancy Sensors

D. Device Plates.

1.2 RELATED SECTIONS

A. Division 07: Firestopping

B. Division 26 Section “Conduit.”

C. Division 26 Section “Basic Electrical Requirements.”

D. Division 26 Section “Wire and Cable.”

E. Division 26 Section “Boxes.”

F. Division 26 Section “Wiring Devices.”

G. Division 26 Section “Grounding and Bonding.”

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 N.E.C. Latest Edition.

C. U.L. Standards.

1.4 SUBMITTALS

A. Submit Shop Drawings for equipment and component devices in accordance with Division 01.

B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

C. Include documentation showing compliance with UL, Fed. Spec. and NEMA references.

1.5 PERFORMANCE REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Arrow-Hart (Cooper Wiring Devices).

2.2 GFCI/TAMPER RESISTANT RECEPTACLE

A. All receptacles shall be Commercial specification grade tamper resistant.
1. Arrow-Hart Model TRVGF20 series rated 20A with integral internal safety shutter.

B. General Description: Straight blade, feed -through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, NEMA 5-20R. Will not energize if line and load wiring are reversed.

C. Device Body:
1. Wall mounted devices shall be Ivory.

2.3 RECEPTACLE

A. All receptacles shall be Commercial specification grade back and side wired with dual USB charging ports.
1. Arrow-Hart Model TR7746 series rated 20A.

B. General Description: Straight blade, feed -through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A.

C. Device Body:
1. Wall mounted devices shall be Ivory.

2.4 WALL SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A Commercial specification grade:
1. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

C. Provide three-way, four-way switches, etc., as indicated matching the Series listed above.
1. Device Body: Toggle handle type, color: Ivory.

D. Provide three way Maestro Series dimming switch system by Lutron. Catalog #MAF-6AM-277-IV and MA-R-277-IV.

2.5 WALL PLATES

A. Decorative Cover Plate:
   1. Wall mounted Plates shall be 302/304 stainless steel as manufactured by Hubbell.

2.6 WALLBOX DIMMING SWITCHES

A. Lutron Diva 0-10V Line voltage dimmer switch.

2.6 LIGHTING OCCUPANCY SENSORS

A. Manufacturers:
   1. The Watt Stopper: Model numbers listed except as noted.
   2. Lightolier.
   3. Light-O-Matic.
   4. Sensor Switch.
   5. Hubbell.
   6. Leviton.

B. Complete with Faceplates, Color: White.

C. Occupancy Sensor – Ceiling mounted: DT-300-White dual technology ceiling mounted sensor
   1. 24 VDC/VAC and halfwave rectified AC
   2. Ultrasonic frequency of 40kHz
   3. Time delays: SmartSet (automatic) and fixed (5, 10, 15, 20, or 30 minutes), walk-through, test-mode. Set units for 15 minute delay to OFF.
   4. Sensitivity adjustment: SmartSet (automatic) or reduced sensitivity (for PIR sensitivity); ultrasonic sensitivity is variable with trimpot
   5. Built-in light level sensor (DT-300) works from 10 to 300 footcandles
   6. Low voltage, momentary switch input for manual operation
   7. DT-300 contains an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
   8. Multi-level, 360° Fresnel lens for superior occupancy detection
   9. Units per power pack: DT-300: up to 2 (B), up to 3 (BZ); DT-305: up to 3 (B), up to 4 (BZ)
   10. Dimensions: 4.50" diameter x 1.02 deep (114.3mm x 25.91mm)
   11. Typical PIR Coverage: 1000 sq.ft.
   12. Typical Ultrasonic Coverage: 800-1200 sq.ft.
   13. UL and CUL listed; Five year warranty
   14. Provide power packs, mounting brackets and other hardware as required for a complete working system to cover the areas indicated.

D. Provide detailed wiring diagrams with submittals.

E. Occupancy sensor ceiling mounted for bathrooms: shall be Wattstopper UT-300 series, ultrasonic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.

C. Provide matching blank face plate for all unused wall boxes.

D. Install switches with Off position down.
   1. Locate close to door frame on latch side of door, or beyond swing of door where appropriate.
   2. Where door frames have side lights, switch shall be either located below side light where a 3'-0" mounting height is possible, or beyond the side light. Coordinate with door frame schedule.
   3. Switches indicated in the same area at the same mounting heights shall be ganged together under a common plate.

E. Receptacle and switch plates shall be I.D. with the panel & breaker number.

F. Disconnect switches shall be I.D. with the panel & breaker number.

G. Install receptacles with grounding pole on top.

H. Where devices such as duplex receptacles, telephone/data outlets, and TV outlets are shown adjacent to each other, then group all under a common face plate.

I. All devices, light fixtures, etc., shall employ tamper-proof screws.

END OF SECTION 260141

SECTION 260170 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment grounding conductors.

B. Bonding.

1.2 RELATED SECTIONS

A. Division 26 Section “Basic Electrical Requirements.”

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 (N.E.C.) Latest Edition.

1.4 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

PART 2 - PRODUCTS

2.1 WIRE

A. Material: Copper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Equipment Grounding Conductor: Provide separate, 600 volt insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

C. Provide and install bonding conductor to each item of electrical equipment.

D. Bonding conductors shall be continuous where possible. Where splices are required, provide T & B, or approved equal, compression connectors of approved pattern. Insulate connectors to equivalent thickness of conductors.

END OF SECTION 260170

This Page Intentionally Left Blank

SECTION 260180 - EQUIPMENT WIRING

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Electrical Connections to Equipment Specified under Other Sections Or Furnished by Owner,

B. All line voltage wiring including final branch circuit connections to disconnects, motor controllers.

C. Fused and non-fused disconnect switches for the equipment, except disconnect switches specifically provided with the equipment.

D. Except as specifically noted, motors, variable frequency drives (VFD), isolation transformers for VFD, magnetic or manual starters and thermal overload protection will be furnished with the equipment for installation under Division 26 Section “Equipment Wiring”.
   1. Single pole switches, switch and pilots, and light/fan switches shall be provided and installed under Division 26 Section “Equipment Wiring”. Coordinate with equipment schedules on H&V Drawings.

1.2 RELATED SECTIONS

A. Division 26 Section “Conduit”.

B. Division 26 Section “Basic Electrical Requirements”.

C. Division 26 Section “Wire and Cable”.

D. Division 26 Section “Boxes”.

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 (N.E.C.) Latest Edition.

C. U.L. Standards.

D. ANSI Standards.

1.4 PERFORMANCE REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70. (N.E.C.)

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.

C. Drawings do not show all required disconnect servicing switches. Furnish and locate as required by N.E.C.

D. Size fuses and thermal elements per N.E.C. and manufacturer's recommendations.

E. Connect motors for correct voltage, phase and rotation.

1.5 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

A. Enclosed, heavy-duty type, except as noted with visible blades, Horsepower rated 600-volt and 250-volt ratings as required by the particular circuit.

B. NEMA-1 enclosure, for dry locations; NEMA-3R raintight for exterior locations.

C. Fuses and ampere rating and number of poles as indicated on Drawings, or as required by the specific equipment.

2.2 ACCEPTABLE MANUFACTURERS

A. I-T-E Siemens.

B. General Electric.

C. Square D.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

3.3 INSTALLATION

A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment, but in no case less than the wire specified under Division 26 Section "Wire and Cable."

B. Conduit Connections to Equipment: Dry locations, use flexible conduit. Damp or wet locations, use flexible liquidtight Type UA conduit with approved liquidtight fittings. Maximum length two feet (2').

C. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

E. Make wiring connections in wiring compartment of prewired equipment in accordance with manufacturer's instructions.

F. Install disconnect switches, controllers, control stations, temperature switches as indicated or required.

3.4 EQUIPMENT CONNECTION SCHEDULE

A. See Drawings.

END OF SECTION 260180

This Page Left Intentionally Blank

SECTION 260195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Nameplates and Tape Labels.

B. Wire and Cable Markers.

C. Conductor Color Coding.

1.2 RELATED SECTIONS

A. Division 09 Section "Painting."

B. Division 26 Section "Basic Electrical Requirements."

1.3 REFERENCES

A. NFPA 70 (N.E.C.) Latest Edition.

1.4 REQUIREMENTS

A. Label all circuits on all spaces of panels.

B. Label all safety switches, controls, relays, junction boxes, pull boxes, pilot lights, special switches and outlets.

C. Nameplates shall identify function of device, space controlled, voltage conditions, fuse size, panel serving switch, as indicated or required without abbreviations. Details shall be as approved.

D. Conform to requirements of ANSI/NFPA 70. (N.E.C.) Art. 210, Color code for branch circuits.

1.5 SUBMITTALS

A. Submit Shop Drawings, in accordance with Division 01.

B. Only include if details of nameplates, wiring markers and conductor color code are not as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Nameplates: Engraved three-layer laminated plastic, white letters on a black background. All letters shall be a minimum of ¼" high.

B. Junction Box Labels: Hand lettered with indelible black marker. Indicate voltage and circuit.

C. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

D. Fire Alarm Junction Boxes: Paint red.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install nameplates parallel to equipment lines.

B. Secure nameplates to equipment fronts using screws, or rivets, or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

A. Conductors throughout the building shall be color coded to identify voltage and phases.
   1. All metallic bonding conductors - Green.
   2. Insulated Isolated Grounding Conductor: Green with yellow stripe.
   3. Phase Conductors of 120/208 Volt System: Black, red, blue. Neutral: white.
   4. Phase Conductors of 120/240 Volt System: Black, red. Neutral: White. 120/240 volt system shall not enter same raceways or enclosures as 120/208 volt system.

B. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.

C. Where Conductors Are Not Available in the Colors Indicated, Due to Size, Prewired Cable, or Other Reason: Install identifying adhesive bands 3/4" wide of colors indicated above around each conductor within six inches (6") and twelve inches (12") of each end and at a maximum of five foot (5') intervals along wireways, at back of panelboards, and wherever conductors are accessible.

D. Power and Lighting Circuits in Panelboard Gutters, Pull Boxes, and at Load Connection: Provide wire markers on each conductor and Identify with branch circuit or feeder number.

E. Conductors of different system voltages shall not enter the same raceway, box, gutter, or other types of enclosures.

F. System Control Wires at Control Panel and Load Connection:
   1. Provide wire markers on each conductor and identify with number as indicated on equipment manufacturer's Shop Drawings.
   2. Fire Alarm System: Follow UNH color code and labeling standards.

END OF SECTION 260195

SECTION 260470 – PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Lighting and appliance branch circuit panelboards.

B. Individually mounted circuit breakers.

1.2 RELATED SECTIONS

A. Division 01 Section “Submittal Procedures.”

B. Division 06 Section “Rough Carpentry.”

C. Division 09 Section “Painting.”

D. Division 26 Section “Basic Electrical Requirements.”

E. Division 26 Section “Grounding and Bonding.”

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 N.E.C. Latest Edition.

C. U.L. Standards.

1.4 PERFORMANCE REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (N.E.C.).

B. Furnish products listed and classified by Underwriters Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.

C. Size per Drawings.

1.5 SUBMITTALS

A. Submit Shop Drawings, Owners' Manuals, and Operating Instructions in accordance with Division 01.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement, catalog, specification and sizes, panel dimensions, and gutter space.

1.6 SPARE PARTS

A. Keys: Furnish to Owner 5 keys for each panel. All panels shall be keyed alike or to Owners keying system. Keys shall match existing panels.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES - PANELBOARDS

A. General Electric.

B. Cutler-Hammer/Westinghouse.

C. I-T-E Siemens.

D. Square D.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type with mains and circuits as indicated on the Drawings and all designed for three phase, four wire, solid neutral, 60 cycle service rated for 120/208 volt service as scheduled.

B. Enclosure: NEMA Type 1 except as noted. Code gauge galvanized steel boxes and enameled steel fronts sized for 6" minimum side, top and bottom gutters, or greater as required by NEC.

C. Flush or surface mounting as indicated by the panel schedule, concealed hinge and flush lock all keyed alike.

D. Bus: Copper ratings as scheduled on Drawings. Provide subfeed and feed-through lugs as required. Lugs designed for use for both copper and aluminum conductors. Subfeed lugs shall mean tapped ahead of buses and feed-through shall mean tapped on load side of main and buses.

E. Neutral Bar: Full size insulated from the cabinet and provided with lugs for each branch circuit space in the panel.

F. Bonding strap securely attached to the cabinet with lugs as required to receive the bonding conductors indicated and specified.

G. Minimum Integrated Short Circuit Rating: shall match the existing.

H. Molded Case Circuit Breakers: Toggle type thermal-magnetic, quick-make, quick-break, with silver-plated contacts, bolt-in type, and with common trip for multiple circuits. Breakers shall have a nominal thickness of 1" per pole. Provide circuit breakers UL listed as Type SWD for switching lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where indicated.

I. Cabinets shall be equipped with doors that have keyed locks and flush handles. A typed circuit directory shall be provided in covered frame in each cabinet. Facilities Design & Construction shall approve directory before it is typed.

J. All panelboards rated 100 amps and larger shall have door-in-door front covers.

2.3 INDIVIDUALLY MOUNTED CIRCUIT BREAKERS

A. Circuit Breakers as Main: As specified above for Main Panelboard: U.L. labeled for use as service entrance equipment.

B. Molded Case Circuit Breakers: As specified above in item BRANCH CIRCUIT PANELBOARDS.

C. Enclosure: NEMA Type 1 general purpose except as noted.

D. Flush or surface mounted as indicated.

2.4 CIRCUIT BREAKERS FOR EXISTING PANELBOARDS.

A. Circuit breakers for existing panel boards shall match the existing circuit breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards plumb and properly secured. Recessed panels shall be flush with wall finishes.

B. Height: Per N.E.C.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed directory completely filled-in indicating outlets, fixtures, devices, and locations served by the circuit. Revise directory to reflect circuiting changes required to balance phase loads. (The typed circuit directory shall be provided in covered frame in each cabinet. Facilities Design & Construction shall approve directory before it is typed).

E. Stub 4 empty one inch conduits to accessible location above, ceiling and below floor, from each recessed panelboard that has accessible ceilings above and/or below the panel.

F. Finish painting of flush panelboards and individually mounted breakers shall be as specified in Division 09 Section “Painting”.

G. Properly support backboards, and panels. Coordinate with Division 06 Section “Rough Carpentry”, to provide blocking as required.

H. Properly support backboards, and panels. At non structural walls, provide separate support system for panelboards and equipment. Use UNISTRUT P5000 channels or equal. Length and spacing to form rigid separate wall. In other areas, coordinate with Division 06 Section “Rough Carpentry”, to provide blocking as required.

3.2 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers.

3.3 PANELBOARD SCHEDULE

A. See Drawings.

END OF SECTION 260470

SECTION 260510 – LUMINAIRES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires and accessories.

B. Ballasts.

C. Lamps.

D. Additional wiring methods for luminaires.

1.2 RELATED SECTIONS

A. Division 26 Section "Conduit."

B. Division 26 Section "Basic Electrical Requirements."

C. Division 26 Section "Wire and Cable."

D. Division 26 Section "Boxes."

E. Division 26 Section "Grounding and Bonding."

1.3 REFERENCES

A. NEMA Standards.

B. NFPA 70 N.E.C. Latest Edition as adopted by the State of New Hampshire.

C. U.L. Standards.

D. ANSI/NFPA 101 - Life Safety Code.

1.4 PERFORMANCE REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70 (N.E.C.).

B. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with Division 01.

B. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data - Luminaires: Provide dimensions, ratings, performance data, total input watts and counts of all fixtures including counts of ballast and lamps.

D. Product Data - Ballast: Provide ratings and performance data.

E. Product Data - Lamps: Provide ratings and performance data.

F. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site. Inspect for damage.

B. Protect from moisture, corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 SPARES

A. Provide two of each plastic lens type.

B. Provide replacement lamps for each lamp type installed as follows:
1. 10% where 1000 or more lamps of one type are installed.
2. 20% where less than 1000 lamps of one type are installed.
3. Minimum of 2 lamps for each type.

C. Provide replacement ballasts for each ballast type installed as follows:
1. Minimum of 2 ballasts for each type installed.

1.8 PROJECT CONDITIONS

A. Wiring to fixtures as shown on Drawings is diagrammatic only and is intended to show circuit and switching arrangements. Fixtures shall not be used as raceways except as specifically allowed by N.E.C. Art 410.

B. Where panel designation and circuit numbers are shown with no homerun symbol, wiring to same circuits may share same homerun to panel. See voltage drop and distance restrictions in Division 26 Section "Basic Electrical Requirements."

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Furnish products as specified in schedule on Drawings.

B. All fixtures shall be approved by Underwriters' Laboratories, Inc., and bear Underwriters' labels.

C. In addition to the manufacturers listed on the Drawings, fixtures with equivalent details and matching characteristics as provided by manufacturers listed below shall be considered for approval after review of Shop Drawings.

D. Manufacturers:
1. Hubbell
2. Columbia
3. Cooper
4. Lithonia
5. Kenall
6. Genlyte
7. SPI
8. Advant
9. Lite Control
10. Bega
11. Visa
12. Canlet

E. Ballast: Provide ballast suitable for lamp specified.

F. Luminaire disconnect: all luminaires shall incorporate a UL listed luminaire disconnect. Similar to Thomas & Betts Sta-Kon series LD2-D/LD3-D. (Female connector shall be wired to the line side and the male connected to the ballast.)

G. Lamps: All lamps shall be furnished and installed in each fixture.

2.2 BALLASTS: Rated 120 volts or as noted.

A. Ballast Manufacturers:
1. Osram/Sylvania.
2. Advance.
3. General Electric.

B. T8 Fluorescent Ballast:
1. Fully electronic 25,000 Hz programmed start, two, three and four lamp type. Quantities to allow switching as indicated on plans.
2. Ballasts for all recessed fixtures shall be of the very low heat (VLH) design.
3. Total harmonic distortion shall be less than 10%.
4. Ballast Factor Shall be Normal (minimum 0.88).
5. Where fixtures run end to end, or are within the standard 11 foot ballast whip distance, then efforts shall be made to utilize as many four lamp ballasts as possible (driving four lamps). In all cases, ballasts shall be installed to drive the exact number of lamps they are designed for, Example - one lamp ballast drives one lamp, two lamp ballast drives two lamps, etc. Installation where this criteria is not followed will not be accepted.
6. Where fixtures can use 11 foot whips (master and satellite pairs), ballast shall be installed to drive the exact number of lamps indicated and fixture shall be provided with pre-manufactured ballast whips.
7. Provide for parallel wiring of lamps (series wiring of lamps is not allowed)

C. T5HO linear lamp Fluorescent Ballast:
   1. Fully electronic 25,000 Hz programmed start, two, three and four lamp type. Quantities to allow switching as indicated on plans.
   2. Ballasts for all recessed fixtures shall be of the very low heat (VLH) design.
   3. Total harmonic distortion shall be less than 10%.
   4. Ballast Factor Shall be Normal (minimum 0.88).
   5. Where fixtures run end to end, or are within the standard 11 foot ballast whip distance, then efforts shall be made to utilize as many four lamp ballasts as possible (driving four lamps). In all cases, ballasts shall be installed to drive the exact number of lamps they are designed for, Example - one lamp ballast drives one lamp, two lamp ballast drives two lamps, etc. Installation where this criteria is not followed will not be accepted.
   6. Where fixtures can use 11 foot whips (master and satellite pairs), ballast shall be installed to drive the exact number of lamps indicated and fixture shall be provided with pre-manufactured ballast whips.
   7. Provide for parallel wiring of lamps (series wiring of lamps is not allowed)

D. T4 Fluorescent Ballast:
   1. Fully electronic 25,000 Hz instant start, two, three and four lamp type. Quantities to allow switching as indicated on plans. Provide only rapid start lamps which are specifically designed to operate properly on Program rapid start electronic ballasts.
   2. Ballasts for all recessed fixtures shall be of the very low heat (VLH) design.
   3. Total harmonic distortion shall be less than 10%.
   4. Ballast Factor Shall be Normal (minimum 0.88).

E. T5 Biax/Dulux Fluorescent Ballast:
   1. Fully electronic 25,000 Hz instant start, two, three and four lamp type. Quantities to allow switching as indicated on plans. Provide only rapid start lamps which are specifically designed to operate properly on instant start electronic ballasts.
   2. Ballasts for all recessed fixtures shall be of the very low heat (VLH) design.
   3. Total harmonic distortion shall be less than 15%.
   4. Ballast Factor Shall be Normal (minimum 0.88).
   5. Ballasts shall be installed to drive the exact number of lamps they are designed for, Example - one lamp ballast drives one lamp, two lamp ballast drives two lamps, etc. Installation where this criteria is not followed will not be accepted.

2.3 LAMPS

A. Lamp Manufacturers:
   1. Sylvania/Osram.
   2. Philips.
   3. Venture Lighting International.
   4. General Electric.

B. Four foot Fluorescent Lamps: T8 - High Performance 28watt & T5HO (5000 lumen) as scheduled, Energy saving 3500K, 85 CRI, designed to operate properly when driven by ballasts indicated on schedule and under article 2.2 BALLAST.

C. Two foot Fluorescent Lamps: T8 - High Performance 17watt (1400lumen) as scheduled, Energy saving 3500K, 85 CRI, designed to operate properly when driven by ballasts indicated on schedule and under article 2.2 BALLAST.

D. T5 Biax/Dulux fluorescent Lamps: 40W Energy saving 3500K, 3150 lumen, 82 CRI, as scheduled, designed to operate properly when driven by program rapid start ballast. 39W Energy saving 3500K, 2900 lumen, 82 CRI, as scheduled, designed to operate properly when driven by program rapid start ballast.

E. T4 compact fluorescent Lamps: 42W – 3200 lumen, 32W – 2400 lumen, 26W – 1800 lumen, 82 CRI, designed to operate properly when driven by program rapid start ballast, 3500K.

F. All lamps shall meet the EPA'S Toxicity characteristic Leaching Procedure (TCLP) tests for low mercury and non-hazardous for the purpose of disposal.

G. Incandescent Lamps: Rated 130 volt.

H. Provide lamp types specified for luminaire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Complete with 660 watt sockets, wiring, ballasts, stems, hangers, fittings, end plates, pendant feeds, aircraft cable, etc.

B. Install in accordance with manufacturer's instructions.

C. Fixtures in sloping ceilings shall have angle face plate for proper orientation of fixture.

D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Fixtures shall have frame and trim details to match the ceiling suspension system furnished. Coordinate details with Acoustical Treatment Section and installation with the Ceiling Installer to assure fixtures are centered on tiles or on joints as required.

E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Install spacers where required to allow proper installation of rabbeted (Tegular) ceiling tiles. Secure to prohibit movement.

F. Install clips to secure recessed luminaires in place. Install recessed luminaires to permit removal from below.

G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

H. Install wall mounted luminaires at height as indicated.

I. Install accessories furnished with each luminaire.

J. Additional Wiring Methods For Luminaires:
   1. Refer to Division 26 Section "Basic Electrical Requirements: Performance Requirements."
   2. Refer to Division 26 Section "Wire and Cable: Wiring Methods."

3. Recessed and surface incandescent fixtures: Wiring rated minimum 300EF in metallic conduit where required for Underwriters' approval.
4. Fluorescent Fixtures: Wiring within housings and between fixtures and junction boxes above ceilings shall be Type THHN insulated conductors rated for use at temperatures not lower than 90E C.
5. Wiring From Recessed Fixtures To Junction Boxes: As described in Division 26 Section "Basic Electrical Requirements: Performance Requirements."
6. Wiring to Exterior Pole Mounted Luminaires and Bollards: Per Division 26 Section “Conduit” - Conduit Requirements for underground installations and Division 26 Section “Wire and Cable” - Wiring Methods for underground installations and as shown on the Drawings. Where tapped conductors are used at the base of the pole, provide fusing on each current carrying conductor to protect wiring up pole.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

L. Install specified lamps in each luminaire.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Locate fixtures to avoid interference with mechanical and structural features.

3.3 FIELD QUALITY CONTROL

A. All fixtures and equipment shall be in first-class condition at time of delivery of building to Owners with all scratches, mars, etc., refinished to factory standards.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.4 ADJUSTING/CLEANING/RELAMPING

A. Relamp luminaires whose lamps have failed at Substantial Completion and six (6) months thereafter.

B. Clean electrical parts to remove conductive and deleterious materials.

C. Remove dirt and debris from enclosure.

D. Clean photometric control surfaces using procedures as recommended by manufacturer.

E. Clean finishes and touch up damage.

3.5 SCHEDULE

A. Shown on Drawings.

END OF SECTION 260510