# Streets West Facility HVAC and Lighting Upgrade

**SECTION 00 31 46**
**PERMITS**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Each project has varying requirements for permits, inspections, and fees based on the scope, size, and location of the project.

B. The City of Madison (Owner) is subject to all permits, inspections and associated fees for construction, demolition, utility connection, storm water management, and other similar requirements that may be required to complete the scope of work associated with these contract documents.

C. The General Contractor (GC) shall be responsible for obtaining all permits, inspections and paying for all associated fees unless specifically identified within this specification.

### 1.2. REFERENCES

A. The following references are not intended to be all inclusive. It shall be the GC's responsibility to determine all requirements based on the scope of work in the contract documents.

B. City of Madison Ordinances: Review all ordinances that may require a permit or fee that may be connected with a required permit. Contact the following City Agencies to determine the exact requirements during bidding

1. Building Inspection
2. Zoning
3. Engineering
4. Water Utility
5. Traffic Engineering
6. Others as may be specified by the contract documents.

B. State Statutes

C. Other Regulatory Regulations

D. Other Agencies or companies that may have related requirements

1. Madison Metropolitan Sewerage District
2. Local gas and electric utility companies
3. Other utility companies

### 1.3. GENERAL CONTRACTORS REQUIREMENTS

A. The GC shall be responsible for all of the following:

1. Execute application for all required permits as may be required by the scope of work described within the contract documents.
2. Scheduling all required inspections that may be conditions of any required permits.
3. Paying for other permits not explicitly stated as excluded in this section.

B. The GC is not responsible for paying for the City Building, City HVAC, City Electrical, City Plumbing, Madison Fire Department Sprinkler and Madison Fire Department Fire Alarm permits.

C. The GC shall provide high quality scanned images of all required permits and inspections and upload them to the Contract Documents-Regulatory Documents Library on the Project Management Web Site.

## PART 2 – PRODUCTS – THIS SECTION NOT USED

## PART 3 – EXECUTION – THIS SECTION NOT USED

**END OF SECTION**

# SECTION 00 43 25
# SUBSTITUTION REQUEST FORM (DURING BIDDING)



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The City of Madison uses a specific list of preferred products for various specification items to establish standards of quality, utility, and appearance required.

B. The City of Madison will not allow substitutions for specified Products except as follows:
   1. The Product is no longer produced or the product manufacturer is no longer in business.
   2. The manufacturer has significantly changed performance data, product dimensions, or other such design criteria for the specified Product(s).
   3. Products specified by naming one or more Products or manufacturer's and "or approved equal" or "approved equivalent."

C. The procedures in this specification shall apply to all proposals by Contractors, Suppliers, Vendors, and Manufacturers when the conditions in item 1.1.B. above have been met during the bidding phase.

### 1.2. RELATED SPECIFICATIONS

A. 01 25 13 Product Substitution Procedures

## PART 2 – PRODUCTS – THIS SECTION NOT USED

## PART 3 - EXECUTION

### 3.1. REQUESTING A SUBSTITUTION DURING BIDDING

A. In the event that a substitution is requested during the bidding phase the Contractor, Supplier, Vendor, or Manufacturer shall do all of the following:
   1. Submit a Substitution Request Form for each different product. Use a printed/scanned copy of the form at the end of this specification as a cover sheet.
   2. Support your request with complete data, drawings, specifications, performance data and samples as appropriate. A complete submission shall include the following:
      a. Substitution Request Form as a cover sheet
      b Comparison of qualities of the proposed substitutions with that specified.
      c. Changes required in other elements of the Work because of the substitution.
      d. Effect on the construction schedule.
      e. Cost data comparing the proposed substitution with the Product specified.
      f. Any required license fees or royalties.
      g. Availability of maintenance service and source of replacement materials.
   3. Submit the Substitution Request Form and all required supporting documentation to the City Project Manager and Project Architect.
      a. Submissions to be done as complete PDF files for each product, appropriately titled
      b. Email submissions to the Project Architect and City Project Manager at the email addresses provided on the last page of Section D of the contract documents.
         i. The subject line shall include the contract number and "Request for Substitution". Example: Contract 1234 – Request for Substitution
   4. Submissions must be received by the substitution request deadline specified in Section A of the Contract Documents.

**3.2. SUBMISSION REVIEW**

A. The Project Architect, City Project Manager, members of the design team, and the Owners staff shall review all submissions for substitutions during the bidding phase.

**3.3. SUBSTITUTION APPROVAL**

A. All requests for substitutions that have been approved shall be published by Addenda to the bid documents.

**END OF SECTION**

# SECTION 00 43 43
# WAGE RATES FORM



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The Reimbursable Hourly Worksheet is a contractor provided document that indicates the basic rate of pay, fringe benefits, and each companies cost of required insurance for all Trades and Classifications that will be performing productive labor during the execution of this contract.
   1. Rates shall be similar to recognized rates published by the Bureau of Labor Statistics, Associated General Contractors (AGC), Associated Builders and Contractors (ABC), appropriate union contracts, and other similar organizations or documents.

B. The Reimbursable Labor Rate Worksheet shall provide the basis for labor rates being used on Change Order Request forms.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 26 57 Change Order Request
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 32 19 Submittals Schedule

## PART 2 – PRODUCTS – NOT USED

## PART 3 - EXECUTION

### 3.1. GENERAL REQUIREMENTS

A. Prior to the Pre-Construction Meeting the City Project Manager (CPM) or the City Construction Manager (CCM) shall provide the GC a copy of the *Reimbursable Labor Rate Worksheet.xls*.
   1. See the last page of this specification for an example of the worksheet.

B. The GC shall provide all subcontractors that will be performing productive labor during the execution of this contract with additional copies of the worksheet as needed.

C. All contractors shall be required to fill out and submit completed worksheets for all Trades and Classifications of labor that will be performing productive labor during the execution of this contract.

### 3.2. GENERAL CONTRACTORS RESPONSIBILITIES

A. The GC shall consolidate all Trades and Classifications into one master Excel Workbook of all trades.

B. The GC shall provide the combined workbook as required by Section 1.6 of Specification 01 32 19 Submittals Schedule for review and approval by the Owners Representatives.
   1. Submittal shall be an Exported PDF of the completed Excel Workbook.
      a. As an Exported PDF the individual worksheets will be bookmarked and the document will be word searchable for easy reference.

C. The GC shall only use the rates posted in the approved submittal throughout the execution of this contract.

## Reimbursable Hourly Rate Worksheet

*(see bottm of page for instructions)*

Project Name:

Project Location:

Project Number:

Contractor:

Rates are based on the following documentaton:

**Enter TRADE Here:**

**Carpenter**

| Classification: | | Foreman | Journeyman | Laborer | Apprt 1 | Other | Other | Other |
|---|---|---|---|---|---|---|---|---|
| **Base Rate (BR)** | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Vacation | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Health Insurance | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Pension | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Apprenticeship | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| *Sub-total* | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| **BR Sub-total** | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Work. Comp | % of BR | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Gen Liability | % of BR | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| WI Unemploy | % of BR | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| Fed Unemploy | % of BR | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| FICA | % of BR | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| *Sub-total* | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |
| **TOTAL COST** | | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 |

Enter **YOUR** percentage of base rate in the column below.

| % of BR | |
|---|---|
| 0 | - Work. Comp |
| 0 | - Gen Liability |
| 0 | - WI Unemploy |
| 0.6 | - Fed Unemploy |
| 7.65 | - FICA |

**Form Instructions:**

1. Provide a work sheet for ALL Trade Classifications that will be performing on site productive labor during the execution of this project.

2. Responsible contractor to complete only boxes that are shaded, all non-shaded boxes are formula driven.

3. Contractor shall provide the name of the source used for these rates. (union contract, Bureau of Labor and Statistices, AGC, ABC, etc.) and be prepared to provide copies if so requested.

**END OF SECTION**

**SECTION 01 25 13**
**PRODUCT SUBSTITUTION PROCEDURES**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The City of Madison uses a specific list of preferred products for various specification items to establish standards of quality, utility, and appearance required.

B. The City of Madison will not allow substitutions for specified Products except as follows:
   1. The Product is no longer produced or the product manufacturer is no longer in business.
   2. The manufacturer has significantly changed performance data, product dimensions, or other such design criteria for the specified Product(s).
   3. Products specified by naming one or more Products or manufacturer's and "or approved equal" or "approved equivalent."

C. The City of Madison will not allow substitutions for specified Products as follows:
   1. For Products specified by naming only one Product and manufacturer, no substitute product will be considered.
   2. For Products specified by naming several Products or manufacturers select any one of the products or manufacturers named, which complies with the specifications. No substitute product will be considered.

D. Request for substitutions from any party other than the General Contractor (GC) will not be accepted.

### 1.2. RELATED SPECIFICATIONS

A. Section 00 43 25 Substitution Request Form (During Bidding)
B. Section 01 26 13 Request for Information (RFI)
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 33 23 Submittals

## PART 2 – PRODUCTS

### 2.1. SUBSTITUTION REQUEST FORM

A. During bidding all contractors (General and Sub-contractors) and suppliers of materials or products shall reference Specification Section 00 43 25 and provide a pdf copy of the Substitution Request form located at the end of that section with all required attachments directly to the Project Architect.

B. After bidding only the GC shall submit a request and shall use the form located at the end of this specification and submit the request on the Project Management Web Site.

## PART 3 - EXECUTION

### 3.1. REQUESTING A SUBSTITUTION DURING BIDDING

A. In the event that a substitution is requested during the bidding phase the Contractor or Supplier shall meet the substitution request deadline listed in the bidding documents. No substitution request will be considered during the bidding period after the stated substitution request deadline.

B. See specification 00 43 25 Substitution Request Form (During Bidding).

### 3.2. REQUESTING A SUBSTITUTION AFTER AWARD OF CONTRACT

A. A substitution request will only be considered after award of contract if it meets the qualifying provisions as described in 1.1.B.1 and .2 above.

B. The GC shall submit a substitution request using the digital form on the Project Management Web Site.

1. Consulting Staff, Owner and Owners Representatives will review the request and provide the appropriate approvals and feed back to the GC.

**3.3. UNAUTHORIZED SUBSTITUTIONS**

A. Any Contractor who substitutes products without proper authorization by the Owner and Architect will be required to immediately remove and replace the product and all costs required to conform to the Contract Documents shall be borne by the General Prime Contractor.

**END OF SECTION**

# SECTION 01 26 13
# REQUEST FOR INFORMATION (RFI)



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Contractors shall use the RFI form/process to request additional information or clarification regarding the construction documents.

B. All RFI documentation will be processed through the through the Project Management Web Site (PMWS).

### 1.2. RELATED SPECIFICATIONS

| | | |
|---|---|---|
| A. | Section 01 26 46 | Construction Bulletin (CB) |
| B. | Section 01 26 57 | Change Order Request (COR) |
| C. | Section 01 26 63 | Change Order (CO) |
| D. | Section 01 31 23 | Project Management Web Site (PMWS) |
| E. | Section 01 91 00 | Commissioning |

### 1.3. PERFORMANCE REQUIREMENTS

A. RFI issues initiated by any contractor shall be done through the General Contractor (GC).
   1. RFIs submitted by any Sub-contractor under the GCs control shall be returned with no response.

B. Submit a new RFI for each issue. Only multiple questions that are of a similar nature may be combined into one RFI shall be allowed and responded to.

### 1.4. QUALITY ASSURANCE

A. The GC shall be responsible for all of the following:
   1. Ensure that any request for additional information is valid and the information being requested is not addressed in the construction documents.
   2. Ensure that all requests are clearly stated and the RFI form is completely filled out.
   3. Ensure that all Work associated an RFI response is carried out as intended.

B. The Project Architect /Project Engineer (A/E PROJ MGR) shall be responsible for the following:
   1. Ensure that all responses to contractor initiated RFIs are properly responded to in a timely fashion.
      a. The CPM, Owner, consulting staff, and other City staff shall be responsible for the initial review of the RFI. The A/E PROJ MGR shall be responsible for codifying all consultant and Owner/City staff comments into a unified RFI response.

## PART 2 – PRODUCTS

### 2.1. REQUEST FOR INFORMATION FORM

A. The RFI form is located on the Project Management Web Site.

## PART 3 - EXECUTION

### 3.1. CONTRACTOR INITIATED RFI

A. Immediately on discovery of the need for additional information or interpretation of the Contract Documents any contractor may initiate an RFI for additional information or clarification through the GC.

B. The GC shall use the Project Management Web Site and completely fill out the form.

1. Thoroughly explain the issue at hand, provide backup information (photographs, sketches, drawings, data, etc.) as necessary, and clearly state the question or problem that requires a resolution. Combine like or related issues but do not include multiple issues on one form.
    a. Example. If a duct interferes with other critical piping and electrical work include all issues into one RFI.
    b. Example. If you have a question regarding the chiller and another regarding toilet partitions create separate RFIs.

**3.3. RFI RESPONSES**

A. Responses to simple RFI issues shall be completed within five (5) working days of the RFI form being submitted.

B. Responses to more complex issues may require additional time or may require a Construction Bulletin to be published. The initial RFI shall be responded to within five (5) working days stating that the RFI is being reviewed and provide an estimated date for the response.

C. The following GC generated RFIs will be returned without action:
    1. Requests for approval of submittals
    2. Requests for approval of substitutions
    3. Requests for approval of Contractor's means and methods.
    4. Requests for coordination information already indicated in the Contract Documents.
    5. Requests for adjustments in the Contract Time or the Contract Sum.
    6. Requests for interpretation of A/E's actions on submittals.
    7. Incomplete RFI or inaccurately prepared RFI.

**3.4. COMMENCEMENT OF WORK RELATED TO AN RFI**

A. The GC shall only proceed with the Work of an RFI when additional information is not required.

B. The GC shall not proceed with any Work associated with an RFI while it is under review.

C. The GC shall not proceed with any Work associated with an RFI that clearly states a CB will be issued in response to the RFI.

D. The GC will be required to immediately remove and replace unauthorized Work and all costs required to conform to the Contract Documents shall be borne by the GC.

**END OF SECTION**

# SECTION 01 26 46
# CONSTRUCTION BULLETIN (CB)



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Construction Bulletins (CB) are formal published construction documents that modify the original contract bid documents after construction has commenced. CBs may be published for many reasons, including but not limited to the following:
   1. Clarification of existing construction documents including specifications, plans, and details
   2. Change in product or equipment
   3. A response to a Request for Information
   4. Change in scope of the contract as either an add or a deduct of work

B. CBs provide a higher degree of detail in response to a Request for Information (RFI) through directives, revised plans/details, and specifications as necessary.

C. The CB may change the original contract documents through additions or deletions to the Work.

D. Where the directives of a CB are significant enough to warrant a Change Order Request (COR) the GC shall use all information provided in the CB to assemble all required back-up documentation for additions and deletions of materials, labor and other related contract costs for the COR.

E. All CB documentation will be processed through the Project Management Web Site (PMWS).

### 1.2. RELATED SPECIFICATIONS

| | | |
|---|---|---|
| A. | Section 01 26 13 | Request for Information (RFI) |
| B. | Section 01 26 57 | Change Order Request (COR) |
| C. | Section 01 26 63 | Change Order (CO) |
| D. | Section 01 31 23 | Project Management Web Site (PMWS) |
| E. | Section 01 91 00 | Commissioning |

### 1.3. PERFORMANCE REQUIREMENTS

A. Project Architect /Project Engineer (A/E PROJ MGR): The A/E PROJ MGR shall be the only person authorized to publish a CB as needed for any reason indicated in section 1.1.A above. The A/E PROJ MGR shall consult as necessary with any of the following while drafting the CB and shall confirm final direction with the CPM prior to issuing a CB:
   1. City Project manager (CPM)
   2. Owner
   3. Members of the consulting staff
   4. Members of city staff
   5. The General Contractor
   6. Sub-contractors
   7. Commissioning Agent (CxA)

B. General Contractor: The GC shall be responsible for the following as needed:
   1. Executing the directives of the CB when they believes that no changes in labor, materials, equipment, or contract duration will be required for additions or deletions.
   2. Submit a COR when they believes that a change in labor, materials, equipment or contract duration will be required for additions or deletions.

**1.4. QUALITY ASSURANCE**

A. The A/E PROJ MGR shall be responsible for ensuring the final CB sufficiently provides direction, details, specifications and other information as necessary for the GC to perform the intended Work.

B. The A/E PROJ MGR shall be responsible for ensuring the final CB is published as expeditiously as practical based on the complexity of the CB being written. CBs that may affect the GC critical path shall be given priority.

**PART 2 – PRODUCTS**

**2.1. CONSTRUCTION BULLETIN FORM**

A. The CB form is located on the Project Management Web Site.

**PART 3 - EXECUTION**

**3.1. WRITING THE CONSTRUCTION BULLETIN**

A. The A/E PROJ MGR shall draft a CB as needed using the Construction Bulletin form on the Project Management Web Site.

1. The A/E PROJ MGR and/or consulting staff as necessary shall provide specifications, model numbers and performance data, details and other such information necessary to clearly state the intentions of the CB.
2. The consulting staff, CPM, Owner, CxA and other City Staff shall review the draft and recommend changes as needed.
3. The A/E PROJ MGR shall amend the draft as necessary into a final CB for review.
4. Full plan sheets and entire specification sections referred to within a CB, shall be reissued with the CB.

B. Once the final CB has been approved the A/E PROJ MGR shall "Submit" the CB through the Project Management Web Site to the City Project Manager.

C. The City Project Manager will close and distribute the CB.

**3.2. EXECUTING THE CONSTRUCTION BULLETIN**

A. The GC shall acknowledge receipt of the CB on the Project Management Web Site as instructed in the Tutorial Manual provided to the awarded contractor.

B. The GC shall notify all Sub-contractors of the CB and publish the CB to all field sets of drawings and specifications as appropriate.

C. The GC shall execute the directives of the CB or submit COR documentation as necessary during the execution and implementation of the CB.

1. See Specification 01 26 57 Change Order Request (COR)

**END OF SECTION**

# SECTION 01 26 57
# CHANGE ORDER REQUESTS (COR)



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Except in cases of emergency, no changes in the Work required by the Contract Documents may be made by the General Contractor (GC) without having prior approval of the City Engineer or their representative.

B. The City may at any time, without invalidating the Contract and without Notice to Sureties, order changes in the Work by written Change Order (CO). Such changes may include additions and/or deletions.

C. Where the City desires to make changes in the Work through use of written Change Order Request (COR), the following procedures apply:

1. If requested by the City, the GC shall prepare and submit a detailed proposal, including all cost and time adjustments to which the GC believes it will be entitled if the change proposed is incorporated into the Contract. The City shall be under no legal obligation to issue a Change Order for such proposal.
2. The parties shall attempt in good faith to reach agreement on the adjustments needed to the Contract to properly incorporate the proposed change(s) into the Work. In the event that the parties agree on such adjustments, the City may issue a Change Order and incorporate such changes and agreed to adjustments, if any.
3. In some instances, it may be necessary for the City to authorize Work or direct changes in Work for which no final and binding agreement has been reached and for which unit prices are not applicable. In such cases the following shall apply.
    a. Upon written request by the City, the GC shall perform proposed Work
    b. The cost of such change may be determined in accordance with this specification.
    c. In the event agreement cannot be accomplished as contemplated herein, the City may authorize the Work to be performed by City forces or to hire others to complete the Work. Such action on the part of the City shall not be the basis of a claim by the GC for failure to allow it to perform the changed Work.

D. Where changes in the Work are made by the City through use of a force account basis, the GC shall as soon as practicable, and in no case later than ten (10) working days from the receipt of such order, unless another time period has been agreed to by both parties, give the City written Notice, stating:

1. The date, circumstances and source of the extra work; and,
2. The cost of performing extra work described by such Order, if any; and,
3. Effect of the order on the required completion date of the Project, if any.

E. The giving of each Notice by the GC as prescribed by this specification, shall be a requirement to liability of the City for payment of any additional costs incurred by the GC in implementing changes in the Work. Under this specification, no order or statement of the City shall be treated as a Change Order, or shall entitle the GC to an equitable adjustment of the terms of this Contract or damages for costs incurred by the GC on any activity for which the Notice was not given.

F. In the event Work is required due to an emergency as described in this specification the GC must request an equitable adjustment as soon as practicable, and in no case later than ten (10) working days of the commencement of such emergency.

G. All GC requests for equitable adjustment shall be submitted to the CPM per the specifications below. Such requests shall set forth with specificity the amount of and reason(s) for the proposed adjustment and shall be accompanied by supporting information and documents.

H. No adjustment of any kind shall be made to this Contract, if asserted by the GC for the first time, after the date of final payment.

I. This specification shall be used by the GC when preparing documentation for any COR to ensure each has been properly and completely filled out as required by the City of Madison.

J. All COR documentation will be processed through the Project Management Web Site (PMWS).

**1.2. RELATED SPECIFICATION SECTIONS**

A. Section 01 26 13 Request for Information (RFI)

B. Section 01 26 46 Construction Bulletins (CB)

C. Section 01 26 63 Change Order (CO)

D. Section 01 31 23 Project Management Web Site (PMWS)

E. Section 01 91 00 Commissioning

F. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".

1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
   http://www.cityofmadison.com/business/pw/specs.cfm
   a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
   b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.

**1.3. DEFINITIONS AND STANDARDS**

A. LABOR: The amount of time and cost associated with the performance of human effort for a defined scope of Work. Labor is further defined as follows:

1. Labor rate is the total hourly rate which includes the basic rate of pay, fringe benefits plus each company's cost of required insurance, also referred to as a reimbursable labor rate.
2. Unit labor is the labor hours anticipated to install the corresponding unit of material.
3. Labor cost is the labor hours multiplied by the hourly labor rates.

B. MATERIAL: Actual material cost is the amount paid, or to be paid, by the GC for materials, supplies and equipment entering permanently into the Work, including cost of transportation and applicable taxes. The cost shall not exceed the usual and customary cost for such items available in the geographical area of the project

C. LARGE TOOLS AND MAJOR EQUIPMENT: Large tools and major equipment are those with an initial cost greater than $1,500, whether from the GC or other sources.

1. Tool and equipment use and time allowed is only for extra work associated with change orders.
   a. Rental Rate is the machine cost associated with operating a piece of equipment for a defined length of time (hour, day, week, or month) and shall not exceed the usual and customary amount for such items available in the geographical area of the project.
   b. Rental cost is the rental rate multiplied by the anticipated duration the equipment shall be required.
2. The GC shall provide a breakdown of all rental rates to indicate what items and costs are associated with the rate. Examples of items to include in the breakdown would be fuel consumption, lubrication, maintenance and other similar expenses but not including profit and overhead.
3. When large tools and equipment needed for Change Order work are not already at the job site, the actual cost to get the item there is also reimbursable.

D. BOND COST: The cost shall be calculated at 1% of the total proposed change order.

E. SUB-CONTRACTOR COSTS: Sub-contractor costs are for those labor, material, and equipment costs required by subcontracted specialties to complete the Change Order work.

F. OVERHEAD AND PROFIT Markup: The allowable markup percentage to a COR by the GC and Sub-contractors for overhead and profit. All of the following are expenses associated with overhead and profit and shall not be reimbursable as individual items on any COR:

1. CHANGE ORDER PREPARATION: All costs associated with the preparing and processing of the change order.
2. DESIGN, ESTIMATING, AND SUPERVISION: All such efforts, unless specifically requested by Owner as additional Work to be documented as a COR or portion thereof.

3. INSTALLATION LAYOUT: The layout required for the installation of material and equipment, and the installation design, is the responsibility of the GC.
4. SMALL TOOLS AND SUPPLIES: The cost of small hand tools with an initial cost of $1,500 or less, along with consumable supplies and expendable items such as drill bits, saw blades, gasoline, lubricating or cutting oil, and similar items.
5. GENERAL EXPENSE: The general expense, which is those items that are a specific job cost not associated with direct labor and material such as job trailers, foreman truck, and similar items.
6. RECORD DRAWINGS: The preparation of record or as-built drawings.
7. OTHER COSTS: Any miscellaneous cost not directly assessable to the execution of the Change Order including but not limited to the following:
    a. All association dues, assessments, and similar items.
    b. All education, training, and similar items.
    c. All drafting and/or engineering, unless specifically requested by Owner as additional Work to be documented as a Change Order proposal or portion thereof.
    d. All other items including but not limited to review, coordination, estimating and expediting, field and office supervision, administrative work, etc.

G. Contract Extension: The necessary amount of time to be added to the contract deadlines for the completion of a change order.

**1.4. CONTRACT EXTENSION**

A. The GC shall not assume that every COR will require a Contract Extension. If the GC feels a contract extension is warranted, they shall provide sufficient scheduling information that shows how the COR being requested impacts the critical path of the project.

B. The City of Madison strongly encourages the GC to explore alternative methods and practices prior to submitting a COR with a request for contract extension.

**1.5. OVERHEAD AND PROFIT MARKUP**

A. Pursuant to the City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction, Section 104.7, Extra Work, the following maximum allowable markups shall be strictly enforced on all change orders associated with the execution of this contract.
1. The total maximum overhead and profit shall not exceed fifteen percent (15%) of the total costs.
2. The total maximum overhead and profit shall be distributed as follows:
    a. For work performed and materials provided solely by the General Contractor, fifteen percent (15%) of the total costs.
    b. For work performed and materials provided solely by Sub-contractors and supervised by the General Contractor:
        i. Supervision of the GC, five percent (5%) of the total Sub-contractor cost.
        ii. Sub-contractors work and materials ten percent (10%) of the total Sub-contractor cost.

**1.6. PERFORMANCE REQUIREMENTS**

A. The GC shall become thoroughly familiar with this specification as it will identify procedures and expenses that are or are not allowed under the Change Order and Change Order Request process.

B. The GC shall be responsible for all of the following:
1. Carefully reviewing the CB that is associated with the COR.
2. Collecting required supporting documentation from all contractors that quantify the need for a COR.
    a. Labor hours and wage rates
    b. Material costs
    c. Equipment costs

C. The following shall apply to establishing prices for labor, materials, and equipment costs:
1. Where Work to be completed has previously been established by individual bid items in the contract bid proposal the GC shall use the unit bid prices previously established.
2. Where Work to be completed was bid as a Lump Sum without individual bid items the GC shall provide a breakdown of all labor, materials, equipment including unit rates and quantities required.

D. The completion date is determined by Owner. The schedule, however, is the responsibility of the GC. Time extensions for extra Work will be considered when a schedule analysis of the critical path shows that the Change Order Request places the Work beyond the completion date stated in the Contract.

**1.7. QUALITY ASSURANCE**

A. The GC shall be responsible for ensuring that all COR supporting documentation meets the following requirements prior to completing the COR form on the Project Management Web Site:
   1. Sufficiently indicates labor, material, and other expenses related to completing the intent of the CB.
   2. No costs exceed the usual and customary amount for such items available in the geographical area of the project, and no costs exceed those established under the contract.

B. The Project Architect /Project Engineer A/E PROJ MGR, Commissioning Agent (CxA), City Project Manager (CPM), other members of the consulting staff, and city staff shall review all COR requests to ensure that the intent of the CB will be met under the proposal of the COR or request additional information as necessary.

**PART 2 – PRODUCTS**

**2.1. CHANGE ORDER REQUEST FORM**

A. The COR form is located on the Project Management Web Site.

**PART 3 - EXECUTION**

**3.1. ESTABLISHING A CHANGE ORDER REQUEST**

A. Upon receipt of a Construction Bulletin (CB) where the GC believes a significant change in contract scope warrants the submittal of a COR the GC shall do all of the following within ten (10) working days after receipt of the CB:
   1. Review the CB with all necessary trades and sub-contractors required by the change in scope.
      a. Additions or deletions to the contract scope shall be as directed within the CB.
      b. Additions or deletions of labor and materials shall be determined by the GC based on the directives of the CB.
   2. Assemble all required back-up documentation for additions and deletions of materials, labor and other related contract costs as previously outlined in this specification.
   3. Submit a COR request form on the Project Management Web Site.

B. Submitting a COR does not obligate the GC to complete the work associated with the COR nor does it obligate the Owner to approve the COR as a change to the contract.

**3.2. SUBMIT A CHANGE ORDER REQUEST FORM**

A. This specification shall provide a subject overview only. In depth instructions shall be provided to the awarded Contractor in a PDF Instructional Manual.

B. The GC shall select the appropriate link on the Project Management Web Site.

C. The software will open a new COR form and the GC shall provide all of the following information:
   1. DO NOT perform any calculations on this worksheet, only provide the raw data as requested below. All calculations, totals, and markups shall be computed as described within this specification.
   2. Provide a summary description of the COR request, and justification for any requested time extension to the contract, indicate the number of calendar days being requested for the extension and add any attachments to the form as needed.
   3. Provide all GC self-performance data including all of the following:
      a. Materials description, quantities, and unit costs.
      b. Labor hours and rates for all Foremen, Journeymen, and Apprentices by trade.
      c. Equipment descriptions, quantities, unit costs and rates.
   4. Provide all Sub-contractor data including all of the following:
      a. Materials description, quantities, and unit costs.
      b. Labor hours and rates for all Foremen, Journeymen, and Apprentices by trade.
      c. Equipment descriptions, quantities, unit costs and rates.
   5. Ensure all calculations performed by the form have been completed correctly. Contact the CPM directly if you suspect an error before hitting the save button.

D. When all data has been entered submit the COR form. This will kick off the COR Review and Approval process.

**3.3. CHANGE ORDER REQUEST REVIEW, APPROVAL, AND PROCESSING**

A. The A/E PROJ MGR and CPM shall review all CORs submitted by the GC.

1. Additional consulting staff and city staff having knowledge of the components of the COR shall review and advise the A/E PROJ MGR and CPM as to the accuracy of the items, quantities, and associated costs of the COR as directed by the CB.
2. The CPM shall review the COR with the Owner.

B. If required the A/E PROJ MGR and CPM, shall in good faith, further negotiate the COR with the GC as necessary. All amendments to any COR shall be documented within the Project Management Web Site software.

C. After final review of the COR the CPM and Owner may accept the COR.

D. The CPM shall prepare the COR in the form of an official Board of Public Works Change Order for final review and approval as outlined in Section 01 26 63 Change Order (CO).

E. The GC shall not act upon any accepted COR until it has received final approval through the Public Works process as an official CO to the Work unless instructed to do so by the CPM. Proceeding without the final approval of a fully authorized Change Order is at the GC's own risk.

**3.4. EMERGENCY CHANGE ORDER REQUEST**

A. In the event Work is required due to an emergency as described in the Contract Documents, the GC must request an equitable adjustment as soon as practicable, and in no case later than ten (10) working days of the commencement of such emergency.

B. The GC shall provide full documentation of all labor, materials and equipment used during the period of emergency as part of the COR submittal.

**END OF SECTION**

# SECTION 01 26 63
# CHANGE ORDER (CO)



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Except in cases of emergency, no changes in the Work required by the Contract Documents may be made by the General Contractor (GC) without having prior approval of the City Project Manager (CPM).

B. The City may at any time, without invalidating the Contract and without Notice to Sureties, order changes in the Work by written Change Order. Such changes may include additions and/or deletions.

C. The Change Order (CO) is a Board of Public Works (BPW) form that is reviewed and approved by a specific process.

D. The CO form is typically made up of multiple Change Order Requests (CORs) and/or Bid Items as appropriate depending on the type of project and how the contract was bid.

E. All CO documentation shall be processed through the Project Management Web Site (PMWS).

### 1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 26 13 Request for Information (RFI)
B. Section 01 26 46 Construction Bulletin (CB)
C. Section 01 26 63 Change Order Request (COR)
D. Section 01 31 23 Project Management Web Site (PMWS)
E. Section 01 91 00 Commissioning

### 1.3. BOARD OF PUBLIC WORKS PROCEDURE

A. The Board of Public Works has a very explicit procedure for the review and approval of all change orders associated with any Public Works Contract as follows:
   1. The Supervisory Chain of the CPM shall review and approve any CO under $20,000 provided it does not include either of the following:
      a. The CO does not request a time extension to the contract.
      b. The CO does not cause the contract contingency sum to be exceeded.
   2. The Board of Public Works shall review and approve any CO that requires any of the following:
      a. Any CO over $20,000.
      b. Any CO requesting a time extension to the contract regardless of the monetary value of the CO.
      c. Any CO that that causes the contract contingency sum to be exceeded.

B. The Board of Public Works generally meets every other week and only once in August and December. The GC is cautioned that, under normal scheduling, a CO requiring a BPW review will take a minimum of two (2) weeks to achieve final approval.
   1. The City shall not be responsible for additional delays to the Work caused by the scheduling constraints of the Board of Public Works.

C. *SPECIAL NOTE:* The GC is cautioned to never proceed unless told to do so by the CPM. Only in rare instances may the CPM give a written notice to proceed on a COR without an approved CO. Proceeding without the written notice of the CPM or an approved CO is at the GC's own risk.

## PART 2 – PRODUCTS

### 2.1. CHANGE ORDER FORM

A. The CO form is located on the Project Management Web Site. The CPM shall click the link in the left margin of the project web site opening a new form. Project information is pre-loaded, the CPM only needs to enter information and make attachments as needed to complete the form.

## PART 3 - EXECUTION

### 3.1. PREPARATION OF THE CHANGE ORDER

A. The CPM shall prepare the required CO forms in the Project Management Web Site as follows:
   1. Provide information for all contract information.
   2. Provide a general description of the items described within the change order.
   3. Provide detailed information for each Item on the CO form. At the option of the CPM, they may include multiple Change Order Requests each as their own item.
   4. Provide required pricing and accounting information as needed for the item.
   5. Insert attachments of contractor/architect provided information that clarifies and quantifies the CO. Attachments may include but not be limited to material lists, estimated labor, revised details or specifications, and other documents that may be related to the requested change.
   6. Save the final version of the completed CO.

### 3.2. EXECUTION OF THE CHANGE ORDER

A. Upon saving the CO as described in section 3.1 above, the software associated with the Project Management Web Site shall notify the GC that the CO has been drafted and is ready for review. The GC shall do the following:
   1. Open the CO form using the link provided in the email notification and review all items on the form.
   2. The GC shall notify the CPM immediately of any errors or discrepancies on the form and shall not sign or save it.
      a. The CPM shall make any corrections as needed, re-save the form, and notify the GC.
   3. If/when the GC concurs with the CO form as drafted the GC shall digitally sign the form and click SAVE.

B. After the GC digitally signs/saves the CO it shall be routed through the Project Management Web Site for additional review and/or approvals. The CPM shall do the following:
   1. Monitor the review process to ensure the software is working properly at each review step.
   2. Ensure that proper BPW procedures are executed as needed by the CO approval process.
      a. Schedule the CO on the next available BPW agenda if required.
         i. Attend the BPW meeting to speak on the CO to board members and answer questions.
         ii. The GC and/or the Project Architect /Project Engineer (A/E PROJ MGR) may be required to attend the BPW meeting to address specific information as it relates to the Work and/or materials associated with the CO.
   3. Monitor final approval and distribution of the CO.
   4. Notify the GC that the CO has been completed.
   5. Ensure that the CO is posted to the next Public Works payment schedule.
   6. Verify that the GC's next Progress Payment-Schedule of Values show the CO as part of the contract sum.

C. Upon final approval of the CO the GC may proceed with executing the Work associated with the CO.

**END OF SECTION**

# SECTION 01 29 73
# SCHEDULE OF VALUES



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The Schedule of Values (SOV) is a Contractor provided statement that allocates portions of the total contract sum to various portions of the contracted work and shall be the basis for reviewing the Contractors Progress Payment Requests.

B.

C. The General Contractor shall be responsible for filling out and updating the SOV in the Project Management website with each Progress Payment Request.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 26 63 Change Order (CO)
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 23 Project Management Web Site (PMWS)
D. Section 01 32 26 Construction Progress Reporting
E. Section 01 33 23 Submittals
F. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".
   1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
      http://www.cityofmadison.com/business/pw/specs.cfm
      a. Click on the "Part" chapter identified in the specification text. For example, if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
      b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.

### 1.3. RELATED DOCUMENTS

A. The following documents shall be used as the basis for initiating and maintaining the SOV worksheets throughout the execution of this contract.
   1. Drawing documents and specifications (including general provisions) as provided with the bid set documents and any published addendums.
   2. Documents associated with revisions or clarifications to number 1 above after awarding of the contract, including but not limited to:
      a. Construction Bulletins
      b. Request for Information
      c. Approved Change Orders
   3. The latest daily/weekly Construction Progress Report
   4. Other specifications as identified in Section 1.2 above

### 1.4. BASIS OF VALUES

A. The Contractor shall provide a breakdown of the Contract Sum in sufficient detail to assist the Architect and City Project Manager in evaluating Progress Payment Requests. The breakdown detail may require a labor and material breakdown for each division of work or trade or as directed by the CPM.

B. The total sum of all items shall equal the Contract Sum.

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. APPLICATION FOR PAYMENT**

A. The Contractor shall use the Project Management website or Payment with each Progress Payment Request.

B. Completely fill out the Pay Application per the tutorial provided for the PMWS

1. Fill out to reflect the current status of the contract through the payment date being requested.
2. The City of Madison calculates retainage on Public Works Contracts as follows:
   a. In general, across the duration of the contract, 2.5% of the total contract sum, including change orders, is withheld for retainage as referenced from the City of Madison FACILITIES MANAGEMENT SPECIFICATION 110.2:
      i. Beginning with Progress Payment 1, 5% retainage will be withheld until such time that 50% of the total contract sum has been paid out.
      ii. No additional retainage will be withheld after 50% of the total contract sum has been paid, unless additional change orders have been approved after the 50% milestone has been reached. Per City of Madison FACILITIES MANAGEMENT SPECIFICATION 110.2, additional retainage up to 10%, may be held in the event there are holds placed by Affirmative Action or liquidated damages by BPW.
      iii. Retainage for additional change orders after the 50% milestone will be withheld at the rate of 2.5% of the total cost of the change order.
      iv. Retainage is based on the change orders posted to the City's contract worksheet at the time the progress payment is processed.

C. Only change orders that have been finalized and posted to the City of Madison's Application for Partial Payment worksheet may be itemized into the SOV documents.

D. The Contractor shall sign and date the application.

**3.2. PROJECT MANAGEMENT WEBSITE SOV SPREADSHEET**

A. The Contractor shall use the PMWS spreadsheet provided by the City to itemize their SOV for this contract. Provide additional sheets as necessary.

B. Provide information by any method that allocates portions of the total contract sum to various portions of the contracted work. Possible methods include combinations of the following:

1. By division of work
2. By contractor, sub-contractor, sub sub-contractor
3. By specialty item or group
4. Other methods of breakdown as may be requested by the City Project Manager or City Construction Manager at the pre-construction meeting.

C. Provide total cost of the item/description of work including proportionate shares of profit and overhead related to the item.

**3.3. INITIAL SCHEDULE OF VALUES SUBMITTAL**

A. The Contractor shall upload their initial SOV to the Project Management Web Site, no later than five (5) working days after the Pre-construction Meeting.

1. The level of detail shall be as described in section 3.2 above.

B. The Project Architect /Project Engineer (A/E PROJ MGR) and the City Project Manager (CPM) shall review the SOV as any other submittal and may require modifications to reflect additional detail as necessary.

C. The Contractor shall resubmit the SOV as necessary until such time as the A/E PROJ MGR and CPM have sufficient detail for assessing and approving future Progress Payment Applications.

D. Progress Payment Application 1 will not be processed until such time as the Contractor has met this requirement regardless of the amount of work completed per the application.

**3.4. SOV FOR PROGRESS PAYMENT REQUESTS**

A. The Contractor shall update the initial SOV with each Progress Payment Application as follows:

1. Initial items and values as part of Section 3.3 above will not be adjusted once the original Schedule of Values submittal has been approved.

2. Change orders shall be added as additional items and values at the bottom of the SOV as they become approved and posted to the City's contract worksheet. The value for each change order shall be the value indicated on the SOV and shall stand alone. Values shall not be split out or combined with other existing items with similar work descriptions on the original SOV.
3. Fill out columns to properly reflect the work completed and materials received since the last Progress Payment Application.
4. Only materials delivered and stored on the project site may be reflected on SOV progress updates.

B. Provide an updated project schedule with each Progress Payment application.

C. See Specification 01 29 76 Progress Payment Procedures for additional information on submitting Progress Payment Applications.

**END OF SECTION**

**SECTION 01 29 76**
**PROGRESS PAYMENT PROCEDURES**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The General Contractor (GC) shall review this and all related specifications prior to submitting progress payment requests.

B. Progress payment requests (Partial Payment-PP) for this contract shall be applied for by the GC in the Project Management Web Site (PMWS)

C. The City Project Manager (CPM) shall review and amend or approve the PP on the Project Management Web Site.

D. After approval of the PP by the CPM, they shall forward the PP to the appropriate agencies for BPW contractual review and payment processing.

### 1.2. RELATED SPECIFICATIONS

| | | |
|---|---|---|
| A. | Section 01 26 63 | Change Order (CO) |
| B. | Section 01 29 73 | Schedule of Values |
| C. | Section 01 31 19 | Progress Meetings |
| D. | Section 01 31 23 | Project Management Web Site (PMWS) |
| E. | Section 01 32 16 | Construction Progress Schedules |
| F. | Section 01 32 26 | Construction Progress Reporting |
| G. | Section 01 33 23 | Submittals |
| H. | Section 01 45 16 | Field Quality Control Procedures |
| I. | Section 01 77 00 | Closeout Procedures |
| J. | Section 01 78 13 | Completion and Correction List |
| K | Section 01 78 23 | Operation and Maintenance Data |
| L. | Section 01 78 36 | Warranties |
| M. | Section 01 78 39 | As-Built Drawings |
| N. | Section 01 78 43 | Spare Parts and Extra Materials |
| O. | Section 01 79 00 | Demonstration and Training |

### 1.3. RELATED DOCUMENTS

A. The following documents shall be used when evaluating PP requests.

1. Daily and weekly construction progress reports filed since the last payment request.
2. Contractors Schedule of Values as updated from the last payment request. See Specification 01 29 73.
3. Any document that may be required to be submitted for review and approval, as noted by the specifications listed in Section 1.2 above, or the Progress Payment Milestone Schedule in Section 1.4 below, to achieve a required bench mark of contract progression or contract requirement.

### 1.4. PROGRESS PAYMENT MILESTONES

A. City Engineering-Facility Management has developed the Project Payment Milestone Schedule (Section 1.4 below) to assist the GC in providing required construction specific documentation and general contractual documentation in a timely manner.

B. The Progress Payment Milestone Schedule is not an all inclusive list. Multiple agencies review progress payment requests and contract closeout requests. Missing, incomplete, or incorrect documentation for any agency may be a cause for not processing progress payments. It shall be the sole responsibility of the Contractor for providing documentation as required or requested to the appropriate agencies.

C. The milestone schedule is based on the contract total sum and shall be valid for most contracts. Milestone submittals will be required with whatever progress payment hits the percentage of contract total indicated in the schedule.

D. The CPM shall review the milestone schedule with each progress payment request and at their option may elect to hold processing the progress payment until such time as the contractor has met the requirements for providing construction specific documentation.

E. It shall be the General Contractors responsibility to comply with all BPW Contract Administration requirements and related deadlines as outlined in the Award Letter, Award Checklist, and Start Work Letter.

| ***Progress Payment (PP) Milestone Schedule*** | | |
|---|---|---|
| ***Milestone Description*** | ***Due Before*** | ***Remarks*** |
| BPW Contract Administration Documentation<br>• Workforce profiles<br>• Best Value Contracting Documentation<br>• Sub-contractors prequalification approval & Affirmative Action plans<br>• Submittals Schedule<br>• Other as may be required | PP-1, or start work as applicable | • For GC and Sub-contractors before PP-1 regardless of scheduling<br>• Sub-contractors (if applicable), due 10 days before they may start work<br>• Sub-contractors (if applicable), due 10 days before they may start work<br>• Specification 01 32 19 |
| | | |
| Required Construction Submittals/Administrative Documents<br>• Contractors Project Directory<br>• Schedule of Values<br>• Waste Management Plan<br>• Closeout Requirement Checklist<br>• Warranty Checklist<br>• Time Lapse Construction Camera (camera installed and operational)<br>• Restoration specialist(s) qualifications | PP-1 | References<br>• Specification 01 31 23<br>• Specification 01 29 73<br>• Specification 01 74 19<br>• Specification 01 77 00<br>• Specification 01 78 36<br>• Specification 01 32 33<br>• Various Specifications |
| | | |
| Construction Progress Milestones<br>• Early submittals, per submittal schedule<br>• Detailed Contract Schedules | PP-1 | See specifications for specific requirements<br>• Specification 01 32 19, Examples: concrete mix, structural steel, products with long lead times<br>• See Specification 01 32 16 |
| | | |
| General Construction Progress Requirements are all up to date<br>• Progress Schedules<br>• Submittals/Re-submittals (ongoing)<br>• Schedule of Values<br>• Progress Reporting<br>• LEED Documentation<br>• Waste Management documentation<br>• QMOs are being addressed and closed<br>• Progress Cleaning<br>• As-Built Drawings | Each future PP | Verified with each Progress Payment Request<br>• Specification 01 32 16<br>• Specification 01 33 23<br>• Specification 01 29 73<br>• Specification 01 32 26<br>• All specifications with LEED documentation requirements<br>• Specification 01 74 19<br>• Specification 01 45 16<br>• Specification 01 74 13<br>• Specification 01 78 39 |
| *** All of the above are being updated on the Project Management Web Site as required** | | |
| | | |
| BPW Contract Administration Documentation<br>• Weekly payroll reports<br>• Best Value Contracting Reports<br>• SBE Reports | 25% CT or PP 2 | See 1.4.E above. *This progress payment will be with held by BPW for any missing contractual documentation.* |

| ***Progress Payment (PP) Milestone Schedule*** | | |
|---|---|---|
| ***Milestone Description*** | ***Due Before*** | ***Remarks*** |
| | | |
| Construction Progress Milestones<br>• Construction/Contract Closeout Meeting #1<br>• Submittals/Re-submittals complete | 50% CT | • Specification 01 31 19<br>• Specification 01 33 23 |
| | | |
| Operation and Maintenance (O & M) drafts | 60% CT | • Specification 01 78 23 |
| | | |
| Construction/Contract Closeout Meeting #2<br>• Construction closeout checklist | 70% CT | • Specification 01 31 19<br>• Specification 01 77 00 |
| | | |
| BPW Contract Administration Documentation<br>• Request Finalization Review from BPW | 80% CT | This is a recommendation to the GC and is not a requirement of this PP.<br>• Specification 01 77 00 |
| | | |
| Construction Progress Milestones<br>• Operation and Maintenance (O & M) finals, accepted<br>• All major QMO issues resolved<br>• As-Built Drawings, Division Trades ready for GC review | 80% CT | • Specification 01 78 23<br>• Specification 01 45 16; Items that could prevent occupancy<br>• Specification 01 78 39 |
| | | |
| All of the following shall be completed for this PP:<br>• Regulatory Inspections completed<br>• All QMO reports closed<br>• Demonstration and Training completed<br>• Attic Stock completed<br>• Final Cleaning | 90% CT | Contractor to determine the proper order of completion:<br>• Governing ordinances and statutes<br>• Specification 01 45 16<br>• Specification 01 79 00<br>• Specification 01 78 43<br>• Specification 01 74 13 |
| | | |
| Construction Closeout Procedures:<br>• Letter of Substantial Compliance sent to BI and DHS as needed<br>• Certificate of Occupancy issued<br>• As-Built Drawings, finals, accepted<br>• City Letter of Substantial Completion<br>• Warranty letters dated and issued | 100% CT | • Specification 01 77 00<br>• Generated/Signed by the Architect<br>• Building Inspection<br>• Specification 01 78 39<br>• Signed by the City Engineer<br>• Specification 01 78 36 |
| *** Completion of this begins the one year warranty.** | | |
| | | |
| BPW Contract Administration Documentation Contract Closeout Procedures<br>• Construction Closeout has been completed<br>• Contractor requests final payment of retainage upon receiving City Letter of Substantial Completion<br>• All BPW contractual requirements are verified | Final | • Specification 01 77 00<br>• Contractor must provide any missing BPW Contractual Documentation |
| *** Completion of this closes the contract but not the warranty period/bond.** | | |

| *Progress Payment (PP) Milestone Schedule* | | |
|---|---|---|
| ***Milestone Description*** | ***Due Before*** | ***Remarks*** |
| | | |
| ***NOTE:* CT = Contract Total less held retainage** | | |

**1.5. PROGRESS PAYMENT SUBMITTAL**

A. Each progress payment submittal shall be completed in the Project Management Website. See guide on the Project Management Website for the procedure.

B. Submit all required construction progress documentation to the appropriate Project Management Web Site component as described in guides.

C. In general the following shall apply to all PP requests:

1. Materials or products:
   a. On order, being shipped, etc. may not be invoiced.
   b. Received and stored on the project site may be invoiced.
   c. Being manufactured off site at any location may not be invoiced (example: cabinetry, ductwork, etc.)
   d. Completed products stored off site locally waiting for delivery to the project site may be invoiced with prior approval by the CPM. All of the following conditions must be met to be allowed:
      i. Items must be visually inspected by CPM to verify product is complete.
      ii. Item must be stored inside a compatible structure and the structure and contents must be insured.
      iii. Contractor is responsible for condition until installation is completed.
2. All labor and equipment, including rental time for the current progress period may be invoiced.
3. Only completed installations may be invoiced to 100% based on the Schedule of Values.

D. DO NOT submit BPW Contract Administration Documentation for review with Progress Payment Requests, submit them directly to the correct agency and in the correct format as instructed from information in your BPW Contract Award Packet instructions.

**PART 2 - PRODUCTS - THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. GENERAL CONTRACTOR PROCEDURE**

A. The GC shall use the Project Management Website for each PP request.

1. The GC shall subtotal the work completed to date for all of the original Schedule of Value items.
2. Ensure that any newly posted change orders have been entered.
3. The GC shall submit the PP request in the Project Management Website. The username and date will be automatically recorded.
4. The GC shall provide the dates from and to for the PP being requested.
5 . The GC shall provide the list of all contractors/sub-contractors that were actively working during the dates indicated above. The guide details the appropriate location for this list.
   a. All contractors/sub-contractors named must be in compliance with all City requirements (Pre-qualified, Affirmative Action Plan on file, etc). The PP will be held and not processed by the City of Madison until all contractors/sub-contractors are in compliance.
   b. Do not list the names of suppliers or manufacturers, doing so will slow down processing and require a re-submittal of the paperwork.
6. The GC shall attach a copy of the current Project Schedule.

**3.2. CITY PROJECT MANAGER PROCEDURE**

A. The CPM shall review all documents submitted by the GC to ensure the schedule of values accurately reflects the work completed to date.

B. The CPM may elect to hold processing of any progress payment pending submittal of required progress payment milestones.

C. When verified, the CPM shall send the PP and required documentation to the appropriate City agencies for further processing of the payment request.

D. The PP processing will be completed and available for view within the PMWS.

**END OF SECTION**

**SECTION 01 31 13**
**PROJECT COORDINATION**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Project Coordination covers many areas within the execution of the Contract Documents and the requirements of proper coordination are the applicable to all contractors executing the Work of this contract.

B. This specification provides general information regarding project coordination for the General Contractor and all Sub-contractors. All contractors shall be familiar with project coordination requirements and responsibilities that may be defined in other specification within these Contract Documents.

C. The General Contractor shall at all times be responsible for the project, project site, and execution of the Contract Documents.

### 1.2. RELATED SPECIFICATIONS

| | | |
|---|---|---|
| A. | Section 01 29 76 | Progress Payment Procedures |
| B. | Section 01 31 19 | Progress Meetings |
| C. | Section 01 31 23 | Project Management Web Site |
| D. | Section 01 32 16 | Construction Progress Schedules |
| E. | Section 01 32 19 | Submittals Schedule |
| F. | Section 01 33 23 | Submittals |
| G. | Section 01 43 39 | Mockups |
| H. | Section 01 45 16 | Field Quality Control Procedures |
| I. | Section 01 60 00 | Product Requirements |
| J. | Section 01 77 00 | Closeout Procedures, including all specifications referenced therein |
| K. | Section 01 91 00 | Commissioning |

### 1.3. GENERAL REQUIREMENTS

A. The following general requirements shall applicable to all contractors:
   1. Cooperate with the Owner, all authorized Owner Representatives, Project Architect and all consultants of the Owner.
   2. Materials, products, and equipment shall be new, as specified and to industry standards except where otherwise noted.
   3. Labor and workmanship shall be of a high quality and to industry standards.

B. Existing conditions:
   1. Verify all existing conditions noted in the contract documents with actual filed locations. Verify dimensions, sizes and locations, of structural, equipment, mechanical and utility components.
   2. Report any inconsistencies, errors, omissions, or code violations in writing to the General Contractor (GC) immediately.
   3. Annotate any inconsistencies, errors, omissions on the GC As-Built record drawings immediately for future reference.

C. Contract Documents:
   1. The Contract Documents are intended to include everything necessary to perform the work. Every item required may not be specifically mentioned, shown, or detailed.
      a. Except where specifically stated all systems and equipment shall be complete, installed, and fully operable.
      b. If a conflict exists within the contract documents the contractor shall furnish the item, system, or workmanship of the highest quality, largest, largest quantity, or most closely fits the intent of the contract documents.

c. Manufacturers recommended installation details shall be verified and used prior to installation of products and equipment so as to not void warranties.

D. Errors and Omissions
1. No Contractor shall take any advantage of any apparent error or omission in the construction documents.
2. The City of Madison shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the construction documents.

E. Owners Representatives
1. All contractors shall be familiar with various Owner Representatives having Quality Management responsibilities for the duration of this project including but not limited to the following:
a. Project Architect, responsible for all decisions affecting the code compliance and design intent of the construction documents.
b. Consulting Architects and Engineers, responsible for providing consulting services to the Project Architect, Owner, and City Project Manager, also responsible for Quality Management of the construction documents.
c. Owner, the designated representative of the City Agency that will occupy the project upon completion.
d. City Project Manager, responsible for all day to day decisions regarding the execution and performance of this Public Works Contract.
e. Consulting City Staff, responsible for providing consulting services to the Project Architect, Owner, and City Project Manager, also responsible for Quality Management of the construction documents.
f. Commissioning Agent (CxA), responsible for ensuring that the project is meeting the Owner's Project Requirements and related quality assurance procedures.
2. Owner Representatives shall be attending progress meetings, pre-installation meetings, performing or being present for final testing and acceptance and quality management reporting during the execution of the contract documents as outlined in other specifications.

**1.4. GENERAL CONTRACTOR PERFORMANCE REQUIREMENTS**

A. Assume the responsibility for all Work specified in the Contract Documents except where specifically identified to be performed by the Owner or other contractor separately hired by the Owner.
1. Coordinate all work by Owner, equipment provided Owner, or contractor hired by the Owner into the project schedule.

B. Provide all construction management responsibilities as specified in other Division 1 specifications including but not limited to:
1. Scheduling of work
2. Coordination of work between other Trades and Sub-contractors
3. Construction administration and management
4. Site layout, cleanliness, and protection of completed work/stored materials
5. Waste Management
6. Quality Assurance and Quality Control

C. Use Diggers Hotline and private utility locating companies to accurately locate all public and private utilities on the property as needed. The GC is responsible for any repair or replacement to any public or private utility damaged during the execution of the Work

D. Report any inconsistencies, errors, omissions, or code violations in writing to the Project Architect immediately. Failure to report inconsistencies prior to beginning work shall indicate that the GC accepted all existing conditions.

E. The GC shall be responsible for assigning work and related responsibilities where the Contract Documents may not clearly state who is responsible for providing the work, material, or product.

F. Provide construction management oversight of all items described in Section 1.5 below.

G. Coordinate and assist CxA as outlined within 01 91 00 and as directed by Owner.

**1.5. SUB-CONTRACTOR PERFORMANCE REQUIREMENTS**

A. Be familiar with all of the contract documents as they pertain to your Work, adjacent work and the overall progress of the project.
1. All Sub-contractors shall be familiar with all Division 1 specifications as they may apply to progress, progress payments, quality control construction management, and closeout of the contract.

B. Coordinate your Work with all adjacent work and existing conditions.

1. Perform your work in proper sequence according to the GC's project schedule and in relation to the work of other trades.
2. Notify other sub-contractors and trades whose work may be connected to, combined with, or influenced by your work and allow them reasonable time and access to complete their work.
3. Join your work to the work of others in accordance with the intent of the Contract Documents.
4. Order materials and schedule deliveries to facilitate the general progress of the Work.

C. Cooperate with all other trades to facilitate the general progress of the work. This shall include providing every reasonable opportunity for the installation of work by others and the storage of their materials and equipment.
1. In no case shall any contractor exclude from the premises or work any Sub-contractor or their employees.
2. In no case shall any contractor interfere with the execution or installation of Work by any other Sub-contractor or their employees.

D. Arrange your work, equipment, and materials and dispose of your construction waste so as to not interfere with the work or storage of materials of others.

E. Coordinate all work as indicated during pre-installation meetings with Owner Representatives, the GC and other trades. Any work improperly coordinated shall be relocated as designated by the Owner Representative at no additional cost to the City.

F. Coordinate and assist CxA as outlined within 01 91 00 and as directed by Owner.

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 – EXECUTION – THIS SECTION NOT USED**

**END OF SECTION**

**SECTION 01 31 19**
**PROJECT MEETINGS**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to identify various project related meetings and the responsible parties for scheduling, agendas, minutes, and required attendance.
B. This specification is not intended to be inclusive of all meeting types or a complete list of required meetings.
C. This specification is not intended to cover planning and execution meetings between the General Contractor (GC) and their sub-contractors.

### 1.2. RELATED SPECIFICATIONS

A. 01 31 23 Project Management Web Site
B. 01 32 16 Construction Progress Schedules
C. 01 43 39 Mockups
D. 01 91 00 Commissioning

### 1.3. PROJECT MEETING TYPES

A. The following project meeting types may be used but not limited to the following
1. Preconstruction Meeting
2. Project Management Web Site – Tutorial Meeting
3. Construction Progress Meetings
4. Pre-installation Meetings (including mock-up review meetings)
5. Weekly Trade Meetings
6. Special Meetings
7. Commissioning Meetings

### 1.4. GENERAL REQUIREMENTS

A. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

## PART 2 – PRODUCTS – NOT USED IN THIS SECTION

## PART 3 - EXECUTION

### 3.1. PRECONSTRUCTION MEETING

A. After execution of the Contract the City Project Manager (CPM) shall schedule and conduct the Preconstruction Meeting at the Owner's facilities. The CPM shall coordinate the meeting agenda with the Project Architect and the GC Project Manager.
B. The CPM shall be responsible for the final agenda.
C. The CPM and Project Architect shall take notes on the meeting and post completed meeting minutes.
D. Attendance shall be required by all of the following:
1. Owner Representative(s)

2. Architect and applicable sub consultant(s)
3. General Contractor and applicable subcontractors and suppliers
4. City Quality Management Staff
5. Commissioning Agent
6. Others, as may be invited for particular agenda items.

E. Topics of the Preconstruction Meeting shall include but not be limited to the following:
1. Staff and contractor introductions
2. Completion Date
3. BPW Administrative requirements and due outs
a. Small Business Enterprise (SBE) (if applicable)
b. Certified payroll forms
c. Workforce profiles
d. Best Value Contracting (BVC)
4. General Facility Management Division 1 Specifications, including:
a. Section 01 29 76 Progress Payment Procedures
b. Section 01 31 23 Project Management Web Site (overview)
c. Section 01 45 16 Field Quality Control Procedures
d. Section 01 77 00 Closeout Procedures
e. Section 01 91 00 Commissioning
5. Project Meeting scheduling
a. Section 01 31 19 Project Meetings
6. Construction Schedule
7. Commissioning Process

**3.2. PROJECT MANAGEMENT WEB SITE – TUTORIAL MEETING**

A. The CPM shall schedule and conduct a virtual tutorial presentation of the PMWS prior to the beginning of construction.
B. The CPM shall be responsible for the final agenda, there will be no minutes.
C. The required attendance list in 3.1.D. above shall apply except for City Staff in items 1 and 4 who are already familiar with the PMWS system.

**3.3. CONSTRUCTION PROGRESS MEETINGS**

A. In general, all of the following shall apply:
1. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
2. The attendance shall be from the required attendance list in 3.1.D. above.

B. The General Contractor Project Manager (GCPM) shall:
1. Schedule and conduct all construction progress meetings biweekly or more frequently as required.
2. Prepare agenda for meetings including, but not limited to the following:
a. Safety
b. Current Schedule, including review of the critical path and 6-week look ahead schedule
c. Status of project related documentation (Submittals, RFIs, CBs, etc.)
d. Quality Observation Log and status of correction of deficient items
e. Project questions and issues from meeting attendees
f. BPW Administration Check
g. Other as needed
h. Status of CORs and COs to be reviewed outside the standard progress meeting time.
3. Make physical arrangements for meetings.
4. GCPM to post meeting agendas to the appropriate libraries on the Project Management Web Site (PMWS) no less than two (2) working days prior to the scheduled meeting. Notify all required attendees, applicable parties to the contract, and others affected of the posted meeting agenda.
5. Preside at meetings.
6. Route a meeting attendance roster for attendees to sign-in on.
7. GCPM to record the minutes of the meeting; include significant proceedings and decisions. Post meeting minutes to the PMWS no more than two (2) working days after the completed meeting. Meeting minutes shall include a scanned copy of the attendance sign-in sheet. Notify all required meeting attendees, applicable parties to the contract, and others affected by decisions made at the meetings.
8. The above requirements do not apply to GC/sub-contractor meetings.

**3.4. PRE-INSTALLATION MEETINGS**

A. The GCPM shall schedule and conduct all pre-installation meetings, including mockup reviews, before each construction activity that requires coordination with other trades.

B. The GCPM shall be responsible for the final agenda and meeting minutes.

C. The GCPM will work with all concerned parties to resolve issues as needed and submit RFI's if necessary.

D. Required attendance shall be from the list in 3.1.D. above and shall be personnel having a stake in the outcome of the installation or knowledge of the system being installed.

E. In the event the Contractor installs equipment or materials without a pre-installation meeting the Contractor shall be solely responsible for removing, replacing, repositioning materials and equipment as instructed by the Project Architect or City Project Manager at no additional cost to the City.

**3.6 PRE-CONTRACT CLOSEOUT MEETINGS**

A. Two (2) Pre-contract Closeout Meetings shall be held to review the closeout procedures, requirements, and contract deliverables.

1. Pre-contract Closeout Meeting #1 shall be scheduled prior to the 50% Progress Payment Request is being requested. This meeting shall discuss items such as closing out QMO reports, providing O&M drafts and finals, payroll and Affirmative Action documentation, and other contract deliverables.
2. Pre-contract Closeout Meeting #2 shall be scheduled prior to the 80% Progress Payment Request is being requested. This meeting shall discuss, but not be limited to, the status of scheduling final regulatory inspections, cleaning up outstanding QMO's, demonstration and training, attic stock; and finalization review of payroll and other related documents.

B. The GCPM shall schedule, coordinate, and make physical arrangements for both meetings.

C. All of the following shall be required to attend both meetings:

1. The GCPM and the GC Field superintendent
2. All Subcontractor Project Managers regardless of the current status of their work.
   a. The GCPM may excuse a Subcontractor PM if they are confident that all contractual requirements for closeout by the subcontractor have been completed and/or delivered to the GCPM. The list of attendees shall be reviewed and agreed upon with CPM ahead of the meeting.
   b. At the option of these project managers the field supervisors may also attend.
3. The Project Architect and at least one design consultant from each discipline represented by the plans and specifications to address open QMOs, final tests, reports, etc.
4. The Owner
5. The CPM
6. Quality Management staff as needed to address open QMOs, final tests, reports, etc.
7. The Commissioning Agent

D. The CPM shall publish an agenda and chair the meeting.

**3.7 OTHER SPECIAL MEETINGS**

A. The Contractor shall schedule special meetings per the requirements of the LEED Specification, the Project Quality Management Plan, the Commissioning Plan and as indicated by other specifications.

B. Special meetings include but are not limited to the following:

1. Waste Management Conference
2. Equipment start up meetings
3. Testing and balancing meetings
4. Commissioning meetings
5. Other meetings as necessitated by the contract documents

**END OF SECTION**

**SECTION 01 31 23**
**PROJECT MANAGEMENT WEB SITE**



## PART 1 – GENERAL

### 1.1. GENERAL DESCRIPTION

A. The City of Madison (CoM) has established a cloud-based Project Management Tool (PMT) using an Autodesk product called Autodesk Construction Cloud (ACC).

B. The software is used throughout the design, construction and warranty process of major remodels and new construction projects.

C. Initially deployed in mid-2023, the PMT software will be deployed on all projects. The PMT software is cloud-based software and therefore will receive regular updates and enhancements.

### 1.2. AUTODESK CONSTRUCTION CLOUD PROCEDURE OVERVIEW

A. The CoM PMT is 3 main modules. The Autodesk Docs (https://help.autodesk.com/view/DOCS/ENU/) module is a document management file system that is the foundation of ACC. The Build https:/help.autodesk.com/view/BUILD/ENU/ module has many sections that assist in performing day to day functions of design/construction management while reducing the use of different software platforms, surface mail, email and email attachments. Finally, the Cost management (https://help.autodesk.com/view/BUILD/ENU/?guid=Cost_Overview) module is used to manage project finances.

1. Files within Autodesk Docs can store a wide variety file formats (https://help.autodesk.com/view/DOCS/ENU/?guid=Supported_Files_Docs) including but not limited to Word, Excel, PDF, photographs (all popular formats), etc.
2. The Issues section within the Build module is used for Punch Lists, Quality Control and Warranty issues.
3. File Folder and module section access are controlled by Permission Groups and Permission Level

B. A tutorial document on the web based PMT will be provided to the General Contractor (GC) who is awarded the contract. Additional training will be provided as needed for the GC and Sub-Contractors (SC) by the CoM.

C. The PMT has predefined work flows that channel automated alerts as documents are uploaded, reviewed, and completed. These workflows are designed for inbound information from the contractor as well as outbound information from the Architectural/Engineer consultant and the Owner.

D. The GC will be required to receive email notifications, access the internet to review related documentation and be able to upload/download documentation to the various project modules or folders.

E. The SC's will be required (at a minimum) to receive email notifications and access the internet to review related documentation. Prior to setting up the final PMT the GC and CPM shall meet to review all ACC workflows, the GC will determine to what level over the minimum requirements the SC's will be involved.

F. At final project closeout with the GC, the CoM will provide the Project Architect/Project Engineer (A/E PROJ MGR) and the GC, an exported version of the complete project in ACC.

### 1.3. RELATED SPECIFICATIONS

A. The following specification sections are directly related to the CoM PMT system.

1. 01 25 13 Product Substitution Procedures
2. 01 26 13 Request for Information (RFI)
3. 01 26 46 Construction Bulletins (CB)
4. 01 26 57 Change Order Request (COR)
5. 01 26 63 Change Order (CO)
6. 01 29 76 Progress Payment Procedures
7. 01 31 19 Project Meetings
8. 01 32 16 Construction Progress Schedules
9. 01 32 26 Construction Progress Reporting

10. 01 32 33 Photographic Documentation
11. 01 33 23 Submittals
12. 01 45 16 Field Quality Control Procedures (Owner)

## PART 2 - PRODUCTS

### 2.1. AUTODESK CONSTRUCTION CLOUD SYSTEM RELATED PRODUCTS

A. Autodesk Construction Cloud is an Autodesk based software that requires no additional software installation, hardware or other special requirements/applications for the users. There are no costs associated with the use of this system.

B. Please consult Autodesk's web site for the latest system requirements (https://help.autodesk.com/view/BUILD/ENU/?guid=System_Requirements_ACC)

## PART 3 - EXECUTION

### 3.1. POST BID-OPENING

A. After bids have been opened, a successful bidder has been determined, and bid acceptance procedures have been initiated the City Project Manager (CPM) will contact the GC to provide the following information.

1. Autodesk Construction Cloud Help (https://help.autodesk.com/view/BUILD/ENU/) and Learning Center (https://learnacc.autodesk.com/) are kept up to date with latest ACC features.
2. For more customized workflows, Project Management Software Tutorials have been developed. These tutorials are in a PDF printable format with screen shots and associated instructions on how to access and use the PMT.
3. A blank Project Directory in an Excel spread sheet format. The contractor shall provide the following information for GC and SC staffs as indicated on the spreadsheet. This will generally be the Project Manager for the GC as well as the Sub-contractors and the GC Site Supervisor.
   a. Last Name, First Name
   b. Company Name
   c. Email address (valid, work related)
4. Phone Contact number and professional name must be entered by each user themselves via https://profile.autodesk.com/
5. The GC shall provide the above information for all SC's where the GC is not self-performing the work.
6. The GC may provide project foreperson information for work being self-performed if he/she so desires.

### 3.2. POST PRE-CONSTRUCTION MEETING

A. The GCPM will return the completed Project Directory spread sheet to the CPM no later than the Pre-construction meeting.

B. The City Project Admin is responsible for uploading all project directory data into ACC, adding users to project and licenses to users for all non-city staff (GC/SC staffs).

C. All GC/SC staff will be notified through an automated email from Autodesk directing them to create an Autodesk account if they do not already have one. It is the responsibility of each GC/SC to follow the instructions to setup their own account

D. Once the GCPM has received his/her project invitation, uploading of contract related documents can begin. This would include but not be limited to project schedules, submittals, RFI's, and other documents as needed.

E. All workflows, review of documentation, and general archiving of construction related documentation will be conducted on the PMWS. These documents will generally not be emailed.

F. The following documents related to the execution of the contract will not be part of the PMT:

1. All documentation related to executing the contract, such as:
   a. Sub Contractors list
   b. Affirmative Action documentation
   c. Bonding documentation
   d. Documentation associated with payroll verification
   e. Final documentation associated with closing out the contract
2. Any documentation required/generated by ordinance, code or statute, such as;
   a. Erosion Control inspections
   b. Building Inspection Department inspections

**END OF SECTION**

# SECTION 01 32 16
# CONSTRUCTION PROGRESS SCHEDULES



## PART 1 – GENERAL

### 1.1. SCOPE

A. This specification is to identify various project related schedules associated with indicating construction progress and outlook. The following schedules are the responsibility of the General Contractor (GC).
   1. Overall Project Schedule
   2. 6 Week Look-out Schedule

B. This specification is not intended to include internal schedules generated by the contractors during their planning and execution of the contract.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 31 19 Progress Meetings
D. Section 01 74 13 Progress Cleaning
E. Section 01 77 00 Closeout Procedures
F. Section 01 78 23 Operation and Maintenance Data
G. Section 01 78 36 Warranties
H. Section 01 78 39 As-Built Drawings
I. Section 01 78 43 Spare Parts and Extra Materials
J. Section 01 79 00 Demonstration and Training
K. Section 01 91 00 Commissioning
L. Other specification within the construction documents that may indicate the need for scheduling any event with Owner, Project Architect, Owner Representatives, including any owner provided equipment.

## PART 2 – PRODUCTS – THIS SECTION NOT USED

## PART 3 - EXECUTION

### 3.1. OVERALL PROJECT SCHEDULE (OPS)

A. The GC shall prepare an OPS that covers the duration of the contract from the pre-construction meeting through the end of construction to final contract closeout.
   1. The GC shall review Specification 01 77 00 Closeout Procedures to become familiar with definitions, differences, and requirements for closing out the construction and contract including the association with progress payments.

B. The GC shall provide copies and lead a discussion on the OPS during the pre-construction meeting.
C. The OPS shall indicate start and end dates of each task associated with the project.
D. The OPS shall clearly indicate the critical path of the project.
E. The GC shall update the OPS as often as necessary during the duration of the project. Updates will be briefed as needed during bi-weekly progress meetings.

### 3.2. 6 WEEK LOOK-OUT SCHEDULES (LOS)

A. The GC shall prepare the initial LOS to include detail of daily tasks for the first six (6) weeks of construction in depth for the Pre-construction meeting. The LOS shall be compatible and complimentary to the OPS.
B. The GC shall provide copies and lead a discussion on the LOS during the pre-construction meeting.

C. The LOS shall indicate start and end dates of each major task, associated related sub-tasks, and required parallel or pre-requisite tasks required to complete the major task on time.

D. The LOS shall also include identifying and scheduling such events as:

1. Pre-installation meetings and mock-up review meetings.
2. Quality management reviews of installations before they are covered.
3. Owner provided equipment as designated by the contract documents.
4. Work by others as designated by the contract documents.
5. Critical submittal dates.

E. The GC shall update the LOS prior to each bi-weekly progress meeting to indicate the next 6 weeks of scheduled work. Updates will be briefed during each bi-weekly progress meeting.

**3.3. PROJECT MANAGEMENT WEB SITE (PMWS)**

A. The GC shall upload all project schedules and updates to the PMWS in an original PDF version of the scheduling document. Scans will not be permitted.

**END OF SECTION**

# SECTION 01 32 19
# SUBMITTALS SCHEDULE



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The General Contractor shall submit a complete and comprehensive list of all submittals anticipated during the execution of this contract.

B. The GC shall include the Administrative submittals identified in item 1.5 below and shall be required to up load them to the Project Management Web Site.

C. The initial Submittals Schedule shall be based on the original contract documents used at the time of bidding and any posted addenda through awarding of the contract.

D. The Submittal Schedule may be appended during the execution of the contract based on amendments to the contract in the form of Change Orders, Construction Bulletins, and other related documents that add, or change the scope of the work.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site (PMWS)
C. Section 01 33 23 Submittals

### 1.3. RELATED DOCUMENTS

A. The following documents shall be used as the basis for initiating the original Submittals Schedule.
   1. Drawing documents and specifications (including general provisions) as provided with the bid set documents and any published addenda.

B. The following documents shall be used to amend the submittals schedule as needed during the execution of this contract.
   1. Documents associated with revisions or clarifications to number A.1 above after awarding of the contract, including but not limited to:
      a. Construction Bulletins
      b. Approved Change Orders

### 1.4. SUBMITTAL DEFINITIONS

A. Administrative Submittal: Any submittal that may be required by a Division 1 Specification and as noted in Section 1.5 below.

B. Critical Path Submittal: Any early submittal that needs a priority review due to early construction use or long lead times where a delay could affect the critical path of the construction schedule

C. Submittal: Any material, product, equipment, or general requirement as outlined in this and other specifications that require a favorable review or acceptance prior to proceeding with procuring the item or proceeding with the Work.

### 1.5. SUBMITTAL REQUIREMENTS

A. The GC and all Sub-contractors shall review the construction documents including the specifications of their individual Division or Trade to compile a complete list of all materials, products, or equipment that will require a positively reviewed submittal to be completed prior to procurement and installation.

1. Submittals shall include but not be limited to any of the following that may apply:
    a. Shop Drawings
    b. Product Data
    c. Assembly Drawings
    d. Engineered Drawings
    e. Product Samples

B. The following items will require an approved submittal, verify with specifications for specific needs and requirements:
1. Contractor certifications for specialized work such as asbestos removal, well drilling, controls, AV, etc.

**1.6. ADMINISTRATIVE SUBMITTALS**

A. The GC shall upload the following submittals within 15 working days of receipt of the City of Madison Start Work Letter. All Administrative Submittals shall be approved prior to requesting Progress Payment Number 1.
1. Contractors Project Directory, see specification 01 31 23, discuss requirements with CPM
2. Schedule of Values, see Specification 01 29 73
3. Submittals Schedule, see Specification 01 32 19
4. Waste Management Plan, see Specification 01 74 19
5. Closeout Requirement Checklist, see Specification 01 77 00
6. Warranty Checklist, see Specification 01 78 36

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. OVERALL RESPONSIBILITIES OF ALL CONTRACTORS**

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of submittals to the General Contractor.

B. Each list shall indicate the title of the submittal, the associated specification of the submittal, whether the submittal can be considered an early/middle/late submittal, the anticipated date the submittal will be provided and the anticipated date the submittal needs to be approved.

C. Contractors shall be aware that the goals for submittal review by the Architect staff and City staff will be as follows:
1. For items on the Critical Path as identified by the GC, five (5) working days
2. For most other submittals ten (10) working days
3. Additional time may be needed for complex submittals or if re-submittals are required.

D. The City will provide a spreadsheet to provide the format of the Submittal Schedule as part of the first administrative submittals.

**3.2. GENERAL CONTRACTORS RESPONSIBILITIES**

A. The General Contractor shall be responsible for all of the following:
1. Consolidating all submittal lists from individual contractors into one master list with the provided spreadsheet on the Project Management Web Site
2. Reviewing all submitted lists for completeness, timing with the overall contract, etc. The GC shall meet with individual contractors to make changes as necessary.
3. Upload the completed Submittals Schedule to the Submittal Library on the Project Management Web Site See Specification 01 33 23 Submittals for more information on this procedure.
4. Resubmit the schedule as needed after initial reviews have been completed.

B. The GC shall work with other contractors to amend the Submittals Schedule throughout the execution of the project based on changes and modifications as needed.

C. The GC and Project Architect shall be responsible for reviewing and briefing the submittal schedule and submittals status at each bi-weekly construction meeting.

**3.3. STAFF REVIEW RESPONSIBILITIES**

A. The Project Architect, consulting staff, Commissioning Agent (CxA), Owner, and city staff will review the Submittal Schedule for completeness per the plans and specifications within their divisions of work. The reviewing staff may provide comments as needed. Some examples might include the following:
1. Submittal not required
2. Provide photos of samples with digital submittal
3. Insure one submittal for complete system

4. Append the schedule to include…

B. The Project Architect and City Project Manager will finalize review comments regarding the Submittal Schedule. Re-submittal of the submittal schedule may be required.

**END OF SECTION**

# SECTION 01 45 16
# FIELD QUALITY CONTROL PROCEDURES



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The City of Madison has developed a multi-faceted Quality Management Program that begins with contract signing and runs through contract closeout to ensure the best quality materials, workmanship, and product are delivered for the contracted Work.
   1. The Project Management Web Site is a Construction Management tool that provides contractors and staff a single on-line location for the daily operations and progression of the Work.
   2. The Quality Management Observation (QMO) is an ongoing observation of the construction process as it progresses. The City of Madison does not use a “Punch List” or “Corrections List” as it is typically known throughout the construction industry. The QMO process acts as an “in progress punch list”.
      a. By using the QMO process the City of Madison’s goal is to have a zero item punch list prior to the 90% progress payment and owner occupancy.

B. All contractors shall be required to review the specifications identified in Section 1.2 below, and other related specifications identified therein to become familiar with the terminology and expectations of this City of Madison Public Works contract.

C. It is the intent of this specification to outline the requirements, expectations, and responsibilities of the General Contractor (GC), Project Architect, and other representatives of the Owner for items of Quality Assurance and Quality Control.
   1. This specification is not intended to conflict with Specification 01 40 00 Quality Requirements or other specifications requiring testing and inspecting services.
   2. This specification does not relieve the GC from any requirements associated with regulatory inspections performed by the City of Madison Building Inspection Unit, or inspectors from other agencies as required by code.
   3. Any testing performed by an Owner’s Representative does not relieve the GC from performing any testing that may required by the construction documents.

### 1.2. RELATED SPECIFICATION SECTIONS

A. Section 01 26 13 Request for Information (RFI)
B. Section 01 29 76 Progress Payment Procedures
C. Section 01 31 13 Project Coordination
D. Section 01 31 23 Project Management Web Site (PMWS)
E. Section 01 40 00 Quality Requirements
F. Section 01 77 00 Closeout Procedures
G. Section 01 78 13 Completion and Correction List
H. Section 01 91 00 Commissioning

### 1.3. PERFORMANCE REQUIREMENTS

A. All contractors shall be responsible for a proper quality assurance/quality control (QA/QC) program throughout the execution of the Work defined within the construction documents, including all recognized construction industry standards and all applicable regulatory codes.

B. The GC shall be responsible for all of the following:
   1. Monitor the quality of all workmanship, supplies, materials, and products being installed by all contractors and installers to ensure they meet or exceed the minimum requirements set forth by the construction documents.
   2. Submit a Request for Information (RFI) whenever manufacturers' instructions or referenced standards conflict with the construction documents before proceeding with the Work.
   3. Ensure that Work requiring special certifications or licensing is being performed by is being performed and supervised by personnel that meet the appropriate requirements.
      a. Ensure that all certificates and licenses are current throughout the execution of the project.

C. The CoM and its representatives shall perform quality assurance and quality control activities throughout the execution of this project. This in no way relieves the GC of maintaining an acceptable QA/QC program. =

**1.4. QUALITY ASSURANCE**

A. The GC shall be responsible for the following:
   1. All materials, equipment, and products shall be new, clean, undamaged, and meet the performance specifications defined within the construction documents including favorably reviewed submittals.
      a. Any material, equipment, or product that does not meet the requirements of the construction documents shall be removed and replaced, including any adjacent and related work, at the GCs expense.
   2. All Work shall be performed by persons properly trained and/or qualified to produce workmanship of the quality specified in the construction documents.
   3. Providing access to updated as-builts, addenda, submittals, bulletins and other related construction documents at the project site.

B. The CoM and its representatives may be responsible for any of the following:
   1. Attend pre-installation meetings
   2. Attend construction progress meetings
   3. Review all submittals
   4. Conduct field visits for QA/QC purposes, provide feedback to the GC and sub-contractors using Quality Management Observation (QMO) reports.
   5. Review delivered equipment
   6. Witness equipment installations, startups, testing as specified in other specifications

**1.5. QUALITY MANAGEMENT OBSERVATION REPORT**

A. The Quality Management Observation report or QMO is used as a QA/QC tool by those entities responsible for QA/QC activities, including but not limited to, the GC, CoM, Project Architect /Project Engineer(A/E PROJ MGR), CX agent, etc.

B. QMOs are designed to be an early observation of non-conforming construction work before it becomes buried by follow on work. As such it is most often used as an "in progress punch list".

C. QMO forms are part of the Quality Control Library on the Project Management Web Site.

**PART 2 – PRODUCTS - THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. QUALITY MANAGEMENT RESPONSIBILITIES**

A. While making routine progress visits to the construction project the GC, CPM, CxA and A/E PROJ MGR, and applicable others shall observe the details of the construction and installations to ensure that the intent of the construction documents is being followed.

B. If during the progress visit there is a determination of contract non-conformance a QMO report shall be initiated to begin the documentation process.
   1. The GC field superintendent shall be informed immediately of any issue that may cause harm, damage to finished work, or be buried prior to properly filing a QMO report.

C. The following information when filing a QMO report:
   1. Open a QMO report in the Project Management Web Site
   2. Enter the date and time of the field visit
   3. Provide references to construction documents if any (examples; specification, drawing page, details, approved submittals, RFI, CB, etc)
   4. Provide a short title for the observation being made

5. Provide a detailed description of the observation being made
6. Select all categories (Sitework, Structure, Enclosure, Interior, etc) from the given list that may apply to the observation being reported.
    a. For each category selected additional boxes shall open with contractor names associated with each category.
7. Select all contractors from the lists provided that may need to be aware of the observation.
8. Provide any attachments that may help provide reference to the observation.

D. The software for the Project Management Website will email notifications that a QMO report has been initiated.

**3.2. RESPONDING TO A QMO**

A. The GC shall be responsible for determining the course of action required to remedy the non-conforming issue and shall coordinate and direct the contractor(s) responsible for any work related to the observation.

B. All contractors assigned to remedy the observation by the GC shall provide follow-up responses
1. Open the QMO report in the Project Management Web Site.
2. Enter a description of your follow-up response in the box provided.
3. Add attachments (pictures) if needed to show the work has been completed.

**3.3. GENERAL CONTRACTORS FOLLOW-UP**

A. The GC shall inspect the work to ensure that all assigned contractors have remedied the observation to the intent of the construction documents.

B. The GC shall respond with any additional comments in their response box.

**3.4. QMO CLOSEOUT PROCEDURE**

A. The person who initiated the QMO shall review the remedied work and if properly corrected shall close and date the QMO form.
1. In the event there are still issues the Quality Manager can add additional comments in the response area, and re-issue the QMO for additional review as needed.

B. Once the person who initiated the QMO has closed the item the CPM shall review and verify with the A/E PROJ MGR that the Observation has been properly remedied and provide final closure on the QMO.

**3.5. CONSTRUCTION CLOSEOUT**

A. The GC shall note that successful close out QMOs are required for construction closeout as follows:
1. Certain progress payments as identified in Specification 01 29 76 are contingent QMO reports being properly closed out.
2. Specification 01 77 00 defines all construction closeout requirements.

**END OF SECTION**

**SECTION 01 60 00**
**PRODUCT REQUIREMENTS**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to provide general guidelines and responsibilities related to the receiving, handling, and storage of all materials and products from arrival on the job site through installation.
   1. Immediate inspection of delivered goods means a timely replacement if damaged.
   2. Proper storage helps prevent damage and loss by weather, vandalism, theft, and job site accidents.
   3. Proper storage helps with job site performance and safety.
   2. Proper handling helps prevent damage and job site accidents.

B. Each Contractor shall be directly responsible for the receiving, handling, and storage of all materials and products associated with the Work of their Division or Trade.

C. Each Contractor responsible for Work associated with Owner provided materials or products shall be responsible for the receiving, handling and storage of the material/product as outlined in Section 3.8 below..

### 1.2. RELATED SPECIFICATIONS

A. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".
   1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
      http://www.cityofmadison.com/business/pw/specs.cfm
      a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
      b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.
      c. City Standard Detail Drawings (SDD) may be located from the index in Part VIII.

B. Section 01 57 21 Indoor Air Quality

C. Section 01 74 13 Progress Cleaning

D. Section 01 76 00 Protecting Installed Construction

E. Other Divisions and Specifications that may address more specifically the requirements for the storage and handling of materials and products associated Work of other Divisions or Trades.

### 1.3. QUALITY ASSURANCE

A. The GC shall be responsible for ensuring that these minimum storage and handling requirements are met by all contractors on the project site including but not limited to the following:
   1. Receiving deliveries of materials, products, and equipment.
      a. Inspect all deliveries upon arrival for damage, completeness, and compliance with the construction documents.
         i. Deliveries shall remain in original packaging or crates, shipping manifest shall be kept with the delivery and the packaging shall have visible identification of the items within the packaging.

b. Immediately report any damaged products or equipment to the GC, begin arrangements for immediate replacement.
c. Materials or equipment that have been damaged, are incomplete, or do not comply with the construction documents shall not be permitted to be installed.

2. All materials and products shall be stored within the designated limits of the project site. Only store the amount of material necessary for upcoming operations so as not to interfere with other construction activities and access to Work by the Owner and Architect. Any offsite storage shall be at the expense of the contractor storing the material or product. All offsite storage requirements shall comply with this specification. All offsite storage of materials is subject to Owner Representative Quality Management review at any time.
3. Large storage containers may be used but shall be weather tight, securable, placed on concrete blocks, timbers, or jack stands and shall be level.
4. When lifting equipment is required the equipment rating shall be greater than the loading requirements of the item being lifted. In addition all of the following shall apply as necessary:
   a. Only designated and/or designed lift points shall be used.
   b. Large items shall have tag lines and handlers at all times during lifting operations.
   c. Lift at multiple points as needed to prevent bending.
5. Materials and products stored inside of the structure shall comply with all of the following:
   a. Storage shall not be allowed to impede the flow of work in progress.
   b. Storage shall not be allowed to hide completed work from review and inspections.
   c. Storage shall not exceed the design loads of the structural components it is being stored upon.
6. All materials and products shall be stored according the manufacturers minimum recommended requirements. All of the following shall be considered before storing any product or material:
   a. Dust and dirt
   b. Moisture and humidity, including rain and snow
   c. Excessive temperatures, direct sun, etc
   d. Product or material weight and size
   e. Potential for breakage
   f. Product incompatibility with other products such as corrosiveness, chemical reactions, flammability, etc.
   g. Product or material value and replacement cost
7. The Contractor shall be responsible for providing fully functional tarps or plastic wrap, to protect materials and products from the weather. All coverings shall be free of large holes and tears, and shall be tied, strapped, or weighted down to resist blowing.
8. The Contractor shall be responsible for any temporary heating, cooling, or other utility requirement that may be associated with the storage of a material or product.
9. The Contractor shall be responsible for securing materials and products of value such as copper, A/V equipment, etc. Such items shall be stored in securable shipping containers, job trailers or other such storage devices. Container shall be kept secured when not in use.

B. The GC shall inspect the job site daily to ensure that all products and materials stay weather tight and are secured against vandalism or theft as required by this specification.
C. The Owners Representative may at any time request improvements regarding storage of any material or product being provided under these construction documents.

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. GENERAL CONTRACTOR REQUIREMENTS**

A. Designate material storage and handling areas as needed including all of the following:
   1. Designate specific areas of the site for delivery and storage of materials to be used during the execution of the Work.
   2. Designated areas shall not be located so as to interfere with the installation of any Work including Work by others such as the installation of utilities or the maintenance of existing utilities. This shall include not storing items in active utility easements as designated by the site plan.
B. Arrange for openings in the building as needed to allow delivery and installation of large items. Openings shall be appropriately sized to include the use of booms, slings, and other such lifting devices that may be larger than the item being installed.

1. When openings are required in completed Work (new or existing) the GC shall be responsible for providing an appropriate opening and for restoring the opening to the original or better condition upon completion. Restoration shall be weather tight and complete.

C. Repeated moving and handling of items being stored shall not be allowed. The GC shall be responsible for any damage and replacement because of mishandling or excessive handling.

**3.2. BULK MATERIAL**

A. Bulk material such as sand, gravel, top soil and other types of fill shall be stored away from the construction area and shall be stock piled as follows:
1. All bulk material shall be piled safely and efficiently in as small an area as practical. Only store the amount of material necessary for upcoming operations so as not to interfere with other construction activities and access to Work by the Owner and Architect.
2. All stock piles shall have silt fence/sock properly installed around the perimeter to prevent erosion and loss of material. Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION Section 210.1(f) and other related specification or details.
3. Fine grained material shall be protected with tarps to prevent blowing. Tarps shall be weighted or staked to stay in place.

B. Bulk material such as brick, concrete block, stone, and other palletized materials shall be stored on original shipping pallets until ready for use.

**3.3. DRY PACKAGED MATERIAL**

A. Dry packaged material such as cement, mortar, etc shall be stored on pallets, on slightly elevated ground or clear stone pad to keep water away from the base of the material being stored. Protect from moisture.

**3.4. STRUCTURAL AND FRAMING MATERIAL**

A. All structural and framing material shall be stored in an organized manner arranged by type, size and dimension. Materials shall be stored on pallets or timbers as necessary and shall not be allowed to lie directly on the ground.

B. Long and heavy items shall be supported at several points to prevent bending and warping.

**3.5. EQUIPMENT**

A. Equipment delivered to the site shall be stored away from all construction activities until the item can either be moved inside or properly installed.

B. Equipment shall be stored on slightly elevated ground or clear stone pad to keep water away from the base of the equipment.

**3.6. FINISH PRODUCTS**

A. Finish products such as flooring, tile, counters, lockers, toilets, partitions, lighting, and other similar items should not be delivered and stored until the structure has been enclosed, is weather tight, temperature controlled and the contractor is ready for such items to be installed.
1. Storage of finished products outside for any length of time shall not be allowed.

B. Products that cannot be stored inside the structure shall be stored in secured containers or job trailers until such time as they are ready to be installed.

C. Products with a high potential for breakage such as glass, mirrors, tiles, toilet fixtures, etc. shall be stored with additional protection as necessary such as but not limited to the following:
1. Store in original shipping containers until ready for installation.
2. Do not store in high traffic areas.
3. Shield with other materials such as cardboard, plywood, or similar products.

**3.7. DUCTWORK, PIPING, AND CONDUIT**

A. All piping and conduit shall be stored horizontally unless otherwise specified by the manufacturer or Division and Trade Specifications.
1. Do not store directly on grade.
2. Cover metal pipes and tubes to prevent rust and corrosion, allow ventilation to prevent condensation.
3. Whenever possible use pipe stands for storing pipe and conduit to prevent tripping and rolling hazards.

B. All ductwork shall be stored horizontally or vertically as necessary unless otherwise specified by the manufacturer or Division and Trade Specifications.
1. During storage, both ends of each duct shall be protected with plastic sheathing to prevent dust and dirt from getting inside the duct. Sheathing shall be sufficiently taped to the duct.

2. After installation, free/open ends shall remain protected with taped plastic sheathing and or temporary filters as specified by division or Trade specifications.

**3.8. OWNER PROVIDED, CONTRACTOR INSTALLED EQUIPMENT**

A. Section 3.8.A. shall apply to all equipment being provided to any contractor directly from the Owner for installation under the contract.

1. The Owner or Owners Representative shall do the following:
    a. Inspect all deliveries upon receipt and notify manufacturer of any issues directly.
    b. Review the received shipment with the contractor.
        i. Only provide products or materials to the contractor that were not damaged through shipping or handling.
        ii. Confirm missing products or materials and anticipated delivery schedule if known.
2. The Contractor responsible for the installation of Work associated with Owner provided materials or products shall “take ownership” and provide safe and secure storage and handling as previously described within this specification.
    i. The Contractor shall be liable for the repair or replacement of any material or product damaged after taking ownership of the product from receipt through final acceptance.

B. Section 3.8.B. shall apply to all equipment being provided by the Owner but shipped directly to any sub-contractor or the project site for installation under the contract.

1. The GC and/or Contractor responsible for the Work associated with the Owner provided materials or products shall do the following:
    a. Inspect all deliveries upon receipt and notify the Owner or Owners Representative of any issues directly.
        i. Owner or Owners Representative shall notify manufacturer of any issues directly.
    b. Review the received shipment with the Owner or Owners Representative
        i. Confirm missing products or materials and anticipated delivery schedule if known.
2. The Contractor shall “take ownership” and provide safe and secure storage and handling as previously described within this specification.
    i. The Contractor shall be liable for the repair or replacement of any material or product damaged after taking ownership of the product from receipt through final acceptance.

**END OF SECTION**

# SECTION 01 73 29
# CUTTING AND PATCHING



## PART 1 – GENERAL

### 1.1. SUMMARY

A. This Section includes general procedural requirements for cutting and patching including, but not limited to the following:
   1. Examination
   2. Preparation
   3. Performance
   4. Cleanup and Restoration

### 1.2. RELATED SPECIFICATION SECTIONS

A. Divisions 02 through 32 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

B. Division 07 Section "Penetration Fire Stopping" for patching fire-rated construction.

### 1.3. DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

C. Level Alpha

### 1.4. QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components ina manner that results in reducing their capacity to perform as intended or that may result in increased maintenance or decreased operational life or safety.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that may result in increased maintenance or decreased operational life or safety. Some miscellaneous elements include the following:
   1. Water, moisture, or vapor barriers
   2. Membranes and flashings
   3. Exterior curtain-wall construction
   4. Equipment supports
   5. Piping, ductwork, vessels, and equipment
   6. Noise and vibration control elements and systems

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

**1.5. WARRANTY**

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

B. All cutting and patching work performed under this contract shall be warranted like new work as defined by the Specification governing the work.

## PART 2 - MATERIALS

**2.1. GENERAL**

A. Comply with requirements specified within other sections of the Specifications.

B. In-Place Materials: Use materials identical to existing in-place materials. For exposed surfaces use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

## PART 3 - EXECUTION

**3.1. EXAMINATION**

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

**3.2. PREPARATION**

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction and existing conditions during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations. If the failure to protect, or the lack of protection, of in-place construction and/or existing conditions results in damage, the contractor shall be responsible for repair to previous condition.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to eliminate interruption to occupied areas.

**3.3. PERFORMANCE**

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete or Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 3l Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

D. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

**3.4. CLEANUP AND RESTORATION**

A. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

1. Clean piping, conduit, and similar features before applying paint or other finishing materials.
2. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
4. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
5. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.
7. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
8. Any smoke and fire caulking that has been disturbed must be replaced by the Contractor as required by code.

**END OF SECTION**

**SECTION 01 74 13**
**PROGRESS CLEANING**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. Throughout the execution of this contract all contractors shall be responsible for maintaining the project site in a standard of cleanliness as described in this specification.

B. All contractors shall also comply with the requirements for cleaning as described in other specifications.

C. Work included in this specification shall include but not be limited to:

1. Safety Cleaning
2. Project Site Cleaning
3. Progress Cleaning
4. Final Cleaning

### 1.2. RELATED SPECIFICAITONS

A. Section 01 35 00 Special Procedures
B. Section 01 60 00 Product Requirements
C. Section 01 74 19 Construction Waste Management and Disposal
D. Section 01 76 00 Protecting Installed Construction

### 1.3. QUALITY ASSURANCE

A. The General Contractor (GC) shall conduct daily inspections, more often if necessary, of the entire project site to ensure the requirements of cleanliness are being met as described within these specifications.

B. All contractors shall comply with other regulatory requirements as they apply to waste recycling, reuse, hauling, and disposal requirements of any governmental authority having jurisdiction.

C. The Owner reserves the right to have work done by others in the event any contractor fails to perform cleaning as described within these specifications. The cost of any Owner provided cleaning shall be charged to the contractor through a deduct change order.

## PART 2 - PRODUCTS

### 2.1. CLEANING MATERIALS AND EQUIPMENT

A. The Contractor shall provide all required personnel, equipment, and materials necessary to maintain the required level of cleanliness as described in this specification.

B. Use only cleaning materials and equipment that are compatible with the surface being cleaned, as recommended by the manufacturer, or as approved by the A/E.

C. Use only cleaning materials, equipment, and methods as recommended in the manufacturers care and use guide of the material, finish or equipment being cleaned.

## PART 3 - EXECUTION

### 3.1. SAFETY CLEANING

A. All Contractors shall be responsible for safety cleaning as required by OSHA and other regulatory requirements as applicable.

B. Safety Cleaning shall include but not be limited to the following:
   1. All work areas, passageways, ramps, and stairs shall be kept free of debris, scrap materials, pallets, and other large items that would obstruct exiting routes. Small items such as tools, electrical cords, etc are picked up when not in use.
   2. Form and scrap lumber shall have nails/screws removed or bent over. Lumber shall be neatly stacked in an area designated by the GC.
   3. Spills of oil, grease, and other such liquids shall be cleaned immediately or sprinkled with sand/oil-dry first, then cleaned.
   4. Oily, flammable, or hazardous items shall be stored in appropriate covered containers and storage devices unless actively being used.
   5. Oily, or flammable rags, and other such waste shall only be disposed of in authorized covered containers.
   6. Disposal by burning shall not be allowed at any time.

**3.2. PROJECT SITE CLEANING**

A. This section applies to the general cleanliness of the project site as a whole for the duration of the execution of this contract.

B. Exterior Project Site Areas
   1. The GC and other Contractors as appropriate shall ensure the following levels of cleanliness are applied to the exterior project site areas.
      a. The overall appearance of the project site is neat and orderly. Defined areas for material storage, material waste, job trailers, and the project area are clean and well maintained.
      b. The construction fence is maintained, erect with no gaps, and properly posted per all regulatory requirements.
      c. All erosion control measures are properly maintained, cleaned, and repaired as necessary.
      d. All loose materials (construction or waste) are properly tied or weighted down to resist blowing.
      e. All construction materials are properly covered with fully functional tarps or plastic wrap, protected from the weather, coverings are tied, strapped, or weighted down to resist blowing.
      f. Dust control is applied as necessary or as required by any regulatory requirement.

C. Interior Project Site Areas
   1. All Contractors shall ensure the following levels of cleanliness are applied to the interior project site areas.
      a. The overall appearance of the project site is neat and orderly. Defined areas for material storage, material waste, and project area are clean and well maintained.
      b. Stored materials are kept in original shipping containers whenever possible. Stored materials not in shipping containers are properly stored and protected according to other applicable specifications.
      c. All scraps and debris shall be properly disposed of as often as necessary to keep work areas, passageways, stairs, and ramps free of debris and clear for emergency exiting.
      d. Boxes, pallets, and other such shipping containers, are broken down, stored in a consolidated area or, disposed of as often as is necessary.
      e. Hand tools, supplies, materials, electrical cords not being used are picked up and sptored in gang boxes, not left as walking hazards in work areas, passageways, etc.

D. Job Trailer
   1. The interior of the job trailer shall be kept clean and available as a work space at all times. The GC shall ensure that the following is provided for within the job trailer:
      a. Meeting space including tables and chairs.
      b. Sufficient space for all contractors to access the official construction documents, provide updates, etc.

**3.3. PROGRESS CLEANING**

A. This sub-section shall apply to all Progress Cleaning prior to the installation of finishes, fixtures, and trim (IE rough-in).
   1. For the purposes of this section “clean” shall be defined as a level of cleanliness free of dust and other material capable of being removed by use of reasonable effort using a good quality janitor broom and shop-vac.
   2. Daily cleanings shall be conducted by all contractors at the end of the work day as follows:
      a. Debris in excavated areas shall be removed prior to backfill and compaction.
      b. Debris in wall cavities, chase spaces, etc shall be removed prior to enclosing the spaces.

c. Large items shall be properly stored, returned to designated areas, or disposed of as necessary.
d. Loose materials shall be properly secured.
e. Flammable or hazardous materials are properly stored or disposed of.

3. Weekly cleaning shall be conducted by all contractors as designated by the GC. Weekly cleanings shall include all the above for a daily cleaning and other necessary cleaning as designated by the GC.

B. This sub-section shall apply to Progress Cleaning in preparation for the installation of finishes, fixtures, and trim.
   a. Surfaces receiving finishes shall be thoroughly cleaned prior to contractors applying finish materials. The GC shall be responsible for inspecting the area and surfaces being cleaned for finish prior to the sub-contractor applying the finish. This shall include but not be limited to the following:
      i. Wall surfaces shall be wiped clean of dirt and oily residues, vacuumed free of dust, and shall be free of surface imperfections prior to painting or installing wall coverings.
      ii. Metal surfaces shall be wiped clean of dirt and oily residues, and be free of surface imperfections prior to painting.
      iii. Flooring shall be broom swept of large and loose items then vacuumed clean of dust and small particles, and damp mopped clean and dried prior to installing any flooring finish. Additional cleaning may be required depending on the preparation requirements recommended by the flooring material manufacturer.

C. This sub-section shall apply to Progress Cleaning after the installation of finishes, fixtures, and trim.
   1. For the purposes of this section "clean" shall be defined as a level of cleanliness free of dust and other material capable of damaging or visually disfiguring finished work, finishes, fixtures, and trim.
   2. Progress Cleaning at this point in the contract shall be conducted immediately as follows:
      a. Dust, dirt, etc shall be swept and vacuumed off of finish flooring and trim.
      b. Liquid spills shall be cleaned up according to the spill type. This shall include drips and spills caused by paint, stain, sealants, and other such items.
   3. The Contractor(s) at no additional cost to the Owner shall be responsible for replacing any finished work, finishes, fixtures, and trim damaged or disfigured because of inadequate or improper cleaning.

**3.4. FINAL CLEANING**

A. As noted in Specification 01 29 76 Progress Payment Procedures, Progress Payment Milestone Schedule, Final Cleaning shall not be conducted prior to requesting the 90% contract total progress payment and all of the following shall be complete:
   1. All final regulatory inspections including but not limited to Building Inspection Department and Madison Fire Department inspections have been successfully completed.
   2. All Quality Management Observation (QMO) reports have been closed out.
   3. All Demonstration and Training has been completed.
   4. All Attic Stock has been consolidated and located to its designated area
   5. All protection for installed construction shall be removed prior to final cleaning by the contractor responsible for providing the protections. This shall include the removal of any adhesive residues left behind from tapes. Contractors shall only use manufacturer authorized cleaning materials for removing adhesives, etc.

B. For the purposes of this section "clean" shall be defined as a level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

C. The GC shall be responsible for ensuring that all requirements under this section are being met.

D. General Requirements
   1. Employ experienced personnel or professional cleaners for final cleaning as necessary for the areas or equipment being cleaned.
   2. Cleaning equipment used shall be commercial grade equipment commonly used by professional cleaners.
   3. Cleaning equipment and materials shall be cleaned, rinsed, or replaced to ensure a uniform level of cleanliness is being maintained during the final cleaning. This shall include but not be limited to the following:
      a. Vacuum cleaner bags and/or filters are changed and/or cleaned as often as necessary.
      b. Dust & wipe down rags are washed, rinsed, or replaced before starting each room.
      c. Mopping equipment
         i. Mop water for washing shall have cleaning solution added to the amount and temperature per manufacturer's recommendations. Mop washing water shall be replaced often to maintain the levels of the cleaning solution and temperature required.
         ii. Mop water for rinsing shall remain clean, clear, and be replaced as often as necessary.

iii. Mop heads shall be rinsed often and replaced as necessary.
iv. Mop heads and buckets shall be thoroughly rinsed with each change of water.
v. Only new mop heads shall be used for rinsing.

E. Refer to all other specifications in this contract for specific requirements regarding final cleaning of finishes, fixtures, equipment, etc.

F. Exterior Cleaning shall include but not be limited to the following:
1. All exterior glazing surfaces have been professionally cleaned and are free of dust and streaking.
2. Metal roofs, siding, and other surfaces shall be clean of dirt and free of splashed or excess materials such as sealants, mortar, paint, etc.
3. All exterior furnishings shall be clean, waste receptacles shall be empty.
4. Paved areas shall be clean, free of dirt, oily stains and other such blemishes
5. Exterior lights and diffusers are clean and free of dust.

G. Interior Cleaning shall include but not be limited to the following:
1. Remove all labels, stickers, tags, and other such items which are not required by code as permanent labels.
2. All interior glazing surfaces, including mirrors, have been professionally cleaned and are free of dust and streaking.
3. All interior surfaces have been cleaned of excess materials such as paint, sealants, etc and have been wiped free of dust.
4. Interior metals, fixtures, and trim have been cleaned free of dust and oily residues
5. Carpet flooring has been thoroughly cleaned; vacuumed free of dust, excess glues and other stains removed per manufacturers use and care instructions.
6. Resilient flooring has been thoroughly cleaned; vacuumed free of dust, excess glues and other stains removed, mopped and buffed per manufacturers use and care instructions.
7. Interior non-occupied concrete floors shall be broom cleaned, vacuumed free of dust, excess glues and other stains removed per manufacturers use and care instructions.
8. Light fixtures, lamps, diffusers and other such items have been dusted and cleaned as necessary.

**3.5. CALL BACK WORK**

A. The GC shall be responsible for ensuring that any contractor returning to the project site for completion or correction work has re-cleaned and restored the area to the levels described in section 3.4 above upon completion of the work. This shall include but not be limited to the following:
1. The immediate area(s) where work was completed.
2. Adjacent areas where dust or debris may have traveled.
3. Other areas occupied during the completion of the call back work.
4. Path of entrance/exit, to/from the area(s) of work.

**END OF SECTION**

**SECTION 01 74 19**
**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. This specification includes administrative and procedural requirements for the recycling, re-use, salvaging, and disposal of non-hazardous construction and demolition waste.

B. The General Contractor (GC) shall be fully responsible for complying with all applicable ordinances and other such regulatory requirements during the execution of this contract.

### 1.2. RELATED SPECIFICAITONS

A. 01 29 76 Progress Payment Procedures
B. 01 31 23 Project Management Web site
C. 01 32 19 Submittals Schedule
D. 01 33 23 Submittals
E. 01 77 00 Closeout Procedures
F. Other Divisions and Specifications that may address the proper disposal of construction or demolition waste as it pertains to work being conducted under that particular specification.

### 1.3. CITY ORDINANCES

A. There are two (2) Madison General Ordinances (MGO) that the City of Madison has regarding construction and demolition waste.
   1. MGO 10.185, Recycling and Reuse of Construction and Demolition Debris, describes the requirements associated with this ordinance including definitions, documentation requirements, and penalties.
   2. MGO 28.185, Approval of Demolition (Razing, Wrecking) and Removal, describes the requirements associated with applying for and receiving a demolition permit.

B. All City of Madison, Board of Public Works, contracts being conducted by City Engineering, Facility Management, for construction, remodeling, or demolition shall comply with the above ordinances regardless of project type or size.

### 1.4. DEFINITIONS

A. Clean: Untreated and unpainted material, free of contamination caused by oils, solvents, caulks, and other chemicals.

B. Construction and Demolition Debris: Materials resulting from the construction, remodeling, repair, and demolition of utilities, structures, buildings, and roads.

C. Disposal: Off-site removal of construction and demolition debris and the subsequent sale, recycling, reuse, or deposit in authorized landfill or incinerator.

D. Hazardous: Exhibiting the characteristics of hazardous substance, i.e. ignitability, corrosiveness, toxicity, or reactivity and including but not limited to asbestos containing materials, lead, mercury and PCBs.

E. Non-hazardous: Exhibiting none of the characteristics of a hazardous substance.

F. Nontoxic: Not immediately poisonous to humans or poisonous after a long period of exposure.
G. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product.
H. Recycle: Any process by which construction or demolition debris is diverted from final disposal as solid waste at a permitted landfill and instead is collected, separated, and/or processed into raw materials for new, reused, or reconstituted products; or for the recovery of materials for energy production processes.
I. Recycler: Any recycling facility, transfer station, or other waste handling facility which accepts construction and demolition debris for recycling, or for other transferring to a recycling facility.
J. Recycling: The process of sorting, cleaning, treating, or reconstituting solid waste and other discarded materials for the purpose of preparing the material to be recyclable. Recycling does not include burning, incinerating or thermally destroying waste.
K. Return: To give back reusable items or unused products to vendors for credit.
L. Reuse: Shall mean any of the following:
    1. The on-site use of reprocessed construction and demolitions debris.
    2. The off-site redistribution of a material, for use in the same manner or similar manner at another location.
    3. The use of non-toxic, clean wood as an alternative fuel source.
M. Salvage: To remove a waste material from the project site for resale or reuse by the Owner or others.
N. Toxic: Poisonous to humans either immediately or after a long period of exposure.
O. Trash: Any product or material unable to be re-used, returned, recycled, or salvaged.
P. Waste: Extra materials or products that have reached the end of its useful life or its intended use. Waste includes salvageable, returnable, recyclable and re-useable construction and demolition materials, and trash.

**1.5. PERFORMANCE REQUIREMENTS**

A. The GC shall develop a Waste Management Plan that results in end-of-project rates for salvage/recycling/reuse of 95 percent (minimum) by weight of the total waste generated by the Work. Percentages may be adjusted on a project by project basis depending on selected LEED goals associated with the project.
B. The GC shall salvage or recycle 100 percent of all uncontaminated packaging materials including but not limited to the following:
    1. Paper
    2. Cardboard
    3. Beverage containers
    4. Boxes
    5. Plastic Sheet and film
    6. Polystyrene packaging
    7. Wood crates and pallets
    8. Plastic pails and buckets
C. Promote a resourceful use of supplies and materials through proper planning and handling. Generate the least amount of waste possible by minimizing errors, poor planning, breakage, mishandling, contamination or other similar factors.
D. Use all reasonable means to divert construction waste from landfills and incinerators through recycling, reuse, or salvage as appropriate.

**1.6. SUBMITTALS AND DELIVERABLES**

A. The GC shall provide their completed Waste Management Plan to the Project Management Web Site as a submittal for review by the Project Architect and City Project Manager.
    1. See item 1.8 below for Waste Management Plan submittal requirements.
    2. The Waste Management Plan shall be completed, submitted, and approved as a pre-requisite for Progress Payment number 1.
    3. Copies of all documentation required by this specification shall be submitted to the appropriate Project Management Web Site Library. Documentation shall be reviewed by the City Project Manager during all Progress Payment reviews for compliance and accuracy.
B. The Waste Management Coordinator shall provide copies of items 1 through 5 below to the appropriate Project Management Web Site Library and shall update the Waste Management Summary Log to reflect the records being submitted.
    1. Records of Donations: Indicate receipt and acceptance of itemized salvageable waste donated to individuals or organizations. Indicate if the organization is tax exempt.

2. Records of Sales: Indicate receipt and acceptance of itemized salvageable waste sold to individuals or organizations. Indicate if the organization is tax exempt.
3. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts and invoices.
4. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts and invoices.
5. Statement of Refrigerant Recovery: The Refrigerant Recovery Technician responsible for recovering refrigerant shall provide the GC with a statement indicating all of the following:
   a. All recovery was performed according to EPA Regulations.
   b. All refrigerant present was recovered; indicate the total quantity recovered by unit.
   c. Date of Recovery.
   d. Name, address, company name, and phone number of technician performing the recovery.
   e. Technician shall sign and date the statement.

C. LEED Submittal: The GC shall provide the following information using the appropriate LEED letter template upon project completion: indicating that the requirements of the credit have been met. *NOTE: This requirement shall only apply to projects having a LEED certification goal.*
1. Total waste material generated.
2. Total waste material diverted by diversion method; recycling, salvage, re-use, etc.
3. Which waste streams have been diverted; minimum four different streams required to achieve LEED credit
4. Statement that the credit requirements have been met.
5. GC shall sign the letter.

**1.7. QUALITY ASSURANCE**

A. Waste Management Coordinator: The GC shall be responsible for designating a Waste Management Coordinator. Coordinator may be the GC Supervisor, GC Project Manager or other member of the GC staff having knowledge of proper waste management procedures and all applicable regulations.
B. Regulatory Requirements: comply with all hauling and disposal regulations of authorities having jurisdiction.
C. The Waste Management Coordinator shall comply with Specification 01 31 19 Project Meetings, Section 3.7.B.1 and conduct a Waste Management Conference at the job site. This conference shall be repeated as necessary as additional trades are added to the Work. The conference shall include but not be limited to the following:
1. Identify the Waste Management Coordinator; provide trade contractors with name, phone, and email information.
2. Review and discuss the Waste Management Plan and the roles of the Coordinator.
3. Review the requirements for documenting and reporting procedures of each type of waste and its disposition.
4. Review procedures for material separation; indicate availability and locations of containers and bins.
5. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
6. Review waste management procedures specific to each trade.

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

**1.8. WASTE MANAGEMENT PLAN**

A. Develop a plan consisting of waste identification, a waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume. Use the same units of measure throughout the waste management plan.
1. Waste Identification: Indicate anticipated types and quantities of site clearing, demolition waste, and construction waste that will be generated during the execution of this contract. Include assumptions for the estimates.
2. Waste Reduction Work Plan: The work plan shall consist of but not be limited to all of the following:
   a. Identify methods for reducing construction waste. Re-using, framing and forming materials, re-planning material cuts to minimize waste, etc.
   b. Identify what types of materials will be recycled. Provide lists of local companies that receive and/or process the materials. Include names, addresses, and phone numbers.
   c. Identify what types of materials will be disposed of and whether it will be disposed of in a landfill facility or by incineration facility. Provide lists of local companies that receive and/or process the materials. Include names, addresses, and phone numbers.
   d. Identify methods to be used on site for separating waste including all of the following:

i. Sizes of containers to be used.
ii. Labels to be used on the containers to identify the type of waste allowed in the container.
iii. Designated locations on the project site for waste material containers.

B. If project requires demolition incorporate the ordinance required (MGO 28.185) Recycling and Reuse Plan into the Waste Management Plan.

C. Provide all of the following for the Waste Management Coordinator:
1. Name, employer, employer address, phone number, and email address of the designated coordinator.
a. The GC shall also provide this information with the required Project Directory Submittal at the beginning of the project.

D. If at the option of the GC, they choose to contract with a Waste Management Disposal Company that allows comingled and unsorted waste materials, the GC shall include with their Waste Management Plan the following:
1. Name, address, phone number, state permitting information, and other pertinent information about the disposal company.
2. Documentation from the disposal company indicating company policies and procedures regarding comingled and unsorted waste materials to include:
a. GC responsibilities on the project site.
b. Disposal company procedures for receiving, sorting, recycling, and disposing of comingled and unsorted waste material.

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. PLAN IMPLEMENTATION**

A. Implement the approved waste management plan. Provide adequate containers, storage space, signage, transportation and other items required to implement the plan during the execution of this contract.

B. The GC and Waste Management Coordinator shall be responsible for monitoring and reporting the status of the Waste Management Plan and shall monitor the waste management practices on site as frequently as needed.

C. Train all workers, sub-contractors, and suppliers on proper waste management procedures as appropriate for the work being conducted on the project site.
1. Distribute the waste management plan to everyone concerned within seven (7) days of submittal approval.
2. Distribute the waste management plan to new workers, sub-contractors, and suppliers when they first appear on the project site.
3. Conduct additional training as needed during the execution of the contract to keep a positive focus on the waste management plan.

D. Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent and used facilities.
1. Designate and label specific areas on the project site necessary for separating materials to be salvaged, recycled, reused, donated, and sold.
2. Comply with any specification or regulatory requirements pertaining to dust, dirt, environmental protection, and noise control.

**3.2. HAZARDOUS AND TOXIC WASTE**

A. The Owner shall be responsible under separate contract for the removal of any asbestos related materials. All other materials shall be removed by the GC.

B. All hazardous and toxic waste shall be separated, stored, and disposed of according to all applicable regulations.

C. All hazardous and toxic materials on site shall have a Material Safety and Data Sheet (MSDS) available that indicates storage requirements, emergency information, and disposal requirements as necessary.

**3.3. GENERAL GUIDELINES FOR ALL WASTES**

A. Recycle all paper and beverage containers used by workers, sub-contractors, suppliers and visitors to the project site.

B. All revenues, savings, rebates, tax credits, and other such incentives received from recycling, reusing, or salvaging waste materials shall accrue to the GC unless specified otherwise in the contract documents.

C. Separate recyclable, reusable, and salvageable waste from other waste materials, trash, and debris except where Waste Management Disposal Company allows comingled waste materials, see section 1.8.D above.

1. Separate by type in appropriate containers or designated areas according to the approved waste management plan away from the construction area. Do not store within the drip lines of existing trees.
2. Inspect containers and bins frequently for contamination and inappropriately sorted materials. Remove contaminated materials and resort as necessary.
3. Stockpile bulk materials such as sand, topsoil, stone, etc., on site away from the construction area and without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water, and cover to prevent windblown dust. Do not store within the drip lines of existing trees.
4. Whenever possible store items off the ground and/or protect them from the weather.

**3.4. GUIDELINES FOR RECYCLABLE, RE-USABLE, AND SALVAGEABLE WASTE**

A. The following guidelines is not a complete or all inclusive list and shall be adjusted as needed by the methods and procedures identified in the Waste Management Plan.

B. Asphalt Paving: Break-up into transportable pieces or grind, transport to an authorized recycling facility.

C. Carpet and Pad: Separate carpet and pad scraps, containerize and transport to an authorized recycling facility.

D. Ceiling System Components: Suspended ceiling system components shall be sorted by material type as follows:
   1. Broken, cut, or damaged tiles shall be containerized, transport to an authorized recycling facility.
   2. Damaged, or cut tracks, trim and other metal grid system components shall be sorted with other metals of similar types, palletize, transport to an authorized recycling facility.

E. Clean Fill: When allowed by Division 31 Specifications; concrete, masonry, stone, asphalt pavement, sand and other such materials may be used as clean fill on this project site. The GC shall verify with the Project Architect, Structural Engineer, or Civil Engineer as necessary prior to using any materials as clean fill. Materials shall be processed, placed, and compacted as specified. If not being re-used on site, transport to an authorized recycling facility.

F. Clean Wood Materials: Including but not limited framing cutoffs, wood sheathing or paneling materials, structural or engineered wood products, and pallets or crates. Clean Wood shall be free of paints, stains, oils, preservatives and other such contaminates.
   1. Useable pieces shall be sorted by type and dimension, bundled and transported off site by the GC or returned to the supplier.
   2. Non-useable pieces shall be palletized or containerized, transport to an authorized recycling facility.
   3. Clean, uncontaminated sawdust and wood shavings shall be bagged, transport to an authorized recycling facility.

G. Concrete: Break-up into transportable pieces, remove all reinforcing and other metals, transport to an authorized recycling facility.

H. Glass Products: Shall be sorted by types, do not include light fixture lamps and bulbs. Products broken in shipment shall be returned to the supplier. Broken or cracked items still in frames shall be taped to prevent further breakage and injury to workers. Transport to an authorized recycling facility.

I. Gypsum Board: Stack large clean pieces on wooden pallets or container, store in a dry location, transport to an authorized recycling facility.

J. Light Fixture Lamps and Bulbs: Fluorescent tubes shall be containerized, transport to an authorized recycling facility.

K. Masonry and CMU: Remove all metal reinforcing, anchors, and ties, clean undamaged pieces and neatly stack on pallets, transport damaged pieces to an authorized recycling facility.

L. Metals: Sort metals by type as follows, this does not include piping:
   1. Architectural metals including but not limited to siding, soffit, and roofing panels shall be sorted by material, palletize or bundle as needed and transport to an authorized recycling facility.
   2. Structural steel, sort by size and type; palletize and transport to an authorized recycling facility.
   3. Miscellaneous metals such as aluminum, brass, bronze, etc shall be sorted by type, containerized or palletized as necessary, transport to an authorized recycling facility.

M. Packaging and shipping materials
   1. Cardboard boxes and containers: Breakdown all cardboard boxes and containers into flat sheets. Bundle and store in a dry location until transported for recycling.
   2. Pallets:
      a. Whenever possible require deliveries using pallets to remove them from the project site.
      b. Neatly stack pallets in preparation for reusing them or providing them to other companies for salvage or re-use.
      c. Break down pallets into component wood pieces that comply with the requirements for recycling clean wood materials. Neatly stack or palletize pieces in preparation for transportation.

3. Crates: Break down crates into component wood pieces that comply with the requirements for recycling clean wood materials. Neatly stack or palletize pieces in preparation for transportation.
4. Polystyrene Packaging: Separate and bag materials.

N. Piping and conduit: Reduce all piping and conduit to straight lengths, sort and store by size, material and type. Remove supports, hangers, valves, boxes, sprinkler heads, and other such components, sort and store by size, material and type. Transport to authorized recycling facilities according to material types.

O. Roofing: Roofing materials shall be sorted and containerized by type, transport to authorized recycling facilities according to material types.

P. Site-Clearing Waste: Sort all site waste by type.
1. Only stockpile soils types and quantities required for re-use on the project site. All remaining quantities shall be transported off site to an authorized facility that receives such materials.
2. Brush, branches, and trees with no marketable re-use shall be transported to facilities for chipping into mulch.
3. Trees with a marketable re-use shall be salvaged and transported to facilities that specialize in processing trees for future use as wood products.

**3.5. GUIDELINES FOR DISPOSAL OF WASTES**

A. The following guidelines shall be adjusted as needed by the methods and procedures identified in the Waste Management Plan.

B. Any waste that is contaminated, organic, or cannot be recycled, re-used, or salvaged shall be legally disposed of in an authorized landfill or incinerator. Disposal methods shall follow all applicable regulatory requirements.

C. No waste material of any kind, except those types designated as clean fill in section 3.4 above, shall be allowed to be buried on the project site at any time.

D. No burning of any kind of waste material shall be permitted on this project site at any time.

E. Paint and Stain: Paints, stains, and their containers shall be disposed of as follows:
1. Whenever possible containers should be thoroughly cleaned immediately after emptying and sorted with as appropriate (metal or plastic) for recycling
2. Empty containers, regardless of type or base material, may be disposed of with lids off with general garbage.
3. Latex paint may be placed with general garbage if properly solidified as follows:
a. Small amounts (an inch or less in can): Remove lids and allow paint to dry out in the can and harden. Protect cans from rain and freezing.
b. Large amounts (more than one inch): Mix paint with equal amounts of cat litter, stir and allow to completely dry. Alternate method: mix with commercial paint hardener.
4. Oil-based or combustible paints and stains, regardless of liquid or solid, shall be transported to an approved facility that takes such items such as Dane County Clean Sweep Sites.

F. Treated Wood Materials: Treated wood materials including but not limited to wood that has been painted, stained, or chemically treated shall not be recycled or incinerated.

**END OF SECTION**

**SECTION 01 76 00**
**PROTECTING INSTALLED CONSTRUCTION**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities, guide lines, and requirements related to providing protection to already installed construction.

B. Already installed construction shall include but not be limited to the following:

1. Any existing site feature such as pavement, curbs, drainage features, utilities, landscaping features (trees, shrubbery, plantings, flagpoles, etc) and other such exterior items not associated with the building whether on or adjacent to the project site.
2. Any existing structure on or adjacent to the project site.
3. Any existing interior work that may be adjacent to the new work including all paths of ingress/egress to areas associated with accessing the Work.
4. Any existing feature of any kind within the public right-of-way that may be on the project site property, adjacent to the project site or across the street from the project site.

C. All contractors shall be familiar with the specifications of their Division of Work for specific requirements on protection of the Work.

D. The requirements noted within this specification do not relieve any contractor of the responsibility for compliance with any code, statute, ordinance, or other such regulatory requirement having jurisdictional authority over these contract documents.

### 1.2. QUALITY ASSURANCE

A. It shall be the responsibility of every contractor and worker assigned to the project to be diligent in protecting all existing work, and newly installed construction.

B. It shall be the General Contractors' (GC) responsibility under the contract to provide all reasonable protection methods, materials, or precautionary measures required to protect new or existing construction as described in within this specification to the project as a whole.

1. The GC shall be responsible to ensure any damaged new or existing construction is repaired or replaced at no additional cost to the Contract.
2. The GC at their discretion may direct other contractors to provide and maintain protection of completed work associated with their Division of Work. I.E.: The carpet installer may be required by the GC to provide carpet protection along traveled paths, ingress/egress, etc after installation.

C. It shall be the responsibility of the GC to ensure that all materials being used to protect installed construction are compatible with, and/or adjacent to, the materials being protected. This shall include but not be limited to the material used as covering, tapes used to fasten protective materials, etc.

**1.3. RELATED SPECIFICATIONS**

A. Parts of this specification will reference articles within "The City of Madison FACILITIES MANAGEMENT SPECIFICATIONs for Public Works Construction".

1. Use the following link to access the FACILITIES MANAGEMENT SPECIFICATIONs web page:
   http://www.cityofmadison.com/business/pw/specs.cfm
   a. Click on the "Part" chapter identified in the specification text. For example if the specification says "Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION **2**10.2" click the link for Part II, the Part II PDF will open.
   b. Scroll through the index of Part II for specification 210.2 and click the text link which will take you to the referenced text.
   c. City Standard Detail Drawings (SDD) may be located from the index in Part VIII.

B. Section 01 60 00 Product Requirements

C. Section 01 74 13 Progress Cleaning

**PART 2 - PRODUCTS**

**2.1. FENCING MATERIALS AND BARRICADES**

A. Except where noted in other areas of the construction documents, the responsible contractor shall provide a six foot galvanized chain link fence including full height mesh screen at the project lines as shown on the Civil Drawings. For temporary barricade situations, the responsible contractor may provide one of the following that sufficiently provide a sturdy physical barrier and/or visual barrier as necessary for the intended application.

1. Standard orange construction barrels each with a standard rubber base ring and reflective tape
   a. Provide flashing amber lights as needed to increase night time visibility
2. Steel "T" style fence posts
3. 4'0" high standard orange construction fence
4. Traffic barricades
5. Jersey barriers
6. Other types of fencing or barricades typically used in the construction industry

B. The contractor responsible for providing the fencing materials and barricades shall also be responsible for maintaining them. This shall include but not limited to fixing damaged fencing, standing up barrels that have been knocked over, realigning barrels, and ensuring flashing lights are fully operational at all times.

C. The following fencing and barricade designations, and their use descriptions shall be used throughout this specification to provide uniformity in describing protection requirements.

1. Type A, Jersey Barriers, to be used as permanent blocking devices to deny access to alternate project site entrances or exits.
2. Type B, Traffic Barricades, to be used as temporary blocking devices to deny access to alternate project site entrances or exits.
3. Type C, Construction Barrels without construction fencing shall be used for lane closures, temporary blocking devices to deny access and the protection of single locations (I.E. identify the location of an access structure) that do not require fencing.
4. Type D, Construction Barrels with construction fencing where it becomes necessary to surround an object with a complete visual barricade and it is impractical or unacceptable to install fence posts. The surround shall be constructed in such a manner as to provide a buffer zone around and access to the item being protected.
5. Type E, Steel "T" Fence Posts shall be used at the project lines, as indicated on the Civil Drawings, with six foot galvanized chain link fencing to surround an object with a complete visual barricade and it is practical to install fence posts. The surround shall be constructed in such a manner as to provide a buffer zone around and access to the item being protected. All posts shall be driven installed. Surface mounted posts to only be used for temporary barricades.
6. Type X, Other fencing or barricade types that may be designated and detailed within the construction documents shall use additional alpha numeric designations.

**2.2. EROSION CONTROL PROTECTION**

A. Refer to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.2 for authorized materials associated with erosion control materials.

**2.3. INTERIOR FINISH PROTECTION MATERIALS**

A. Except where noted in other areas of the construction documents or this specification the responsible contractor:
   1. Shall not provide the cheapest or least effective method as an effort to meet any protection requirement.
   2. Shall provide materials of sufficient quality, and durability to provide adequate protection based on the seasonal conditions and the anticipated duration at the time the protection will be needed.
   3. Shall provide sufficient quantity of protection material to protect the construction as needed.

B. Prior to installing protective measures the responsible contractor shall propose to the GC, Project Architect (PA)/Project Engineer (PE) and City Project Manager (CPM) the proposed plan for protection, materials to be used and samples as necessary.
   1. The PA/PE and CPM reserve the right to disapprove any proposed method and/or material and/or make alternate proposals.

## PART 3 - EXECUTION

**3.1. GENERAL EXECUTION REQUIREMENTS**

A. The GC shall be responsible for ensuring all of the following procedures and requirements are implemented as needed for the duration of the Work performed under this contract.

B. The GC shall also be responsible for the following:
   1. Reporting any incident of damage to existing property, right-of-way, or utility to the CPM immediately upon rendering the incident safe, and notifying emergency response teams, and emergency utility crews as needed.
   2. Conduct a site walk through prior to leaving at the end of each day to assess:
      a. Protection measures are properly in place, provide correction actions as necessary.
      b. Note damage to existing completed work and schedule repair/replacement as needed.
   3. Ensure all contractors and workers are being diligent in protecting existing work, and newly installed construction.

**3.2. PROTECT ADJACENT PROPERTIES**

A. Whenever possible through the design process the City of Madison shall have previously provided notice to adjacent property owners that work will be occurring on or near their property. The City of Madison shall also have obtained any permanent or temporary easements that may be necessary to complete any Work on adjacent properties.

B. It shall be the responsibility of the GC to do the following for all Work under this contract being performed on or adjacent to the property line:
   1. Contact the adjacent property owner and provide them with information on the work to be done, equipment to be used, and estimated duration of the work. Information to be updated and communicated to property owner(s) as construction progresses and site conditions change.
      a. If any adjacent property is a rented or leased space the GC shall also make contact and provide the same information to the tenants.
      b. Determine from the owner and/or tenants if there are any concerns for children, pets, special plantings, or other concerns.
   2. Discuss the following with all contractors performing work on or near the property line.
      a. Work to be completed and timeline.
      b. Concerns of adjacent property owners/tenants from item 1 above.
      c. Which protective measures will be necessary to protect adjacent properties and address the concerns of adjacent property owners/tenants.
   3. Ensure all protective measures are placed and maintained during the execution of Work on or adjacent to the property line. Interact with the adjacent property owners/tenants as needed.

C. Any contractor doing work on or adjacent to the property line shall install and maintain any protective measure identified in the contract documents, this specification, or as directed by the GC.

D. The GC shall be responsible for restoring any damage to structure and property located on or adjacent to the property line.
   1. Restoration shall include but not be limited to repair or replacement using like materials and finishes to its original condition or better.
   2. Restoration of landscaping materials shall include watering of any seed, sod, or other planting of any kind for a reasonable period of time to encourage germination and root development.

E. The GC shall keep the CPM informed directly to any issues pertaining to adjacent property owners and tenants.

**3.3. PROTECT LANDSCAPING FEATURES**

A. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.
   1. Whenever possible do not install new landscape features until exterior building construction has been completed, equipment such as scaffolding and lifts are no longer needed and have been removed, and heavy equipment operation is no longer required.
   2. Whenever possible remove and temporarily store all existing landscape features such as benches, waste receptacles, signage, and other such features that will be within the area of Work that can be removed.
   3. Landscape features that cannot be removed such as flag poles, light poles, light bollards, etc. shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil.
   4. Planting beds shall be protected using Type E fencing around the exposed perimeter of the planting bed as needed.
   5. The City of Madison FACILITIES MANAGEMENT SPECIFICATION 107.13 shall apply to all tree protection in and around the project site at all times.

**3.4. PROTECT UTILITIES**

A. The contractor shall be responsible for notifying all utilities to determine emergency response procedures and protection requirements prior to installing any construction protection.
   1. This includes requesting utility marking through Diggers Hotline.
      a. Call 811 or 1-800-242-8511 to request a public utility locate
      b. For emergency locate call (262) 432-7910 or (877) 500-9592
   2. Contact the Owner and CPM for any available private utility information on the property that may be available prior to calling a private utility locating company.

B. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.
   1. Hydrants, lamp posts, electrical transformers, and other utility pedestals shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil. Fence posts shall be located so as to not be directly over the utility main.
   2. Storm sewer structures in pavement shall have proper inlet protection according to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1(g) and Type C Construction Barrels when necessary.
   3. Storm sewer structures in turf and other landscaped areas shall have proper inlet protection according to City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1(g) and Type E fencing for areas on soil.
   4. Stormwater management features such as greenways, retention/detention ponds, bio-filtration ponds and other such features shall be properly protected according to the appropriate erosion control measure specified on the Erosion Control Plan. See multiple sections of City of Madison FACILITIES MANAGEMENT SPECIFICATION 210.1
      a. For the protection of hard to see items such as structures, castings, inlets, etc. in grassy areas provide Type E fencing for areas on soil.
      c. For the protection of storm water management features having special soils and plants such as bio-filtration ponds provide Type E fencing for areas on soil.
   5. Other structures and covers including but not limited to cleanouts, wiring hand holes, valve boxes, access structures, grease trap structures, etc shall be protected as follows:
      a. Provide Type E fencing for areas on soil.
      b. When paving operations are complete provide a construction barrel or cone near structures as necessary depending on required heavy construction traffic.

**3.5. PROTECT PUBLIC RIGHT OF WAY**

A. Except where specifically stated in other areas of the construction documents the following minimal protection requirements shall apply under this section.
   1. All public right-of-way (area from behind the sidewalk to the centerline of the street) shall remain open and accessible except during periods of active work. At such times the public right of way shall be properly closed and signed as referenced in City of Madison FACILITIES MANAGEMENT SPECIFICATION 107.9.
   2. Bus stops and bus stop structures shall remain accessible at all times.
   3. Traffic signage and traffic signals, traffic control boxes shall be protected with Type D fencing for areas on pavement or Type E fencing for areas on soil.

a. Protection at traffic signage/signals shall not obstruct the viewing of the sign/signal for its intended purpose at any time.

B. When additional protection for traffic control is required, the use of barricades, guardrails, lane closures and other such procedures will be detailed within the construction documents.

C. When additional protection for overhead sidewalk cover is required the contract documents shall indicate the specific location and structural requirements of the protective structure.

**3.6. PROTECT STORED MATERIALS**

A. All contractors shall refer to Specification 01 60 00 Product Requirements for all storage and protection requirements of building materials and products delivered to the site.

**3.7. PROTECT WORK - EXTERIOR**

A. Provide all temporary services that may be required to protect the installed material from heat, cold, humidity, etc, while materials such as concrete, mortar, sealants, paints, etc, are drying and/or curing.

B. Open trenches, pits, and other such excavations shall be properly covered, lined, or shored as needed during periods of inclement weather to prevent the caving of soils onto existing work in progress. Refer to the appropriate specifications and/or regulatory requirements governing this type of work as necessary.

C. Provide adequate protection at all openings with heavy duty tarps, plastic sheathing, or wood framing and sheathing as needed to protect interior work in progress from inclement weather as needed.

D. Protect exterior finishes of all kinds with heavy duty tarps or plastic sheathing as needed while landscaping is being installed through full germination of seeded areas or installation of filter fabric and mulches to keep dust, dirt, and mud off of finished exterior surfaces.

E. Designate specific curb mounting points and provide wood blocking where small vehicles, skid loaders and other such equipment may need access to areas being landscaped.

F. Provide plywood turning pads for skid loaders to turn on to prevent tire marking on new pavement.

G. Do not permit the parking of vehicles with any kind of fluid leaks to park on new pavement.

H. The contractor shall be responsible for cleaning, repairing, or replacing any completed work or work in progress under this specification as deemed necessary by the CPM without additional cost to the contract.

**3.8. PROTECT WORK - INTERIOR**

A. The GC shall do all of the following:

1. Provide all temporary services that may be required to protect the installed material from heat, cold, humidity, etc, while materials such as concrete, mortar, sealants, paints, etc, are drying and/or curing.
2. Provide adequate visual and/or physical protection as needed to protect newly completed interior work such as paint, flooring material, sealants, grouts, etc that may be drying and/or curing.
3. Provide adequate space and materials for cleaning boots, tool boxes, supplies, and other items coming into the project site once finish work has begun.
4. Clean dirtied areas and repair/replace damaged areas immediately.

B. The contractors responsible for interior work shall be responsible for protecting their work and finishes from dirt, mud, snow, spills, splatters, and physical damage after installation as follows:

1. Protect vinyl composite, rubber composite, painted/stained concrete, and tiled flooring as follows:
   a. Define foot traffic areas and protect with Ramboard Temporary Floor Protection products as a minimum basis of design or other protection product(s) compatible with installed flooring product if Ramboard is not compatible. Products to be used shall be new.
      i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
      ii. Repair tears immediately, replace worn areas with like material as necessary.
2. Protect carpeted areas as follows:
   a. Define foot traffic areas and protect with a minimum of 6mil, clear, polyethylene sheeting 3 feet wide. Products to be used shall be new.
      i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
      ii. Repair tears immediately, replace worn areas with like materials as necessary.
3. Protect all finished walls in high traffic areas with Ramboard Temporary Wall protection products or approved equal.

i. Tape all edges, seams, etc with a good quality tape that does not leave sticky residue. Do not allow any debris or other material between the installed flooring and the protection material.
ii. Repair tears immediately, replace worn areas with like materials as necessary.

3. Protect counter tops, cabinets, and other finished surfaces with large sheets of thick cardboard or Ramboard products. Do not allow toolboxes, finish materials, parts and other such items to be placed on finished materials.

C. All protection shall stay in place until the CPM, PA/PE, and GC mutually deem the project is ready for Final Cleaning. The contractors responsible for protecting the work shall be responsible for removing the protection and removing any adhesive residue at that time. Contractors shall only use manufacturer authorized cleaning materials for removing adhesives, etc.

D. Contractors doing work in un-protected areas of finished work shall be required to provide drop cloths and other protection as noted within this specification for the duration of their work.

1. Finished areas shall be sufficiently covered to accommodate all equipment, and materials being used to complete the work being done.
2. Finished areas shall be sufficiently covered to prevent splatters, over spray, etc when doing touch-up work.
3. Contractors who do not provide sufficient protection under this sub-section shall be responsible for any costs associated with cleaning, repairing or replacing already finished construction at no additional cost to the contract.

**END OF SECTION**

**SECTION 01 77 00**
**CLOSEOUT PROCEDURES**



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to clearly define and quantify the requirements associated with closing a City of Madison Public Works Contract for facility related work.

B. All contracts have two distinct but related paths. Each path needs to be properly closed independently in order to close the contract as a whole.

1. Construction closeout is related to closing out all of the Work associated with the construction documents.
   a. It shall be the responsibility of all contractors to be fully aware of the required Work and closeout requirements involved in their individual trades.
2. Contract closeout is related to closing out all of the administrative aspects of the contract in general.
   a. It shall be the responsibility of all contractors to be fully aware of the administrative requirements required by the contract and to provide the supporting documentation required.
3. Construction Closeout must be completed before Contract Closeout can begin.

C. This specification will provide general knowledge associated with the following areas:

1. Construction Closeout Requirements
2. Construction Closeout Procedure
3. Contract Closeout Requirements
4. Contract Closeout Procedure
5. Final Payment and Certificate of Completion

### 1.2. RELATED SPECIFICATIONS

A. Contractors shall review all references to other specifications including specifications relating to the execution of the Work associated with their Division or Trade.

| | | |
|---|---|---|
| B. | Section 01 29 76 | Progress Payment Procedures |
| C. | Section 01 31 23 | Project Management Web Site (PMWS) |
| D. | Section 01 32 26 | Construction Progress Reporting |
| E. | Section 01 45 16 | Field Quality Control Procedures |
| F. | Section 01 74 13 | Progress Cleaning |
| G. | Section 01 45 16 | Construction Waste Management and Disposal |
| H. | Section 01 76 00 | Protecting Installed Construction |
| I. | Section 01 78 13 | Completion and Correction List |
| J | Section 01 78 23 | Operation and Maintenance Data |
| K. | Section 01 78 36 | Warranties |
| L. | Section 01 78 39 | As-Built Drawings |
| M. | Section 01 78 43 | Spare Parts and Extra Materials |
| N. | Section 01 79 00 | Demonstration and Training |
| O | Section 01 91 00 | Commissioning |

P. Other requirements as noted in the contract documents signed by the General Contractor

**1.3. DEFINITIONS**

A. ***Substantial Compliance***: A letter provided to the City of Madison Building Inspection and signed by the Project Architect indicating that all Work has been completed to a level that would allow Owner Occupancy and that all construction is in compliance with the construction documents. A copy of this letter is also provided to the State of Wisconsin Department of Health and Safety as necessary to clear plan review requirements. This letter does not represent construction closeout.

B. ***Certificate of Occupancy***: The Regulatory letter from the City of Madison Building Inspection Department indicating that all regulatory requirements and inspections have been completed and the building may now be occupied for its intended use. This letter does not represent construction closeout.

C. ***Certificate of Substantial Completion***: A letter provided by the Department of Public Works, signed by the City Engineer indicating that Construction activities are substantially complete. This letter does represent construction closeout and the date of this letter begins the date of the Warranty Period.

D. ***Construction Closeout***: The point in the contract where all contractual requirements associated the execution of the Work as described in the plans, specifications, and other documents have been successfully met and the items described in 1.3.A, .B, and .C above have been completed.

E. ***Final Progress Payment***: The progress payment associated with achieving Construction closeout as described in 1.3.D above. At this point the contractor may request all monies associated with the contract be paid with the exception of held retainage.

F. ***Contract Closeout***: The point in the contract where all contractual requirements associated with the City of Madison, Board of Public Works contract has been successfully met.

G. ***Final Payment***: The final contract payment submittal that may be approved by the City of Madison after all contractual requirements of the Public Works Contract have been met and any remaining monies (retainage) due to the contractor may be released for the Final Payment.

**1.4. QUALITY ASSURANCE – CONSTRUCTION CLOSEOUT**

A. All contractors shall be responsible for properly executing the construction closeout requirements associated with their Work as described in the specifications governing their Work.

B. The GC shall be responsible for all of the following:

1. Ensuring that all contractors have met the construction closeout requirements associated with their Work.
2. Coordinate the collection of all construction closeout deliverables from all contractors, provide the deliverables to the Project Architect and City Project Manager for review as necessary, and ensure all contractors correct deficiencies of deliverables and resubmit as needed for final acceptance.
3. Ensure all closeout requirements identified in the Construction Closeout Checklist below have been completed as intended by the construction documents.

**1.5. QUALITY ASSURANCE – CONTRACT CLOSEOUT**

A. The City of Madison, Department of Civil Rights (DCR) monitors contract compliance for construction and procurement contracts to ensure that local, state and federal regulations are followed by contractors working on City of Madison Public Works (PW) projects. DCR will monitor all PW projects from contract award through the final payment at the close of the project. Contractors will be required to submit reporting paperwork throughout the PW project process.

1. Contractors are encouraged to visit the web site identified below for additional information, checklists, forms, and other information provided by DCR as it relates to Contract Compliance.
   http://www.cityofmadison.com/Business/PW/contractCompliance.cfm
2. Questions regarding the process should be directed to parties and offices as identified on the various forms, documents, and instructions or contact:
   City of Madison, Department of Civil Rights
   210 Martin Luther King Jr. Blvd., Room 523
   Madison, WI 53703
   (608) 266-4910

B. All Sub-Contractors have submitted the applicable required documents described in item 1.5.D below to the General Contractor (GC) for Contract Closeout.

C. The GC has submitted the required applicable documents described in item 1.5.D below for all contractors to the appropriate City of Madison Agency per instructions associated with each submittal.

D. The documents required for submittal to the City of Madison for Contract Closeout may include any/all of the items listed below depending on contract type. It is the sole responsibility of all contractors to know and submit the required and complete documentation in a timely fashion.

1. Weekly Payroll Reports
2. Employee Utilization Reports
3. Documentation required for Small Business Enterprise (SBE) goals
4. Other documents as maybe required or requested through the Finalization Review Process

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. CONSTRUCTION CLOSEOUT CHECKLIST**

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of all Construction Closeout Requirements to the GC.
   1. The checklist shall include all items identified within the construction documents that require any of the following (and examples) prior to moving into Contract Closeout Procedures:
      a. Documents indicating a specified level of performance has been achieved, such as:
         i. Test reports of all types
         ii. Startup reports
      b. Required documentation, such as:
         i. As-builts and record drawings
         ii. Operation and maintenance data
      c. Physical items to be turned over to the owner, such as:
         i. Attic stock
         ii. Keys
      d. Required maintenance completed, such as:
         i. Ducts cleaned
         ii. Filters replaced
      e. Commissioning and LEED related items and submittals
      f. Owner and Maintenance Training

B. Each list shall indicate the title of the closeout requirement, the associated specification of the requirement, the required result or deliverable, the responsible contractor(s), and a column to verify the item has been turned in and completed.

C. The GC shall be responsible for all of the following:
   1. Consolidating all the closeout lists into one master Construction Closeout Checklist.
      a. The checklist shall be in a tabular data format similar to the sample below
   2. Upload the completed checklist to the Project Management Web Site for review.
   3. Resubmit the checklist as needed after initial reviews have been completed.

D. The GC shall work with all contractors to amend the Construction Closeout Checklist throughout the execution of the project based on changes and modifications as necessary.

| Title | Specification | Description | Responsibility | Completed |
|---|---|---|---|---|
| Quality Management Observation Reports | 01 45 16 | All QMO reports have been properly responded to, reviewed and closed by the CPM. | All, GC | |
| As-Built Drawings | 01 78 39 | As-Built drawings have been reviewed and accepted per the specification | All, GC | |
| Testing and Balancing of HVAC | 23 09 23 | Provide final TnB reports indicating design performance has been achieved | HVAC | |

**3.2. CONSTRUCTION CLOSEOUT REQUIREMENTS**

A. The timely submittal or completion of closeout requirements shall go hand in hand with the Progress Payment Milestone Schedule that can be found in Specification 01 29 76 Progress Payments. No payments shall be made until all requirements for that payment have been met.
   1. The GC and all major Subcontractors, Project Architect /Project EngineerA/E PROJ MGR, and CPM, shall review all requirements for Construction/Contract Closeout during two (2) special meetings.
      a. The first meeting shall be held at the 50% Contract Total Payment milestone. This meeting shall discuss the requirements associated with various construction/contract closeout documentation and events when they are due with respect to progress payments.

b. The second meeting shall be held at the 70% Contract Total Payment milestone. This meeting shall review the contractors progress regarding the closeout checklist, begin making plans for upcoming deadlines such as scheduling training, where to put attic stock, and when they are due with respect to progress payments.

2. The GC, A/E PROJ MGR, and CPM, shall utilize the Construction Closeout checklist to ensure that all construction closeout requirements have been met.

**3.3. CONSTRUCTION CLOSEOUT PROCEDURE**

A. Upon successful completion and final acceptance of all Construction Closeout Requirements the GC may submit to the CPM and A/E PROJ MGR the request for Final Progress Payment (100% contract total, less retainage).

B. The A/E PROJ MGR will confirm with the design consultants, CPM, and other City of Madison staff that all requirements of the Work have been completed and will do the following:
   1. Approve the final progress payment application
   2. Provide the required signed payment documents to the CPM
   3. Provide the required Letter of Substantial Compliance to the following as required:
      a. State Safety and Building Division
      b. Local Building Inspection office
      c. GC
      d. CPM

C. The CPM shall draft the City Letter of Substantial Completion for signature by the City Engineer. This letter shall state any of the following that may still be tied to the contract and/or warranty:
   1. Indicate that the date of the letter shall also be the beginning of the Warranty period.
   2. Indicate any allowed due outs, reasons for them, and anticipated dates of finalization.
      a. QMO issues such as off season testing of equipment
      b. Off season training of equipment

D. The GC and all subcontractors shall finalize all warranty letters associated with their Work using the date noted on the City Letter of Substantial Completion, and provide the CPM with all warranties as described in Specification 01 78 36 Warranties. Upon receipt and final approval of the Warranties the CPM may initiate final processing of the Final Progress Payment (100% contract total, less retainage).

**3.4. CONTRACT CLOSEOUT REQUIREMENTS**

A. The GC and all sub-contractors shall follow all requirements associated with documenting contract compliance and provide documentation as required or requested by DCR or PW staff. All contractors are encouraged to stay current with submissions of the following documentation:
   1. Weekly Payroll Reports no later than the Progress Payment equal to 50% of the contract total.
   2. Employee Utilization Reports
   3. Agent or Subcontractor Affidavit of Compliance with Prevailing Wage Rate Determination
   4. Prime Contractor Affidavit of Compliance with Prevailing Wage Rate Determination
   5. Documentation required for Small Business Enterprise (SBE) goals
   6. Other documents as maybe required or requested through the Finalization Review Process

B. Near the Progress Payment equal to 80% of the contract total the GC shall request in writing a Finalization Review. At that time DCR or PW staff shall prepare a report of all contract documentation submitted to date. A list of missing items or outstanding issues will be emailed to the GC. No additional follow-up will be generated by DCR or PW Staff.

**3.5. CONTRACT CLOSEOUT PROCEDURE**

A. The Contract Closeout Procedure will not begin until the Construction Closeout Procedure has been completed.

B. When the GC feels they have successfully met all of the Contract Closeout Requirements associated with Section 3.3 above the GC may submit to the request for Final Payment to the CPM.

C. The CPM shall sign and submit the Final Payment request for processing.

D. DCR and PW staff shall do a complete review of all documentation associated with item 3.3.A above.

E. The GC shall be notified directly by DCR or PW Staff of any documentation that may still be missing, have incomplete information, or other outstanding issues. It shall be the responsibility of the GC to continue follow-up with DCR and PW staff until all documentation has been successfully submitted and accepted.

F. When all required documentation associated with Contract Closeout has been successfully submitted and accepted by DCR and PW Staff the City of Madison shall process the Final Payment of any remaining monies including retainage.

**END OF SECTION**

# SECTION 01 78 23
# OPERATION AND MAINTENANCE DATA



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guide lines related to providing well documented and complete Operation and Maintenance (O&M) Data related to general facility use, equipment, systems, finishes, and materials to City of Madison Staff (Owner, Owner Representatives, Maintenance, and Custodial Personnel) as needed.

B. Operation and Maintenance Data shall apply to both of the following categories except where specific requirements are noted under their separate titles as follows:

1. Operation and Maintenance Data: Generally shall mean the owner manual that provides information on start-up, shut-down, operation, troubleshooting, maintenance, parts, and other such documentation as it pertains to all equipment and systems installed under the Work.
2. Use and Care instructions: Where applicable use and care instructions shall also be considered O&M for such things as flooring, tile, partitions, and other such finishes and trim related items, installed under the Work.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 77 00 Closeout Procedures
D. Section 01 78 13 Completion and Correction List
E. Section 01 78 19 Maintenance Contracts
F. Section 01 78 36 Warranties
G. Section 01 79 00 Demonstration and Training
H. Section 01 91 00 Commissioning
I. Other Divisions and Specifications that may address more specifically the requirements for O&M Data.

### 1.3. QUALITY ASSURANCE

A. All O&M Data shall meet the requirements identified in Section 1.4 below.

B. All contractors shall provide O&M Data for each piece of equipment, system, or finish installed during the installation of the Work. O&M Data shall be provided to the General Contractor (GC) for verification and submittal.

C. The GC shall be responsible for receiving all required O&M Data files from all contractors for verifying that all files submitted meet the requirements in Section 1.4 below.

### 1.4. O&M DATA REQUIREMENTS

A. O&M Data shall be provided in digital PDF format as follows:

1. PDF files shall be complete first generation consumer useable editions of PDF documents as provided by any of the following:
   a. Product manufacturer
   b. Supplier of product
   c. Product manufacturer internet site

2. Acceptable PDF files shall have the following functionality:
    a. Word searchable
    b. Key areas are bookmarked
    c. Table of Contents and/or Index linked to content is preferred whenever possible.
3. Scanned printed material, with word searchable capabilities, saved as a PDF, is not acceptable and will be rejected without further review.

B. O&M Data shall include but not be limited to the following manufacturers' published information as appropriate for the equipment, system, material, or finish:
1. Installation instructions
2. Parts lists, assembly diagrams, explosion diagrams
3. Wiring diagrams
4. Start-up, shut-down, troubleshooting and other related operation procedures
5. Lubrication, testing, parts replacement, and other such maintenance procedures
6. General use, care, and cleaning instructions
7. Special precautions and safety requirements
8. A list of certified equipment vendors, service companies, parts suppliers including company name, address, and phone number
9. A list of the recommended spare parts to have on hand at all times
10. A list by type of all recommended lubes, oils, packing material, and other maintenance supplies
11. Copies of final test reports, balance reports, and other related documentation
12. Warranty information for equipment and systems

**1.5. O&M DATA SUBMITTALS**

A. O&M Data shall be prepared as identified in this specification and shall be submitted for review as per the schedule identified in Specification Section 01 29 76, Progress Payment Procedures.

B. O&M Data Draft submittals will be reviewed for content, procedure, and compliance only. A general critique with recommendations for improvement will be made but re-submittals will not be required.

C. O&M Data Final submittals will be reviewed for content, procedure, and compliance. Re-submittals will be required until such time as each submittal is accepted.

*NOTE: Acceptance of O&M Data Final submittals is required to be complete prior to scheduling and conducting owner related training and construction closeout.*

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. O&M DATA PREPARATION - GENERAL**

A. All contractors shall prepare O&M Data for draft and final submission as follows:
1. Obtain digital PDF files for each piece of equipment, system, material or finish as described in Sections 1.4.A.1 and 1.4.A.2 above.
2. Verify that all information as described in Section 1.4.B above is included with the PDF file. Obtain missing information as necessary for a complete submittal.

B. Rename each individual PDF file as follows.
1. Do not use special characters such as #, %, &, /, etc. These characters are reserved by the Project Management Web Site software the City of Madison uses; however the under-score (or under-bar) '_' is an allowed character.
2. Use the following format and examples for renaming your file:
    a. Format: ***Equipment name_What_Project name_Contract number_Year***
        i. *Equipment Name* represents the name of any equipment, system, material or finish as designated in the Contract Documents.
        ii. *What* represents what the file is about
        iii. *Project Name* represents the title of the project or contract. A shortened version of the title may be identified by the City Project Manager to be used by all contractors.
        iv. *Contract number* is the specific identification number the Work was bid under and appears on the plan set title sheet and in each sheet title block
        v. *Year* represents the year the contract will be closed out
    b. Examples of file names

i. AHU 2_Operation Manual_Fire Admin_1234_2015
ii. CPT 2_Use and Care_MPD West_9876_2011

C. All contractors shall submit the completed digital PDF files to the GC in sufficient time for the GC to meet the O&M Data submission deadlines as described in Specification Section 01 29 76, Progress Payment Procedures.

D. O&M Data shall be submitted and reviewed as described in sections 3.2 and 3.3 below.

**3.2. O&M DATA DRAFT SUBMITTAL**

A. All contractors shall prepare and submit the following for an O&M Data Draft review submittal:
1. Prepare three (3) complete O&M Data file samples as described in section 3.1 above.
2. Review all specifications within their Division of Work and prepare a complete O&M Data checklist listing all equipment, systems, materials, or finishes. Checklist shall be in tabular form similar to the example below and shall indicate the title (and plan identifier when applicable) of the O&M Data, the associated specification, and a column to verify the item has been turned in and completed.

B. The GC shall be required to review all contractors' samples and checklists for compliance with this specification and shall return any to the originating contractor that are insufficient for re-submittal.
1. When acceptable to the GC, they shall upload each O&M Data draft submittal file to the O&M Draft library on the Project Management Web Site.

C. The Project Architect, City Project Manager, CxA, Consulting Staffs and Owner Representatives shall review the O&M Data draft submittals and checklist within fifteen 15 working days as follows:
1. Provide general critique comments by Division on O&M Data samples submitted. Critique is intended to provide all contractors with information on strengths and weaknesses of their submittals.
a. Re-submittal of the O&M Data samples will not be required.
2. Review in detail the O&M Data Checklist for completeness. Provide comments as needed.
a. Re-submittal of the O&M Checklist will be required until accepted.

| Title | Specification | Completed |
|---|---|---|
| Overhead Door Operator | 08 36 00 | |
| Air Handling Unit (AHU-3) | 23 00 00 | |
| Water Heater (WH-1) | 22 30 00 | |

**3.3. O&M DATA FINAL SUBMITTAL**

A. All contractors shall prepare and submit the following for an O&M Data Final review submittal:
1. Prepare complete O&M Data files as described in Section 3.1 above according to their approved checklist as described in Section 3.2 above.
2. Submit completed checklist and all final O&M Data files to the GC for final submittal review.

B. The GC shall be required to spot check all contractors' submittals for completeness against their checklists and for compliance with this specification and shall return any to the originating contractor that are insufficient for re-submittal.
1. When acceptable to the GC, they shall upload each O&M Data final submittal file to the O&M Final library on the Project Management Web Site.

C. The Project Architect, City Project Manager, CxA, Consulting Staffs and Owner Representatives shall review the O&M Data final submittals and checklist within fifteen (15) working days as follows:
1. Review the files submitted against the checklist and request any missing files through the GC.
2. Review in detail all of the O&M Data files for completeness.
a. Submittals shall be accepted or rejected as individual PDF files.
b. Contractors shall re-submit entire O&M submittal if any portion is rejected or incomplete.

**3.4. CONSTRUCTION CLOSEOUT**

A. All contractors shall review Specification 01 77 00, Closeout Procedures and Specification 01 79 00 Demonstration and Training.
1. Acceptance of all final O&M Data submittals is required prior to scheduling Demonstration and Training Sessions.
2. Completion of all Demonstration and Training Sessions is required to receive the Substantial Compliance for Occupancy Certificate, and to begin Construction Closeout procedures.

**END OF SECTION**

# SECTION 01 78 36
# WARRANTIES



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guide lines related to providing all Warranties and Guarantees related to the Work, workmanship, materials, equipment, and other such items required by the Construction Documents.

B. Manufacturers' disclaimers and limitations on product warranties do not relieve any contractor of the warranty on the Work that includes the product.

C. Manufacturers' disclaimers and limitations on product warranties do not relieve suppliers, manufacturers and any contractor required to provide special warranties under the contract documents.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 31 23 Project Management Web Site
C. Section 01 77 00 Closeout Procedures
D. Section 01 78 23 Operation and Maintenance Data
E. Section 01 91 00 Commissioning
F. Other Divisions and Specifications that may address more specifically the requirements for Warranties related to the installation of all items and equipment installed under the execution of the Work.

### 1.3. DEFINITIONS

A. See specification 01 77 00 for the definitions of the following terms that may also be used in this specification:
   1. Substantial Compliance
   2. Certificate of Occupancy
   3. Certificate of Substantial Completion
   4. Construction Closeout
   5. Contract Closeout

B. Emergency Repair: The Owner or Owner Representative reserves the right to make emergency repairs as required to keep equipment or materials in operation or to prevent damage to property and injury to persons without voiding the contractors warranty or bond or relieving the contractor of their responsibilities during the warranty period.

C. Installer: The company or contractor hired to install a finished product that was manufactured and supplied specifically for the Work within this contract. The Installer may or may not be the same company that supplied the product. See the definition for supplier.

D. Supplier: Any company that makes a specific finished product for the Work from information within the Contract Documents. Examples of suppliers would include custom cabinets, steel stairs and railings, etc. A supplier would not be a company that distributes items manufactured by others such as an electrical or plumbing supplier.

E. Warranty: A written guarantee from the manufacturer to the owner on the integrity of a product and its installation, and the manufacturers' responsibility to repair or replace the defective product or components within a specified time from the date of ownership. Warranty may also be used interchangeably with Guarantee. The following warranty types may be part of any specification within the Work associated with the Construction Documents:

1. Expressed Warranty: A warranty that provides specific repair or replacement for covered components of a product over a specified length of time.
2. Implied Warranty: A warranty that is not stated explicitly by a seller or manufacturer that the product is merchantable and fit for the intended purpose.
3. Standard Product Warranty: Preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner. Standard warranties may be for any amount of time but shall not be for anything less than one (1) year from the warranty date.
4. Special Warranty: A written warranty required by the Contract Documents either to extend the time limit provided under a standard warranty or to provide greater rights to the Owner.

F. Warranty Date: The effective date that begins all warranty periods required for products, installations, and work-manship associated with the execution of the Work for this contract. The Warranty Date shall be set by the CPM.

G. Related Damages and Losses: When correcting failed or damaged Warranted Work, remove and reinstall (or replace if necessary) the construction that has been damaged as a result of the failure or the construction that must be removed and replaced to obtain access for the correction of Warranted Work.

H. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected reinstate the warranty by a new written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation unless specifically noted otherwise in a specification.

I. Replacement Cost: All costs that may be associated with Work being replaced under warranty including but not limited to the following:
1. Related damages and losses
2. Labor, material and equipment
3. Permits and inspection fees
4. This shall be regardless of any benefit the Owner may have had from the Work through any portion of its anticipated useful service life.

J. Replacement Work: All materials, products, required labor, and equipment necessary to replace failed or damaged warranted to an acceptable condition that complies with the requirements of the original Construction Documents.

K. Owners Recourse: Expressed warranties made to the Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Owner can enforce such other duties, obligations, rights, and remedies.
1. Rejection of Warranties: The Owner reserves the right to reject any warranty and to limit the selection of products with warranties not in conflict with the requirements of the contract documents.
2. Where the Contract Documents require a Special Warranty or similar commitment on the Work or product, the Owner reserves the right to refuse acceptance of the Work until the Contractor presents evidence the entities required to countersign such required commitments have done so.

**1.4. GENERAL CONTRACTORS RESPONSIBILITIES**

A. The General Contractor (GC) shall be responsible to remedy, at their expense, any defect in the Work and any damage to City owned or controlled real or personal property when the damage is a result of:
1. The GC's failure to conform to Contract Document requirements.
   a. Any substitutions not properly approved and authorized may be considered defective.
2. Any defect in workmanship, materials, equipment, or design furnished by the GC or Sub-contractors.

B. All warranties as described in this specification and these Contract Documents shall take effect on the date established by the CPM, as noted in Section 1.3F above.
1. All warranties shall remain in effect for one (1) year thereafter unless specifically stated otherwise in the Contract Documents or where standard manufacturer warranties are greater.

C. The GC's warranty with respect to Work repaired or replaced, including restored or replaced Work due to damage, will run for one (1) year from the date of Owner Acceptance of said repair or replacement.
1. This shall be regardless of any benefit the Owner may have had from the Work through any portion of its anticipated useful service life.

D. Warranty Response
1. See Section 3.5 of this specification.

**PART 2 – PRODUCTS - THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. WARRANTY CHECKLIST**

A. All contractors shall be responsible for reviewing the drawings and specifications within their Divisions of Work to provide a complete and comprehensive list of all Warranty Requirements to the GC.

B. Each list shall indicate the title (and plan identifier when applicable) of the warranted item, the associated specification of the warranted item, the terms of the warranty (years), and a column to verify the item has been turned in and completed.

C. The GC shall be responsible for all of the following:

1. Consolidating all the warranty lists into one master Warranty Checklist.
    a. The checklist shall be in a tabular data format similar to the sample below.
2. Upload the completed checklist to the Submittal Library on the Project Management Web Site for review. See Specification 01 33 23 Submittals for more information on this procedure.
3. Resubmit the schedule as needed after initial reviews have been completed.

D. The GC shall work with all contractors to amend the Warranty Checklist throughout the execution of the project based on changes and modifications as necessary.

| Title | Specification | Terms | Completed |
|---|---|---|---|
| Overhead Door Operator | 08 36 00 | MFR 2yr | |
| Exterior Bench and Trash Receptacles | 12 93 00 | MFR 3 year warranty on finish | |
| Kitchen Sink (SK-1) | 22 42 00 | MFR 5 year | |
| Disposal (D-1) | 22 42 00 | MFR 7 year parts and in-home service | |
| Toilet (WC-1) | 22 42 00 | MFR 1 year limited | |

**3.2. LETTERS OF WARRANTY**

A. All letters of warranty shall be in a typed letter format and provide the following information:

1. The letter shall be on official company stationary including company name, address, and phone number.
2. Indicate project name, contract number, and contract address the warranty is for on the reference line.
3. Provide a description of the warranty(ies) being provided.
    a. Include Division, Trade, or Specification information as necessary.
    b. Only combine warranties of related Divisional Work together. Create new letters for additional Divisions as necessary.
4. Indicate the effective Warranty Date. As noted in Section1.3.F above, the Warranty Date shall be the date the Certificate of Substantial Completion was signed by the City Engineer.
5. Contractor Letters of Warranty shall only be signed by a principal officer of the company.
6. After signing the letter provide the GC with a high quality color scanned image in PDF format and the original signed letter.

B. The GC shall be responsible for the Final Warranty submittal as identified in Section 3.4 below.

C. The GC shall obtain letters of warranty from all of the following:

1. The General Contractor shall provide warranty letters for all Work that was self performed under the contract documents, identify all trades or Divisions of Work.
2. All Sub-contractors shall provide warranty letters for Work performed under the contract documents; identify all trades or Divisions of Work.
3. Suppliers, as required by other specifications within the Construction Documents where the manufacture of a specific product unique to the Work of this contract was required.
    a. The terms and conditions of the Supplier Letter of Warranty shall be as defined by the specifications associated with the Work but shall not be less than the industry standard of repair, or replace defective materials and workmanship within one (1) year of the warranty date.
    b. When the supplier is also the installer a single written letter may be submitted identifying both the warranty for the manufacture of the product and the warranty for the installation of the product.
4. Installers as required by other specifications within the Construction Documents where the installation of a specific product unique to the Work of this contract was required.
    1. The terms and conditions of the Installer Letter of Warranty shall be as defined by the specifications associated with the Work but shall not be less than the industry standard of repair,

or replace defective materials and workmanship associated with the installation of the product within one (1) year of the warranty date.

5. Special Letters of Warranty shall be required from any contractor, supplier, installer or manufacturer who agrees to provide warranty services required by any Division Specification in excess of their Standard Product Warranty.

**3.3. STANDARD PRODUCT WARRANTY**

A. All contractors shall be responsible for collecting and providing copies of all standard product warranties for commercially available products purchased and installed under this contract.

B. Only one copy of the manufacturers' standard warranty needs to be submitted as representative for all quantities of the same model number used throughout the Work.

C. Provide the manufacturers certificate, letter, or other standard documentation for each Standard Product Warranty submitted as follows:

1. Whenever possible a PDF version of the document shall be used.
   a. If a PDF version is used all additional information shall be completed using simple PDF editing tools such as text boxes, highlight, etc.
   b. If a PDF version is not available and an original document is furnished the additional information shall be neatly hand written and highlighted on the document in such a fashion so that it does not obscure any part of the written warranty.
2. Provide the following additional information on each warranty document:
   a. Contract warranty date.
   b. Provide the manufacturer name and model number of the product if not specified within the warranty.
      i. Where the manufacturer name and model number is specified within the warranty it shall be highlighted for visibility.
   c. Provide the plan identifier (LAV-1, WC-2, etc) when applicable.

D. Each completed warranty shall be saved as a digital PDF. The file shall be named using the specification number and item description. I.E. 22 42 00 Toilet (WC-1).pdf
   a. Where an original certificate was furnished provide a high quality colored scan of the completed document with the additional information. Save the scanned image in PDF format and use the same naming convention as indicated above.

E. Provide all PDF files and any original documents to the GC for final consolidation to be provided to the Owner.

**3.4. FINAL WARRANTY SUBMITTAL**

A. The GC shall receive all required warranties (digital PDF and any original documents) from all contractors, suppliers, installers and manufacturers.

B. The GC shall inventory all received warranties with the Warranty Submittal List to ensure all required warranties have been received and all warranty periods are correct according to the specifications.

C. Provide with each Operation and Maintenance Manual a complete copy of any associated warranty.

D. Scan all warranties into a single organized electronic PDF file as follows:
1. Organize the PDF file into an orderly sequence based on the table of contents of the Specifications.
2. Provide a typed Table of Contents for the entire file at the front of the document.
3. Provide bookmarks and links to each individual PDF to enable quick navigation through the PDF document.

E. Upload the warranty submittal to the appropriate document library on the Project Management Web Site for review by the Project Architect (PA)/Project Engineer (PE) and CPM.

F. Correct any deficiencies or omissions and resubmit as necessary.

**3.5. WARRANTY NOTIFICATION, RESPONSE, EXECUTION AND FOLLOW-UP**

A. Warranty Notification:
1. The City of Madison, Project Management Web Site, uses an email notification system for all warranty related issues. The GC will be required to provide, and keep current during the warranty period, a minimum of two (2) email addresses and phone numbers of current employees to receive email notifications and provide response regarding Work associated with these construction documents.
   a. In the event a Warranty Issue is deemed by the City of Madison to be an emergency, the GC shall first receive a phone call with a follow-up email from the Project Management Web Site.
   b. The Contract Closeout-Warranty Issue Library on the Project Management Web Site uses a form for each warranty issue that is logged into the system.

i. The GC shall open each warranty issue form, review the issue description and any attached documentation or photos.
ii. The GC shall also notify any other sub-contractor, supplier, or installer that may be required to review the warranty issue.

B. Warranty Response:
1. The GC shall upon notification by the City of Madison provide warranty response as follows:
a. Critical Systems or equipment: Where damage to equipment and other building components, or injury to personnel is probable provide immediate emergency shut-down information and an on-site response team as soon as possible but in no case shall on-site response exceed 24 hours.
b. For non-critical responses where damage or injury is unlikely provide on-site response no later than the next business day.
c. Where Technical Assistance support is part of the written warranty provide all assistance necessary via phone, text, or internet systems as indicated by the warranty. If issues cannot be resolved provide on-site response no later than the next business day.
d. If the request cannot be supported in sufficient time as outlined above the Owner (or Owner Representative) reserves the right to contact other contractors or service companies having similar capability to expedite the repair or replacement and shall invoice all associated costs to the Owner back to the GC.

C. Warranty Execution:
1. The GC shall provide all repairs or replacements as necessary to restore broken or damaged Work to the original level of acceptance as intended by the Contract Documents.
a. Provide all materials, equipment, products, and labor necessary to complete the repair or replacement associated with the Warranty Issue.
b. Provide all cleaning services as may be required before, during, and after the repair or replacement as per Specification 01 74 13 Progress Cleaning.
c. Provide any protection necessary for existing construction as per Specification 01 76 00 Protecting Installed Construction
d. Provide new letters of warranty when required.

D. Warranty Follow-up:
1. Logged Warranty Issues:
a. The GC shall provide complete documented responses of all logged Warranty Issues. Responses shall provide a description of work completed, by who, inclusive dates, and photos of completed or repaired work.
i. Provide call back response if work is not acceptable.
b. The City Project Manager shall review the submitted response documentation and do a field inspection if necessary.
i. If work is not acceptable, contact GC to review details and expectations of the repair as needed.
ii. If work is acceptable close the Warranty Issue.
2. Quarterly Warranty Reviews:
a. The GC shall be responsible for scheduling quarterly on-site review with all of the following:
i. City Project Manager, and other City staff as needed
ii. Owner and Owner Tenant Representative
iii. Commissioning Agent (CxA)
iv. Plumbing, Heating, Electrical Sub-contractors
v. Other Sub-contractors that may be responsible for open Warranty issues
b. Quarterly reviews shall be scheduled at 3 months, 6 months, and 11 months after the effective date of the warranty. The review meetings shall:
i. Review the status of all open Warranty Issues, determine course of action and estimated date of completion.
ii. In the appropriate quarter, provide shut-down, start-up, testing, and training of off-season equipment as required by the contract documents.
iii. The 11th month review shall review all open Warranty Issues, final plan for resolution, and all Warranty Issues where a new letter of warranty may have been issued.

**END OF SECTION**

# SECTION 01 78 39
# AS-BUILT DRAWINGS



## PART 1 – GENERAL

### 1.1. SUMMARY

A. This specification is intended to provide clear guidelines and identify the responsibilities of all contractors as they pertain to City of Madison contract procedures regarding the accurate recording of the Work associated with the execution of this contract. This shall include but not be limited to work that will be hidden, concealed, or buried.

B. Each contractor shall be responsible for maintaining an accurate record of all installations, locations, and changes to the contract documents during the execution of this contract as it may relate to their specific division or trade.

C. The General Contractor (GC) shall be responsible for ensuring all contractors provide as-built record information to the Master As-Built Document Set as described in this specification.

### 1.2. RELATED SPECIFICAITONS

A. 00 31 21 Survey Information
B. 01 26 13 Request for Information
C. 01 31 23 Construction Bulletin
D. 01 32 33 Photographic Documentation
E. 01 26 63 Change Orders
F. 01 29 76 Progress Payment Procedures
G. 01 31 23 Project Management Web Site
H. 01 33 23 Submittals
I. 01 77 00 Closeout Procedures
J 01 91 00 Commissioning
K. Other Divisions and Specifications that may address more specifically the requirements for field recording the installation of all items associated with the execution of this contract by Division or Trade.

### 1.3. RELATED DOCUMENTS

A. Other related documents shall include but not be limited to the following:
1. Bidding documents including drawings, specifications, and addenda.
2. Required regulatory documents of conditional approval.
3. Field orders, verbal or written by inspectors having regulatory jurisdiction.
4. Shop drawings and installation drawings.

### 1.4. PERFORMANCE REQUIREMENTS

A. The GC shall be responsible for maintaining the “Master As-Built Document Set” in the job trailer at all times during the execution of this contract. This document set shall include all of the following:
1. Master As-Built Plan Set
2. Master As-Built Specification Set
3. Other Document Sets

B. The GC shall designate one person of the GC staff to be responsible for maintaining the Master As-Built Document Set at the job trailer. This shall include, posting updates, revisions, deletions and the monitoring of all contractors posting as-built information as described in this specification.

C. All contractors shall use this specification as a general guideline regarding the requirements for documenting their completed Work. Contractors shall explicitly follow additional specification requirements within their own Division of Trade as it may apply to this specification.

**1.5. QUALITY ASSURANCE**

A. The GC shall be responsible for all of the following:

a. Spot checking all sub-contractors field documents to insure daily information is being recorded as work progresses.

b. Discuss as-built recording to the plan set at weekly job meetings with all sub-contractors on site.

c. Schedule time with sub-contractors in the job trailer for recording as-built information to the plan set.

d. Insure that all sub-contractors are providing clear and accurate information to the plan set in a neat and organized manner.

e. Insure sub-contractors who have completed work have finalized recording all as-built information to the plan set before releasing them from the project site.

B. The Project Architect, the City Project Manager, Commissioning Agent and other design team staff will perform random checks of the Master As-Built Document Set during the execution of this contract to ensure as-built information is being recorded in a timely fashion as the Work progresses. An updated and current Master As-Built Document Set is a stipulation for approval of the progress payment.

## PART 2 – PRODUCTS

**2.1. OFFICE SUPPLIES**

A. The GC shall provide a sufficient supply of office products in the job trailer at all times for all contractors to use in recording as-built information into the plan set. This shall include but not be limited to the following:

a. Red ink pens, medium point. Pens that bleed through paper, markers, and felt tips will not be accepted.

b. The use of highlighters is acceptable. Assign colors to various trades for consistency in recording information.

c. Straight edges of various lengths for drawing dimension, extension and other lines.

d. Civil and Architectural scales

e. Clear transparent, non-yellowing, single sided tape.

f. Correction tape or correction fluid for correcting small errors.

## PART 3 - EXECUTION

**3.1. FIELD DOCUMENT AS-BUILTS**

A. The GC and all Sub-contractors shall be responsible for keeping their own field set of as-built documents including plans, specifications and published changes.

B. Field sets shall be kept dry and in good condition at all times.

C. No Work shall be buried, covered, or hidden, by any additional Work, regardless of Contractor or Trade, until locations of all materials and equipment has been properly documented as described below.

D. All contractors shall be required to record the following as-built information:

a. Notes on the daily installation of materials and equipment.

b. Sketches, corrections, and markups indicating final location, positioning, and arrangement of materials and equipment such as pipes, conduits, valves, cleanouts, pull boxes and other such items. Note all final locations on plan sheets, indicate dimension off identifiable building features. Riser diagrams need only be corrected for significant changes in locations, routing or configuration.

i. The use of photographs in lieu of hand drawn sketches is acceptable.

ii. Photos shall be taken according to Specification 01 32 33 Photographic Documentation

iii. Print photo and markup with dimensions or notes as necessary.

c. Identify by the use of existing plan symbology and notes the size, type, quantity, and use as applicable of materials such as pipes, valves, conduits, etc.

d. Note whether horizontal runs are below slab or above ceiling, include dimensions above or below finished floor elevation.

E. All contractors shall be responsible for transferring the information from their field set of documents to the Master As-Built Plan Set kept in the GC job trailer. See Section 3.3.D. below for the proper procedure.

F. All contractors shall update the GC Master Plan Set as often as necessary, but not less than once per work week.

**3.2. SITE SURVEY AS-BUILT**

A. The Land Surveyor Sub-Contractor shall provide digital as-built information including but not be limited to the following:

a. For underground buried utility laterals and services of all types locate all of the following that may apply:

i. Connection points at all mains
ii. Storm discharge points to open air
iii. All corners and bends regardless of angle, large radius sweeps shall have multiple point locations sufficient to define the sweep.
iv. All vertical drops
v. All wells
vi. Private buried utilities such as buried electrical cables, irrigation systems, etc.
v. Other information that may need to be located in the future by the owner prior to digging

b. Record all surface features including but not limited to the following:

i. Building corners, pavement edges, and other permanent structural features.
ii. All surface covers for inlets, catch basins, cleanouts, access structures, curb stops and other such devices.
iii. Other permanent surface features such as hydrants, lamp posts, and other permanent site amenities.

c. The following data shall be recorded while locating items in sub-sections 3.2.a and 3.2.b above:

i. Flow lines at both ends of pipes
ii. Pipe sizes and material types
iii. Rim elevations for all covers
iv. Sump elevations and invert elevations of all structures
v. Spot elevations for all pads, driveways, walks, stoops, and floors

B. The Surveyor shall provide the final digital as-built on a media and in a format specified in Specification 00 31 21 Survey Information to the GC for turn in to the Project Architect and the Civil Engineer.

C. The Surveyor shall provide two printed as-built site plans to the GC for inclusion in the Master As-Built Plan Set as follows:

1. One sheet to show all features (but not contour information) with text neatly organized for each item identified.
2. One sheet showing contours, contour labels, and features from item 1 above, but with no additional text.

**3.3. MASTER AS-BUILT DOCUMENT SET**

A. The GC shall be responsible for maintaining the Master As-Built Document Set in the job trailer at all times.

1. The Master As-Built Plan Set (Plan Set) shall begin with one complete bid set of drawings and any additional sheets that were supplied by published addenda during the bidding process. The cover sheet shall be titled as the “Master As-Built Plan Set” in large bold red letters approximately 2” in height and shall not be used for any other purpose.

a. The Plan Set shall be kept dry, legible, and in good condition at all times.

b. The Plan Set shall be kept up to date with new revisions within two (2) working days of supplemental drawings being issued. Revisions shall be posted as follows:

i. Insert new, revised sheets into the plan set. Void old sheets but do not remove them from the plan set. Indicate date received and what document (RFI, CB, CO, etc) caused the change.
ii. Insert new, revised individual details into the plan set. Void old details, tape new details over the old details with a “tape hinge” to allow them to be viewed. Indicate date received and what document (RFI, CB, CO, etc) caused the change.
iii. Add new details in appropriate white space on relevant sheets. If no space is available use the back side of the previous sheet or insert a new sheet. Indicate date received and what document (RFI, CB, CO, etc) caused the change.

c. The Plan Set shall be available at anytime for easy reference during progress meetings and for emergency location information of new work already completed.

2. The Master As-Built Specification Set (Spec Set) shall begin with one complete bid set of specifications and any additional specifications that were supplied by published addenda during the bidding process. The Spec Set shall be provided in three "D" ring type binders of sufficient thickness to accommodate the specification set. Multiple binders are allowed as necessary. Label the front cover and binding edge with "Master As-Built Specifications" in bold red letters. Provide other information as necessary to distinguish the contents of multi-volume sets.
   a. The Spec Set shall be kept dry, legible, and in good condition at all times.
   b. The Spec Set shall be kept up to date with new revisions within two (2) working days of supplemental drawings being issued.
   c. The Spec Set shall be available at anytime for easy reference during progress meetings.
3. Other Document Sets may be kept at the GCs option in three "D" ring type binders of sufficient thickness to accommodate the documentation. Other documentation sets may include but not be limited to RFIs, CBs, COs, etc.

C. The Land Surveyor Sub-Contractor shall be required to use digital surveying for all exterior site surveying, and provide deliverable digital as-builts as specified in Specification 00 31 21 Survey Information. As soon as practical the surveyor shall provide the GC with a preliminary copy of installed buried utilities for inclusion with the plan set in the job trailer. The surveyor shall provide final digital as builts as per section 3.2 above.

D. All contractors shall be responsible for updating the Plan Set from their field sets at least once per work week. Updates shall include but not be limited to the following procedures:
   a. All updates shall be done only in red ink. Place a "cloud" around small areas of correction to call attention to the change.
   b. Whenever possible place general work notes, field sketches, supplemental details, photos, and other such information on the reverse side of the preceding sheet. Installation notes including dates shall be kept neatly organized in chronological order as necessary.
   c. Accurately locate items on the plan set as follows:
      i. For items that are located as dimensioned provide a check mark or circle indicating the dimension was verified.
      ii. For items that are within 5 feet of the location indicated on the plans leave as shown and:
         - Provide correct dimensions to existing dimension strings or,
         - Accurately locate with new dimension strings
      iii. For items that are more than 5 feet from the location indicated on the plans
         - Accurately draw the items in the new location as installed and,
         - Accurately locate with new dimension strings and,
         - Note that the existing location is void.
   d. Include dimensioned locations for items that will be buried, concealed, or hidden in the ground, under floors, in walls or above ceilings.
      i. Dimensions shall be pulled from identifiable building features, not from centers of columns or other buried features.
      ii. When necessary pull more dimensions as needed from opposing directions to properly locate single items.

**3.4. AS-BUILT REVIEW AND ACCEPTANCE**

A. The GC shall provide the Master As-Built Plan Set to the Project Architect (PA)/Project Engineer (PE), the City Project Manager (CPM), the Commissioning Agent (CxA) and other design team staff for content review prior to the Progress Payment Milestone indicated in Specification 01 29 76 Progress Payment Procedures. The submitted plan set shall include the digital survey information produced under Section 3.2 above.
   1. If the plan set is not approved:
      a. The PA/PE and CPM shall only be required to generalize deficiencies by trade there shall be no requirement or expectation to generate a "punch list" of required corrections.
      b. The GC and Sub-contractors as necessary shall be responsible for inspecting the installation and correcting the drawings as needed.
      c. The GC shall re-submit the plan set for review.
   2. If the plan set is approved the PA/PE shall take possession of the plan set to be used in providing the owner with digital CAD record drawings. Upon completion of transferring the information to CAD the PA/PE shall provide the Owner with CAD record drawings, record PDFs, and the Master As-Built Plan Set.

**3.5. CHANGES AFTER ACCEPTANCE**

A. No Contractor shall be responsible for making changes to the As-Built record documents after acceptance by the PA/PE and CPM except when necessitated by changes resulting from any Work made by the Contractor as part of their guarantee.

**END OF SECTION**

# SECTION 01 78 43
# SPARE PARTS AND EXTRA MATERIALS



## PART 1 – GENERAL

### 1.1. SUMMARY

A. This specification is intended to provide clear guidelines and identify the responsibilities of all contractors as they pertain to City of Madison contract procedures regarding spare parts, special tools, special materials, and extra materials.

B. Each contractor shall be responsible for knowing the specific requirements of their Division Specifications as they may relate to the general information provided in this specification.

C. The General Contractor (GC) shall be responsible for ensuring all contractors provide spare parts and extra materials as described in this specification.

### 1.2. RELATED SPECIFICAITONS

A. 01 29 76 Progress Payment Procedures

B. 01 31 23 Project Management Web Site

C. 01 77 00 Closeout Procedures

D. Other Divisions and Specifications that may address more specifically how to proceed with spare parts, special tools, special materials, and extra materials.

### 1.3. DEFINITIONS

A. Spare Parts: Any component of a product or assembly that comes pre-packaged or was specially ordered for the explicit use of the product or assembly. This shall include but not be limited to fastening devices, mounting brackets, replacement parts, wheels, pulleys, wiring, alternate assembly pieces, etc.

B. Special Tools: Any tool of any kind that was pre-packaged or specially ordered, and is required to be used for the installation or maintenance of an installed product or assembly as part of this contract.

C. Special Materials: Any oil, lubricant, glue, touch-up paint, or other such material that comes pre-packaged or was specially ordered and is required to be used for the installation or maintenance of an installed product or assembly as part of this contract.

D. Extra Materials (Attic Stock): Any surplus materials in new and useable condition that was installed a part of this contract. Attic Stock shall include but not be limited to the following: ceiling tiles, paint, stain, floor coverings, ceramic tiles, light bulbs/lamps, filters, strainers, etc. Attic Stock shall include partially opened bulk items and additional unopened quantities as directed by other specifications.

### 1.4. PERFORMANCE REQUIREMENTS

A. All contractors shall be responsible for consolidating spare parts, special tools, special materials, and attic stock as it pertains to the specific Work within their Division or Trade.

B. All contractors shall use this specification as a general guideline regarding the requirements for turning spare parts, special tools, special materials, and attic stock over to the owner. Contractors shall explicitly follow specification requirements within their own Division of Trade.

### 1.5. QUALITY ASSURANCE

A. The General Contractor (GC) shall be responsible for all of the following:

1. Coordinate the location for and the delivery of all spare parts, special tools, special materials, and attic stock being provided by all contractors under this contract to one centralized location as designated by the Owner.
2. Verify that all items being delivered are:
   a. Clean, new, and in a usable condition.
   b. Properly sealed, protected, and labeled
   c. Properly documented

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. PACKAGING**

A. Whenever possible all surplus items should remain in their original packaging such as parts envelopes.
B. Package small parts in re-sealable plastic bags (Ziploc) or envelopes with clasp fasteners. Do not use envelopes that seal with glue or tape envelopes closed. Do not leave packaging unsealed.
C. Package like parts together for products or assemblies. I.E. keep all spare parts for flushometers together.
D. Many small packages may be grouped together into a larger container by trade.
E. Do not use unrelated boxes or containers for packaging spare items. I.E. do not use a light fixture box for spare breakers, or flushometers parts.

**3.2. LABELING**

A. Whenever possible the original labeling indicating part numbers and other pertinent information shall remain on the original packaging.
B. If original labeling is not available the contractor shall label all parts and packages using tape or labels and permanent black markers. Tape or labels being used shall absorb the permanent marker without bleeding or allowing ink to be smeared or rubbed off.
C. Labels shall include the name of the product or equipment the item belongs to, part number and/or name, and any other information that would assist maintenance personnel in identifying the piece and related product.
D. Labels shall include plan or specification designations (WC-1, LAV-3, DF-2, CPT-1, etc) that identify the particular product or finish material it represents.
E. Labels for parts stored in clear re-sealable plastic bags may be placed inside the bag. Label shall face out and be able to be read from one side. Multiple bags shall be numbered individually for identification.
F. Label the outside of large containers with the trade name (Plumbing, Electrical, etc).

**3.3. INVENTORY**

A. All contractors shall provide the GC with complete inventories of all spare parts, special tools, special materials, and attic stock that they are providing at the end of the contract. The inventories shall be organized as follows:
   1. The cover sheet shall indicate the Contractors name, address, phone number, identify that the document is the “Spare Parts and Extra Materials Inventory”, and identify the Division or Trade the inventory is for.
   2. Provide an inventory in a tabular format of all items being provided under this and other specifications. The minimum information to be provided for each item on the inventory shall be as follows:
      a. Bag or container number, all items of one bag or container shall be grouped together on the inventory
      b. Item description
      c. Item size (if applicable)
      d. Total quantity provided
      e. Identify if item is a spare part, tool, special material, or attic stock
B. The GC shall consolidate inventories from all sub-contractors into one tabular data sheet organized by Division or Trade of Work.
   1. Upon completing the consolidated list the GC shall upload the completed inventory to the Contract Closeout-Attic Stock Library on the Project Management Web Site.
   2. The GC shall notify the Project Architect and City Project Manager that the scans have been uploaded.
   3. Consulting Staff and Owner Staff shall review the inventories prior to Final Review to verify that minimum required quantities have been met. Deficiencies shall be noted and returned back to the GC for corrective action.

**3.4. STORAGE**

A. Prior to the 80% Progress Payment milestone the GC shall coordinate with the City Project Manager and Maintenance Personnel where spare parts, special tools, special materials, and attic stock shall be stored.

B. The GC shall instruct all contractors as to the location and proper storage procedures.

C. The GC shall be responsible for ensuring the storage area is kept neat and orderly as follows:

1. Like items are stored together by material, product, or trade as necessary.
2. Liquids are stored in sealable containers and the lids have been properly installed to prevent drying out, spillage, etc.
3. All labels are clearly visible and provide the required information.

D. Large items shall be stored so as not to damage other items. Do not stack heavy items or items with distinct shapes/outlines on softer items that may get crushed or imprinted.

**3.5. CLOSEOUT PROCEDURE**

A. Prior to the 90% Progress Payment milestone the GC shall review all attic stock already stored by the contractors to ensure the following:

1. Materials are stored in the proper location(s).
2. All boxes, containers and items are properly labeled according to the submitted/approved inventory.
3. Quantities are correct according to the submitted/approved inventory.

B. The GC shall ensure that all deficiencies are corrected prior to conducting Demonstration and Training Sessions.

C. The GC shall review with Maintenance Staff all inventories and labeling during the scheduled Demonstration and Training Sessions.

D. Any discrepancies associated with Attic Stock shall be resolved and verified prior to the CPM releasing the 90% CT progress payment.

**END OF SECTION**

# SECTION 01 79 00
# DEMONSTRATION AND TRAINING



## PART 1 – GENERAL

### 1.1. SUMMARY

A. The purpose of this specification is to provide clear responsibilities and guidelines related to providing Demonstration and Training (D&T) Sessions related to general facility use, equipment, systems, finishes, and materials to City of Madison Staff (Owner, Owner Representatives, Maintenance, and Custodial Personnel) as needed.

B. All D&T shall be coordinated through the General Contractor (GC), Project Architect (PA)/Project Engineer (PE) and City Project Manager (CPM), and will be based on or customized to the needs of City of Madison Staff being trained. New equipment and systems may have complete D&T sessions as described in this specification while equipment or systems staff is familiar with may have sessions more focused on maintenance only.

### 1.2. RELATED SPECIFICATIONS

A. Section 01 29 76 Progress Payment Procedures
B. Section 01 78 13 Completion and Correction List
C. Section 01 78 19 Maintenance Contracts
D. Section 01 78 23 Operation and Maintenance Data
E. Section 01 78 36 Warranties
F. Section 01 78 39 As-Built Drawings
G. Section 01 78 43 Spare Parts and Extra Materials
H Section 01 91 00 Commissioning
I. Other Divisions and Specifications that may address more specifically the requirements for D&T sessions related to the installation of all items and equipment installed under the execution of the Work.

### 1.3. QUALITY ASSURANCE

A. All contractors shall have the responsibility of preparing for and conducting D&T sessions as determined by this and other Division or Trade related specifications, Owner Operation and Maintenance Manuals, and other such documentation related to the Work.

B. The GC shall have responsibility for:

1. Ensuring that all contractors required to conduct a D&T session have successfully completed all of the following:
   a. Turned in all required documentation for review and documentation has been approved/accepted prior to scheduling D&T sessions.
   b. Other required documentation as needed is available and ready for use during the D&T session.
   c. All systems have been started, tested, and running as per appropriate specification and/or manufacturers recommendations prior to scheduling D&T sessions.
   d. All contractors are sufficiently prepared for their D&T session
   e. Documents the D&T session including date, time, contractor and company name, attendees and other information regarding the session
2. Organizing the coordination and scheduling of all D&T sessions between all contractors and the appropriate representatives of the Owner. These representatives may include any of the following depending on the Work of the Contract:

a. Owner – end users
b. Facility Maintenance personnel
    i. Facility general operation procedures including custodial services
    ii. Electrical
    iii. Mechanical
    iv. Plumbing
    v. Site
c. Information Technology (IT) Department
d. Traffic Engineering – Radio Shop
e. Architects, Engineers and Facility Management staff as project completion overview

**PART 2 – PRODUCTS – THIS SECTION NOT USED**

**PART 3 - EXECUTION**

**3.1. GENERAL REQUIREMENTS**

A. The GC shall develop a specific D&T plan to be scheduled and conducted as described below but no sooner than the meeting discussed in 3.2.A.2 below.

C. The GC shall not schedule D&T sessions to preclude required personnel from attending multiple sessions.

**3.2. COORDINATING AND SCHEDULING THE TRAINING**

A. The GC, PA/PE, CxA and CPM, shall review all Training and Demonstration requirements during two (2) special meetings.
    1. The first meeting shall be held at the 50% Contract Total Payment. During this meeting the following shall be discussed:
        a. Preliminary schedule of training dates to be completed prior to beginning construction closeout.
        b. List of documentation and items that need to be completed and available before and during the training session.
        c. Who (Owner, Maintenance, etc) will be attending what training session(s).
    2. The second meeting shall be held at the 80% Contract Total Payment. This meeting shall review due outs that have not yet been completed for the 90% Contract Total Payment and the requirements necessary for Construction Closeout. All Demonstration and Training sessions shall be completed prior to receiving the 90% progress payment and beginning Construction Closeout Procedures (see Specification 01 77 00).
        a. This does not include any requirement associated with off season equipment preparation and/or demonstration and Training Sessions.

B. All of the Construction Work shall be operationally ready prior to conducting training as follows:
    1. All contractors shall have their As-Built Drawing Records available for reviewing locations of system components during training.
    2. All final and approved Operations and Maintenance Data shall be completed no less than two (2) full weeks prior to the scheduled training.
    3. All systems shall have been started, functionally tested, balanced, and fully operational, and all piping and equipment labeling complete at least two (2) days prior to the scheduled training.
        a. Seasonal equipment shall not be trained out of season. Contractors having seasonal equipment shall work with the GC and CPM for coordinating additional training sessions as appropriate for seasonal equipment.

C. Correction list items that prevent a piece of equipment or system from being fully operational for training shall be corrected prior to conducting the training.

**3.3. TRAINING OBJECTIVES**

A. For each piece of equipment or system installed train on the following objectives/topics as applicable:
    1. System design, concept, and capabilities
    2. Review of related contractor as-built drawings
    3. Facility walkthrough to identify key components of the system
    4. System operation and programming including weekly, monthly, annual test procedures
    5. System maintenance requirements
    6. System troubleshooting procedures
    7. Testing, inspection, and reporting requirements associated with any regulatory requirements
    8. Identification of any correction list items still outstanding

9. Review of system documentation including the following:
    a. Operation and maintenance data
    b. Warranties
    c. Valve charts, tags, and pipe identification markers

B. For each piece of specialty equipment train on the following objectives/topics as applicable:
1. Manufacturers operations instructions
2. Manufacturers use and care instructions
3. Manufacturers maintenance and troubleshooting instructions
4. System operation and programming including weekly, monthly, annual test procedures
5. Identification of any correction list items still outstanding
6. Review of system documentation including the following:
    a. Operation and maintenance data
    b. Warranties

C. End User Orientation
1. Facility walkthrough
2. Security and emergency features
3. General facility operation procedures

D. Facility General Use and Custodial Services – if requested
1. Facility walkthrough
2. Security and emergency features
3. General facility operation procedures
4. Care and maintenance of specialty items, finishes, etc as requested
5. Attic stock inventory and material designations

**3.4. DEMONSTRATION AND TRAINING PROGRAM PREPARATION**

A. Each contractor having a responsibility for providing D&T sessions shall meet with the GC, CPM, and other City Staff as needed to review the extent of the Training Objectives in section 3.3 above needed for each piece of equipment, system, finish, etc. This meeting shall occur no less than four (4) weeks prior to the anticipated training session.

B. The contractor shall use the information from item 3.4.A above to prepare a formal training program for each piece of equipment or system based on the Training Objectives in 3.3 above.
1. The formal training program shall include the following information:
    a. Session title
    b. List of systems, equipment, use, care, etc to be covered during the session
    c. Provide the following for each systems, equipment, use, care, etc to be covered during the session
        i. Name and affiliation of each instructor to be used. As needed and discretion of the Owner the GC to require attendance by the installing technician, installing Contractor and the appropriate trade or manufacturer's representative.
        ii. Qualifications of each instructor to be used. Practical building operation expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment as installed in this project is required by the training personnel. If Owner determines training was not adequate, the training shall be repeated until acceptable to Owner.
        iii. A checklist of all documentation and system/equipment requirements necessary to complete a successful training session and the current status of each
        iv. Any additional documents, training aids, video or other items to be used to complete the training
        v. Any special requirements or needs associated with item iv above to complete the training
    d. The intended audience for the training
    e. The approximate duration of each objective or topic to be covered
2. Submit the completed training program to the GC for review and approval by the PA/PE and CPM.

C. The PA/PE and CPM shall work with staff as necessary to ensure all points of anticipated training needs have been met. The PA/PE and CPM will approve the program as submitted or recommend changes for re-submittal as necessary.

**3.5. CONDUCTING A DEMONSTRATION AND TRAINING SESSION**

A. All contractors shall conduct their required D&T Sessions as follows:
1. Begin with a classroom session
    a. Provide a sign in sheet indicating all training to be conducted, instructors, etc.

b. Provide an overview of the training to be conducted including the approximate schedule.

2. Conduct a general walk-through of the site.
   a. Point out locations of various equipment, valves, charts, and other related items.
   b. Use the Division or Trade As-Built record drawings to indicate locations of hidden or buried items.
3. Provide a demonstration of general equipment/system operation including using the O&M manual.
   a. Startup and shutdown procedures.
   b. Normal operational levels as depicted by any gauges, software, etc.
   c. Indicate warning devices, signs etc. and demonstrate emergency shut-down procedures.
4. Provide a demonstration of all owner level maintenance using the O&M manual.
   a. Indicate frequency of maintenance.
   b. Provide and review all spare parts, special tools, and special materials.
5. Provide and review all spare parts, special tools, special materials, or attic stock as applicable.
6. While conducting D&T sessions:
   a. Allow hands on training whenever practical.
   b. Answer questions promptly
   c. Repeat demonstrations and procedures as necessary.

B. Within two (2) working days of completing the D&T session the contractor responsible for the session shall turn-in any documentation generated including the sign in roster to the GC.

C. The GC shall turn over all training documentation to the PA/PE and CPM upon completion of D&T sessions.

D. Re-schedule any training that has been determined to be inadequate or inappropriate for any reason including but not limited to any of the following;
   1. Unqualified instructor
   2. System installation incomplete or untested to the specifications
   3. Equipment failure during demonstration
   4. Un-expected cancellation

**3.6. CLOSEOUT PROCEDURE**

A. Prior to receiving the 90% Progress payment the GC shall:
   1. Verify with the PA/PE and CPM that each Demonstration and Training Session was conducted properly and according to the submitted plan.
   2. Any required “Off Season” equipment testing, balancing, and Demonstration and Training Sessions have been tentatively scheduled with the GC, necessary sub-contractors, instructors and Owner/Owner Representatives as necessary.

**END OF SECTION**

# SECTION 02 41 00
# DEMOLITION



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to demolition and applies to the entire contract.
B. Remove items indicated, for salvage, relocation, recycling, and removal from premises. Plans show items to be demolished in dashed lines, color or other method that distinguishes from background.
C. Unless noted otherwise, contractor is responsible for proper disposal of all removed and/or demolished material and equipment.
D. Obtain required permits.
E. Take precautions to prevent collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
F. Perform all demolition as indicated on the drawings and as required to accomplish new work. Demolition Drawings are based on casual field observation and/or existing record documents. Verify field measurements and circuiting arrangements as shown on Drawings. Verify that abandoned wiring, piping, ducting and equipment serve only abandoned facilities. Report discrepancies to owner before disturbing existing installation. Beginning of demolition means contractor accepts existing conditions.
G. Demolition all abandoned services and devices in areas affected by this contract, even if not shown on plans. This includes but is not limited to wiring, conduits, ductwork, piping, and equipment. Disconnect all services in a manner which allows for future connection to that service. Disconnect services to equipment at unions, flanges, valves, or fittings wherever possible. Abandon gas, electric and communication utilities in accordance with local utility company requirement.
H. Patch holes and openings caused by removal of material and equipment, or formerly covered by such, with like material and texture of surrounding surface. Paint to match surroundings.
I. Arrange selective demolition schedule so as not to interfere with Owner's operations.

### 1.2. REFERENCES

A. OSHA – Occupational Safety and Health Administration
   1. CFR 1926 - U.S. Occupational Safety and Health Standards.
B. NFPA - National Fire Protection Association
   1. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations

### 1.3. SUBMITTALS

A. PRE-DEMOLITION PHOTOGRAPHS: Record existing conditions by use of preconstruction photographs. Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage cause d by selective demolition operations.
B. PROJECT RECORD DOCUMENTS: Accurately record actual locations of capped and active utilities and subsurface construction.
C. PROPOSED PROTECTION MEASURES: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
D. Schedule of demolition activities with starting and ending dates for each activity.

### 1.4. QUALITY ASSURANCE

A. Coordinate work with owner to minimize disruption to the existing building occupants.
B. Dismantle each structure in an orderly manner to provide complete stability of the structure at all times. Provide bracing and shoring where necessary to avoid premature collapse of structure. Where necessary to prevent collapse of any construction, install temporary shores, underpinning, struts or bracing. Do not commence demolition work until all temporary construction is complete.
C. Verify the locations of, and protect, any buildings, structures, utilities, paved surfaces, signs, streetlights, utilities, landscaping and all other such facilities that are intended to remain or be salvaged. Make such explorations and probes as necessary to ascertain any required protection measures that shall be used before proceeding with demolition.
D. Explosives shall not be used for demolition.

E. Do not demolish or damage equipment and material that is to stay in place. The Contractor shall restore all disturbed areas in accordance with the drawings and specifications. If plans and specifications do not address restoration of specific areas, these areas will be restored to pre-construction conditions as approved by owner.
F. EXISTING WARRANTIES: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.
G. Comply with ASSE A10.6 and NFPA 241.

## PART 2 - PRODUCTS

### 2.1. REPAIR MATERIALS

A. Use repair materials identical to existing materials.
   1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
   2. Use materials whose installed performance equals or surpasses that of existing materials.
B. Comply with material and installation requirements specified in individual Specification Sections.

## PART 3 – EXECUTION

### 3.1. EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
B. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
C. Inventory and record the condition of items to be removed and salvaged.

### 3.2. DEMOLITION

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
B. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
C. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
D. Don't use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
E. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
F. Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
G. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area off-site designated by Owner.
   5. Protect items from damage during transport and storage.
H. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
I. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.
J. Do not allow demolished materials to accumulate on-site.
K. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
L. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
M. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

### 3.3. GENERAL BUILDING DEMOLITION

A. Proceed with demolition in a systematic manner, from top of structure to ground. Complete demolition work above each floor or tier before disturbing supporting members on lower levels.
B. Remove structural framing members and lower to ground by hoists, derricks or other suitable means.
C. Locate demolition equipment and remove structure so as to not impose excessive loads to supporting walls, floors or framing.
D. Break up and remove concrete slabs-on-grade, unless otherwise shown to remain.
E. Masonry and concrete shall be demolished in small sections. Use braces and shores as necessary to support the structure of the building or structure and protect it from damage. Where limits of demolition are exposed in the finished work, cutting shall be made with saws, providing an absolutely straight line, plumb, true and square. Operate equipment so as to cause a minimum of damage to plaster which is to remain, and so as to keep dust and dirt to a minimum.

F. Demolish foundation walls and other below grade features in accordance with the plans. Unless otherwise noted, remove all below grade features to a point 4' below adjoining existing grade, or proposed grade, whichever is lower. Basement and/or lowest level floors more than 4' below existing grade need not be removed, but must be broken up to permit drainage.
G. Backfill and compact below grade areas and voids resulting from demolition of structures and other abandonment and demolition. Backfilling shall not begin until demolition and abandonment has been approved and documented by owner. Prior to placement of fill materials, ensure that areas to be filled are free of standing water, frost, frozen materials, trash and debris.
H. Carefully protect and/or replace drain tiles encountered during demolition which are necessary to maintain site drainage conditions. Immediately repair or replace any drain tiles not scheduled for demolition, but damaged. Report damage to owner.
I. Repairs to drain tile or replacement drain tile shall be comparable or better than the existing drain tile system.
J. Test drain lines with water to assure free flow before covering. Remove all obstructions, retest until satisfactory.

**3.4. UTILITY SERVICES AND BUILDING SERVICES SYSTEMS**

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
    1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
    2. Arrange to shut off utilities with utility companies.
    3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
    4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
        a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
        b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
        c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
        d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
        e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
        f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
        g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

**3.5. PROTECTION**

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
C. Remove temporary barricades and protections where hazards no longer exist.

**END OF SECTION**

**SECTION 07 80 00**
**FIRE AND SMOKE PROTECTION**



## PART 1 – GENERAL

### 1.1. SCOPE

A. This Section includes firestop systems for penetrations and joints through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

B. Contractor shall provide Firestopping per code requirement and to satisfaction of Jurisdiction Having Authority. Plans will show fire rated walls, floors and ceilings and may or may not prescribe a detail or method for firestopping. Contractor shall include all required firestopping in bid and shall be knowledgeable of IBC, NFPA, IFC and other requirements.

C. Provide air seal/firestop systems at following locations, without being limited to:

1. Penetrations through fire-resistance-rated floor assemblies, floor/ceiling assemblies, roof/ceiling assemblies and roof assemblies requiring protected openings including both empty openings and openings that contain penetrations.
2. Penetrations through fire-resistance-rated wall assemblies including both empty openings and openings that contain penetrations.
3. Membrane penetrations in fire-resistance-rated wall assemblies where items penetrate one side of the barrier.
4. Joints in fire-resistance-rated assemblies to allow independent movement.
5. Perimeter joints between fire-resistance-rated floor assemblies, floor/ceiling assemblies, roof/ceiling assemblies or roofs and exterior wall assemblies.
6. Joints, through penetrations, and membrane penetrations in Smoke Barriers and Smoke Partitions. At all openings, voids and penetrations through all floor slabs except openings within shafts constructed with a fire resistance rating and slabs on granular fill.

D. Where a standard listed solution does not exist, contractor shall obtain an Engineering Judgment (EJ) from manufacturer and shall implement that solution as instructed by manufacturer.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.

B. ASTM - American Society for Testing and Materials

1. ASTM E 84 Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E 119 Test Method for Fire Tests of Building Construction and Materials.
3. ASTM E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750F.
4. ASTM E 814 Fire Tests of Through-Penetration Fire Stops.
5. ASTM E 1399 Cyclic Movement and Measuring Minimum and Maximum Joint Widths.
6. ASTM E 1966 Test Method for Resistance of Building Joint.
7. ASTM E 2174 Standard Practice for On-Site Inspection of Installed Fire Stops.
8. ASTM E 2393 Standard Practice for On-Site Inspection of Installed Fire Stop Joint Systems.
9. ASTM E 2307 Standard Test Method for Determining the Fire Endurance of Perimeter Fire Barrier Systems Using the Intermediate-Scale, Multi Story Test Apparatus (ISMA).
10. ASTM G 21 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

C. NFPA - National Fire Protection Association

1. NFPA 70 National Electric Code.
2. NFPA 101 Life Safety Code.
3. NFPA 221 Standard for High Challenge Firewalls, Firewalls, and Fire Barriers Walls
4. NFPA 251 Tests of Fire Resistance of Building Construction and Materials.

D. UL – Underwriters Laboratory

1. UL 263 Fire Tests of Building Construction and Materials.
2. UL 555 Fire Dampers.
3. UL 723 Surface Burning Characteristics of Building Materials.
4. UL 1479 Fire-Tests of Through-Penetration Fire Stops.

5. UL 2079 Tests for Fire Resistance of Building Joint Systems.

**1.3. SUBMITTALS**

A. Product Data Sheets and material safety data sheets (MSDS) for each type of product selected.
B. Where there is no specific third party tested and listed, classified firestop system available for a particular firestop configuration, the contractor shall obtain from the firestop manufacturer, an Engineering Judgment (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal following the "Recommended International Firestop Council Guidelines for Evaluating Firestop Systems in Engineering Judgments".
C. Firestopping schedule: Listing agency approved installation detail for each type of penetration treatment with drawing reference of where each is used (type of penetration).
D. Certification that Firestop Material is asbestos free and complies with local regulations.
E. Certification by fire stopping manufacturer that products supplied comply with specified requirements for volatile organic compounds (VOC's) and are nontoxic to building occupants.
F. Contractor qualifications as noted in "Quality Assurance" article, including certification of manufacturer's training.

**1.4. QUALITY ASSURANCE**

A. Provide Fire-resistive System Listing by a testing and inspection agency in accordance with the appropriate ASTM Standard(s) listed. A qualified testing and inspection agency may be UL, FM Research, Intertek Testing Services, Omega Point Laboratories (OPL) or another agency performing testing and follow-up inspection services for fire-resistive system materials that is acceptable to the authority having jurisdiction.
B. Contractor Qualifications: A firm experienced in installing fire stopping systems similar in material, design, and scope to that indicated for this Project, and who has a record of completing past projects. Qualifications include having three years of fire stopping installation experience, staff, and training to install manufacturer's products per specified requirements. Provide statement from manufacturer certifying contractor's staff has successfully completed manufacturer's training on installation requirements of fire stopping systems that will be used on this Project.
C. Materials made by different manufacturers shall not be intermixed in the same opening.
D. Tested and listed, classified fire-resistive systems are to be used.
E. If another manufacturer has a tested and listed system, then that system shall be considered before an Equivalent Fire Resistance Rated Assembly (EFRRA) is considered.
F. Provide mockup for review for complex fire stops or as required by owner.
G. Manufacturers of fire stopping shall have been successfully producing and supplying these products for a period of not less than 3 years, and shall be able to show evidence of at least 10 projects where similar products have been installed and accepted.
H. Ensure compatibility of materials used in the system including materials used in or on penetrations as well as all adjoining building materials.
I. Fire Performance Evaluation as a component of an NFPA 285 approved wall assembly per the requirements of IBC.

**1.5. PERFORMANCE REQUIREMENTS**

A. FIRE OR SMOKE RATED CONSTRUCTION REQUIREMENTS: Maintain barrier containment and structural floor fire resistance ratings including resistance to smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and at other fire or smoke rated construction gaps. Provide fire stopping systems that resist the spread of fire and the passage of smoke and other gases according to the requirements indicated, including but not limited to the following:
B. PENETRATIONS:
   1. Firestop all penetrations passing through fire resistance rated construction or smoke barriers.
   2. Provide and install complete penetration fire stopping systems that have been tested and approved by a third party testing agency.
   3. F - Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems with F Flame spread ratings indicated, as determined per ASTM E 814, but not less than one hour or the fire-resistance rating of the construction being penetrated.
   4. T - Rated Through-Penetration Firestop Systems: Provide firestop systems with T Thermal Transmission ratings, in addition to F ratings, as determined per ASTM E 814, where required by code and as otherwise indicated.
   5. L – Rated Through-Penetration Firestop Systems: Provide firestop systems with L Air Leakage ratings, in addition to F and T ratings, as determined per UL 1479, where required by code and as otherwise indicated.
   6. W – Rated Through-Penetration Firestop Systems: Provide firestop systems with W Water Resistance ratings, in addition to F, T and L ratings, as determined per UL 1479, where indicated.
   7. Penetration Fire stopping Assembly: Assemblies are specified generally under UL system categories by penetrating item. Manufacturers' product applications shall have specific UL system designations.

UL Through Penetration Classifications

| Fire Stopping System | Construction Penetrated | Type of Construction | UL System Identification |
|---|---|---|---|
| No Penetrating Items | F, W, C | A, B, J, K, L | 0001-0999 |
| Metallic Pipes, Conduit or Tubing | F, W, C | A, B, J, K, L | 1001-1999 |
| Nonmetallic Pipe, Conduit or Tubing | F, W, C | A, B, J, K, L | 2001-3999 |
| Electric Cables | F, W, C | A, B, J, K, L | 4001-4999 |
| Cable, Trays with Electric Cables | F, W, C | A, B, J, K, L | 5001-5999 |
| Insulated Pipes | F, W, C | A, B, J, K, L | 6001-6999 |

| | | | |
|---|---|---|---|
| Electrical Bus duct Penetrations | F, W, C | A, B, J, K, L | 7001-7999 |
| Mechanical Ductwork Penetrations | F, W, C | A, B, J, K, L | 8001-8999 |
| Multiple Penetrations Through Common Openings | F, W, C | A, B, J, K, L | 9001-9999 |
| F = Floor<br>W = Wall<br>C = Floor or Wall | A = concrete floors 5" or less<br>B = concrete floors greater than 5"<br>J = concrete or masonry walls 8" or less<br>K = concrete or masonry walls greater than 9"<br>L = framed wall | | |

C. JOINTS AND PERIMETER SYSTEMS:
1. Firestop all connections with other surfaces or types of construction, at separations required to permit building movement and at other fire rated or smoke barrier construction gaps.
2. Provide and install complete fire stopping systems that have been tested and approved by a third party testing agency.
3. Provide fire-resistive joint systems with fire and smoke resistance ratings indicated and as determined per ASTM E 1966 or UL 2079, but not less than the fire or smoke resistance rating of the construction in which the joint occurs.
4. Provide perimeter fire barrier systems with fire and smoke resistance ratings indicated and as determined per ASTM E 2307, but not less than the fire or smoke resistance rating of the floor construction.

| UL Joint & Curtainwall Classifications | | |
|---|---|---|
| System Type | Movement Capability | Joint Width |
| Floor to Floor (FF): | S, D | 0000-0999 |
| Wall to Wall (WW): | S, D | 0000-0999 |
| Floor to Wall (FW): | S, D | 0000-0999 |
| Head of Wall (HW): | S, D | 0000-0999 |
| Floor to Wall (FW): | S, D | 0000-0999 |
| Curtain Wall (CW): | S, D | 0000-0999 |
| | S = Static<br>D = Dynamic | 0000-0999 <= 2"<br>1000-1999 = >2", =6"<br>2000-2999 = > 6", <=12"<br>3000-3999 = >12", <= 24"<br>4000-4999 = > 24" |

A. SMOKE PARTITION PENETRATIONS AND JOINTS: Fully seal penetrations and joints to prevent the passage of smoke.
B. Provide products that upon curing do not re-emulsify, dissolve, break down or deteriorate from exposure to atmospheric moisture or moisture characteristic to construction.

**1.6. ENVIRONMENTAL AND INDOOR AIR QUALITY IMPACT**

A. VOC CONTENT: Penetration fire stopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

## PART 2 - PRODUCTS

**2.1. MANUFACTURERS**

A. Manufacturers: 3M, Hilti, Tremco, or approved equal.
B. All firestopping systems shall be provided by the same manufacturer and shall be UL listed.

**2.2. PENETRATION FIRE STOPPING**

B. PENETRATIONS IN FIRE-RESISTANCE-RATED WALLS: Provide penetration fire stopping with the following ratings determined per ASTM E 814 or UL 1479:
1. Fire-resistance-rated walls include fire walls and fire-barrier walls.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. PENETRATIONS IN HORIZONTAL ASSEMBLIES: Provide penetration fire stopping with the following ratings determined per ASTM E 814 or UL 1479:
1. Horizontal assemblies include floor assemblies, floor/ceiling assemblies, roof/ceiling assemblies and roof assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall or shaft enclosure above the floor or below the floor.
4. Provide 4" sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

D. PENETRATIONS IN SMOKE BARRIERS: Provide penetration fire stopping with the following ratings determined per UL 1479 with required "L" rating: L-Rating: Air leakage rate of the penetration assemblies measured at .30 inches of water column in both the ambient temperature and elevated temperature tests shall not exceed 5.0 cfm/square foot of penetration opening for each through penetration fire stop system or a total cumulative leakage of 50 cfm for any 100 sf of wall or floor area.
E. PENETRATIONS IN SMOKE PARTITIONS: Seal penetrations with mildew resistant water based latex smoke and acoustic sealant with flame-spread smoke-developed rating of less than 25 as tested in accordance with ASTM E84.
F. PENETRATIONS WITH INSULATED PIPING OR DUCTWORK: Provide penetration fire stop systems designed for continuous insulation except when penetrating piping is constructed of plastic which shall penetrate fire stop without insulation.

G. PENETRATIONS IN FLOORS WITH ANNULAR SPACES EXCEEDING 4" AND EXPOSED TO LOADING AND TRAFFIC: Provide approved means of supporting floor loads and protecting firestop systems.
H. PENETRATIONS FOR TELECOM EQUIPMENT ROOMS OR WHERE CABLE TRAY IS DISCONTINUOUS: Provide a manufactured re-enterable system that features a built-in fire and smoke sealing system that allows cables to be added or removed without the need to remove or reinstall fire stopping materials. Examples of such systems are the STI EZ Path and HILTI Speed Sleeve.
I. PENETRATIONS FOR ALL OTHER COMMUNICATION CABLING APPLICATIONS 2" DIAMETER AND LARGER: Provide a system that utilizes removable and reusable fire stop material. Examples of such systems are the 3M Pass-Through Device, STI FP fire stop plug and HILTI CFS-PL fire stop plug.
J. PENETRATIONS DESIGNED FOR FUTURE PENETRANTS: Provide removable non-sealant fire stop for spare penetrations.
K. Flame Spread and Smoke Developed Ratings: Provide products with flame-spread and smoke-developed indexes of 25 and 450 or less, respectively, or 25 and 50 or less in air plenums, as determined per ASTM E 84.
L. ACCESSORIES: Provide components for each penetration fire stopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration fire stopping manufacturer and approved by qualified testing and inspecting agency for fire stopping indicated.
M. Protect fire stopping systems, including those raised 2" above surrounding floor, from damage due to construction activities.

**2.3. FIRE-RESISTIVE JOINT FIRE STOPPING**

A. Where required, provide fire-resistive joint fire stopping that is produced and installed to resist spread of fire according to code and requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint stopping is installed. Fire-resistive joint fire stopping shall accommodate building movements without impairing its ability to resist the passage of fire and hot gases.
B. JOINTS IN OR BETWEEN FIRE-RESISTANCE-RATED CONSTRUCTION: Provide fire-resistive joint systems with the following ratings determined per ASTM E 1966 or UL 2079:
   1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
C. JOINTS AT EXTERIOR CURTAIN WALL/FLOOR INTERSECTIONS AND PERIMETER FIRE BARRIERS: Provide fire-resistive joint systems and perimeter fire barrier systems with the following rating determined by ASTM E 2307.
   1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
D. JOINTS IN SMOKE BARRIERS:
   1. Fire-resistive Rated Construction: Provide fire-resistive joint systems with the following ratings determined per UL 2079 with required "L" rating.
   2. L-Rating: Not exceeding 5.0 cfm/ft (0.00775 cu. m/s x m) of joint at 0.30 inch wg (75 Pa) at both ambient and elevated temperatures.
E. JOINTS IN SMOKE PARTITIONS: Seal joints with mildew resistant water based latex smoke and acoustic sealant with flame-spread smoke-developed rating of less than 25 as tested in accordance with ASTM E84.
F. FLAME SPREAD AND SMOKE DEVELOPED RATINGS: Provide products with flame-spread and smoke-developed indexes of 25 and 450 or less, respectively, or 25 and 50 or less in air plenums, as determined per ASTM E 84.
G. ACCESSORIES: Provide components of fire-resistive joint systems and perimeter fire barrier systems, including primers and forming materials, which are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.
H. Install tested and listed classified systems that result in fire-resistive joint and perimeter fire barrier materials:
   1. Directly contacting and fully wetting joint substrates.
   2. Completely filling recesses provided for each joint configuration,
   3. Providing uniform, cross-sectional shapes and depths relative to joint width that optimize movement capability and meet tested and listed system requirements.
I. Tool non-sag materials immediately after their application and prior to the time skinning begins. Form smooth, uniform beads of configuration indicated or required to:
   1. Produce fire-resistance rating
   2. To eliminate air pockets
   3. To ensure contact and adhesion with sides of joint.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. PREPARATION
   1. Cleaning and Preparation: Clean and prepare surfaces as recommended by system manufacturer.
   2. Verify system components are clean, dry, and ready for installation.
   3. Verify field dimensions are as shown on the Drawings, are as tested and listed for classified systems, and meet manufacturer requirements and recommendations.
B. IDENTIFICATION
   1. Identify fire stopping with preprinted labels. Attach labels permanently to surfaces adjacent to and within 6 inches (152 mm) of fire stopping edge so labels will be visible to anyone seeking to remove penetrating items or fire stopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
      a. "FIRESTOPPED PENETRATION"
      b. Installed Product
      c. UL System Number
      d. Date of Installation

e. Installing Contractor and Phone Number

2. Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling which include the hourly rating. Such identification shall:
   a. Be located in accessible concealed floor, floor-ceiling or attic spaces;
   b. Be located within 15 feet of the end of each wall and at intervals not exceeding 30 feet measured horizontally along the wall or partition.
   c. Include lettering not less than 3 inches in height with a minimum 3/8 inch stroke in a contrasting color incorporating the wording.
   d. "FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS, _ HOURLY RATING"

C. Maintains integrity of insulation and vapor barriers. Verify that sufficient space is available for the penetration to be effectively fire and smoke stopped.

D. Accessories to include but are not limited to permanent forming/damming/backing materials, temporary forming materials, substrate primers, collars, and steel sleeves.

E. Use non-combustible damming boards for temporary or permanent dams.

F. Install mortar by pumping, trowelling or hand packing into openings to thicknesses required by ULC firestop system.

G. Install insulating air sealant backing material in accordance with CAN/ULC S711.2 (Application Standard).

H. Completely fill and seal voids with air seal/firestop and smoke seal materials. Remove excess air seal/firestop material promptly as the work progresses and upon completion.

I. Tool or trowel exposed surfaces.

J. Allow materials to cure. Do not cover up materials until full curing has taken place.

K. Clean off excess fill materials and sealants adjacent to openings and joints as work progresses. Use methods and cleaning materials approved by manufacturers of fire stopping products and or assemblies in which openings and joints occur.

**3.2. SEALING AND FIRESTOPPING OF PENETRATIONS**

A. FIRE AND/OR SMOKE RATED PENETRATIONS:
   1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with section 07 80 00 – FIRE AND SMOKE PROTECTION

B. NON-RATED PENETRATIONS:
   1. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
   2. At all interior and exterior walls, through-wall conduit penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the sleeve or cored opening and the conduit is completely blocked.

C. PENETRATIONS SUBJECT TO WATER INTRUSION:
   1. For penetrations (both rated and non-rated) in floors subject to water intrusion or in rooms housing electrical equipment (but not within walls) provide one of the following:
      a. Conduit penetration where steel pipe sleeve is used extend steel sleeve 2" above the floor.
      b. Conduit penetration where cast in place fire stopping device/sleeve is used, extend device/sleeve 2" above the floor (provided it meets the device's UL listing).
      c. Conduit penetration where there is no steel sleeve or cast in place fire stopping device/sleeve, provide 2"x 2" x 1/8" galvanized steel angles fastened to floor surrounding the penetration or group of penetrations to prevent water from getting to penetration. Provide urethane caulk between angles and floor and fasten angles to floor minimum 8"on center. Seal corners water tight with urethane caulk.
   2. Floors subject to water intrusion or rooms housing electrical equipment include the following locations:
      a. Food Service/Kitchen Areas
      b. Walk In Coolers/Freezers
      c. Laundries
      d. Restrooms
      e. Locker/Shower Rooms
      f. Janitor Rooms w/ Sinks
      g. Wet Laboratories
      h. Mechanical/Plumbing Equipment Rooms
      i. Swimming Pool Rooms/Pool Equipment Rooms
      j. Chemical/Hazardous Waste Storage
      k. Maintenance/Industrial Shops
      l. Vehicle Storage and Parking Ramps
      m. Greenhouses
      n. Data/Telecommunications Rooms
      o. Electrical Equipment Rooms

**END OF SECTION**

# SECTION 08 91 00
# LOUVERS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to louvers.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. AMCA - AIR MOVEMENT AND CONTROL ASSOCIATION
   1. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Unit dimensions related to wall openings and construction; and, anchorage details and locations.
C. Color Sample

### 1.4. QUALITY ASSURANCE

A. Lovers shall be tested in accordance with ANSI/AMCA Standard 500-L and licensed to bear the AMCA Certified Ratings Program seal for air performance and water and wind-driven sand in accordance with AMCA Publication 511.
B. In existing buildings existing openings may be used for louvers. The louver size on plans is approximate to the existing opening size (e.g. existing window opening). Contractor shall field-measure the openings before ordering louvers. Maximize louver size to the greatest extent possible accounting for support etc.

### 1.5. PERFORMANCE REQUIREMENTS

A. MIN FREE AREA:
   1. 24”x24”: 1.77 ft²
   2. 48”x48”: 9.41 ft²
   3. 96”x96”: 41.49 ft²
B. MAXIMUM AIRFLOW RESISTANCE:
   1. 500 fpm free air velocity: 0.036 in-w.c. (intake) or 0.034 in-w.c. (exhaust)
   2. 1000 fpm free air velocity: 0.16 in-w.c. (intake) or 0.14 in-w.c. (exhaust)
C. WATER PENETRATION:
   1. per AMCA Water Penetration Test on 48”x48” sample
   2. No water penetration under 1,077 fpm free air velocity

### 1.6. WARRANTY

A. Kynar Finish: 10 years

## PART 2 - PRODUCTS

### 2.1. LOUVER CONSTRUCTION

A. BASIS OF DESIGN: Greenheck ESD-635
B. FRAME: Heavy gauge extruded 6063-T5 aluminum, 6 in. x 0.081 in. nominal wall thickness
C. BLADES: Drainable design, heavy gauge extruded 6063T5 aluminum, 0.081 in. nominal wall thickness, positioned at 37° angles 4”o.c.
D. BIRDSCREEN: 3/4 in. x 0.051 in. flattened expanded aluminum in removable frame, outside mount (front)
E. Install in accordance with manufacturer's instructions and all code requirements.
F. Install weather-tight.

### 2.2. FINISH

A. 2-coat 70% KYNAR 500®/HYLAR 5000® AAMA 2605
B. Dry film thickness 1,2 mil (AKA: Duranar®, Fluoropon®, Trinar®, Flouropolymer, Polyvinylidene Fluoride, PVDF2)
C. Color per schedule or chosen by owner.

1 **END OF SECTION**

# SECTION 23 05 00
# COMMON WORK RESULTS FOR HVAC



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to HVAC systems and applies to all sections in this Division.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. AABC - Associated Air Balance Council
   1. AABC - National Standards for Total System Balance
C. ABMA - American Boiler Manufacturers Association
D. ADC - Air Diffusion Council
E. AGA - American Gas Association
F. AMCA - Air Movement and Control Association
G. ANSI - American National Standards Institute
   1. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators
   2. ANSI/NEMA MG-1 - Motors and Generators
   3. ANSI/NFPA 70 - National Electrical Code
H. ARI - Air-Conditioning and Refrigeration Institute
I. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
   1. ASHRAE - ASHRAE Handbook, HVAC Applications, Chapter 37, Testing Adjusting and Balancing.
   2. ASHRAE 111 – Practice for Measurement, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems
J. ASME - American Society of Mechanical Engineers
K. ASTM - American Society for Testing and Materials
   1. ASTM A527 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dipped Process, Lock-Forming Quality
   2. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
   3. ASTM A234 - Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel
   4. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate
   5. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
   6. ASTM D1000 - Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
   7. ASTM D2240 - Standard Test Method for Rubber Property—Durometer Hardness
   8. ASTM E84 - Surface Burning Characteristics of Building Materials
   9. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems
   10. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems
L. AWWA - American Water Works Association
M. AWS - American Welding Society
N. CGA - Compressed Gas Association
O. CTI - Cooling Tower Institute
P. EPA - Environmental Protection Agency
Q. GAMA - Gas Appliance Manufacturers Association
R. IEEE - Institute of Electrical and Electronics Engineers
S. ISA - Instrument Society of America
T. MCA - Mechanical Contractors Association

U. MICA - Midwest Insulation Contractors Association
V. MSS - Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
    1. MSS SP-58 Materials, Design, Manufacture, Selection, Application, and Installation
    2. SP-127 Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, Application
W. NADCA - Mechanical Cleaning of Non-Porous Air Conveyance System Components National Air Duct Cleaners Association
    1. NADCA Understanding Microbial contamination in HVAC Systems
X. NAIME – North American Insulation Manufacturers Association
    1. NAIMA - Cleaning Fibrous Glass Insulated Air Duct Systems
Y. NBS - National Bureau of Standards
Z. NEBB - National Environmental Balancing Bureau
    1. NEBB - Procedural Standards for Testing Adjusting Balancing of Environmental Systems
AA. NEC - National Electric Code
BB. NEMA - National Electrical Manufacturers Association
CC. NFPA - National Fire Protection Association
    1. NFPA 54 - National Fuel Gas code
    2. NFPA 225 - Surface Burning Characteristics of Building Materials
DD. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association. Inc.
EE. TABB – Testing Adjusting and Balancing Bureau
    1. TABB - Tab Procedural Guide, First Edition, 2003
FF. UL - Underwriters Laboratories Inc. - www.ul.com
    1. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors
    2. UL 586 - Standard for High Efficiency Particulate Air Filter Units
    3. UL 723 - Surface Burning Characteristics of Building Materials
    4. UL 795 - Commercial Industrial Gas Heating Equipment
    5. UL 900 - Standard for Air Filter Units
    6. UL 2998 - Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners

**1.3. SUBMITTALS**

A. Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the electrical design documents. Include a statement on the shop drawing transmittal that the equipment submitted and the electrical design documents are in agreement or indicate any discrepancies
B. EQUIPMENT GENERAL:
    1. Weight (dry and wet)
    2. Panel joint(s) and panel details showing thermal breaks.
    3. Base connection details.
    4. Shipping split connections details.
    5. Indicate metal gauges, material finishes, assembly, construction details, and field connection details including the following:
    6. Construction details and material finishes.
    7. All required service and operation clearances.
    8. Filter, coil, and damper performance data.
    9. Piping connection diagrams and field fabrication details.
    10. Unit specific power and control circuit wiring diagrams.
    11. Interconnection wiring diagrams.
    12. Provide calculated 8 octave maximum sound power levels at unit discharge and return connections, and maximum casing radiated sound power levels.
    13. Sound absorption coefficient of panel system obtained using ASTM method of Test for Sound Absorption of Acoustical materials in Reverberation Rooms (ASTM Designation C423-66), and sound transmission loss obtained using procedures conforming to ASTM Designation E90-70, E413-70T and other pertinent standards.
C. FANS:
    1. Indicate fan class, fan performance and motor electrical characteristics. Provide fan curves with specified operating point clearly plotted. Include efficiency data for the design airflows, drive loss and bhp
D. MOTORS AND POWER EQUIPMENT:
    1. Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared specifically for this work.
    2. Lubrication instructions, including list/frequency of lubrication
    3. Table noting full load power factor, service factor, NEMA design designation, insulation class and frame type for each motor provided
    4. Field connection details.
E. HANGERS AND SUPPORTS:
    1. Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service.
F. VIBRATION AND SEISMIC CONTROL:
    1. Include isolator type, materials of construction, isolator free and operating heights, and isolation efficiency based on the lowest operating speed of the equipment supported.

G. BALANCING:
1. General Information: Inside cover sheet identifying Test and Balance Agency, Contractor, Architect, Engineer, Project Name and Project Number. Include addresses, contact names and telephone numbers. Also include a certification sheet containing the seal and signature of the Test and Balance Supervisor.
2. Summary: Provide summary sheet describing mechanical system deficiencies. Describe objectionable noise or drafts found during testing, adjusting and balancing. Provide recommendations for correcting unsatisfactory performances. List instrumentation used during testing, adjusting and balancing procedures.
3. The remainder of the report to contain the appropriate standard NEBB or AABC forms for each respective item and system. Fill out forms completely. Where information cannot be obtained or is not applicable indicate it.
4. Submit to owner daily work activity reports for each day on which testing and balancing work is performed. Reports shall include description of day's activities and description of any system deficiencies.
5. All interim flow rates and final flow rates vs. design flowrates
6. Balancing device settings

H. AIR DISTRIBUTION CLEANING:
1. Submit manufacturer's data and/or Contractor data for the following:
2. List of equipment to be used.
3. Product description and MSDS sheets for cleaners, biocides and encapsulants.
4. Access doors.
5. Provide a report describing pre-cleaning inspection and damage, systems cleaned, methods and materials used, problems encountered, final verification and any remaining problems noted.

## PART 2 - PRODUCTS

### 2.1. IDENTIFICATION

A. MANUFACTURERS: 3M, Brady Corporation, Kolbi Pipe Markers, Seton Identification Products

B. All labels shall be permanent, and machine generated. No handwritten or non-permanent labels are allowed.

C. Before any labelling confer with owner to ensure all labels meet legibility and longevity requirements. Owner may request at no extra cost the use of different colors, different font, size or type of label.

D. EQUIPMENT: Identify all equipment with stencils or engraved name plates. Letters shall not be smaller than 4" unless equipment sizes prevents this size. Where equipment is elevated or away from main walkways, larger letters shall be used to ensure legibility. Letters shall be colored in contrast to background.
1. Engraved nameplates: White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 or Emedolite Style EIP or equal by W. H. Brady).

E. PIPING: Identify all piping with stencils or snap-around pipe marker Equal to Seton Setmark not less than once every 20 feet, not less than once in each room, not less than once per 6' (or larger) section, adjacent to each access door or panel, and on both side of the partition where accessible piping passes through walls or floors. Use one coat of black enamel against a light background or white enamel against a dark background for stenciling, or provide snap-on pipe markers.

| Outside Diameter of Covering | Minimum Letter Size |
|---|---|
| <=2" | 1" |
| <= 6" | 1.5" |
| < 10" | 3" |
| >= 10" | 4" |

F. Label all pipes with name of loop, pipe size, and arrows for flow direction with permanent label. Mark pipes based on served system as "hot", "cold", and as "boiler", "chilled", "geothermal" and also as "glycol", "hard", "soft" or "water". Label all gauges. Use one coat of black enamel against a light background or white enamel against a dark background.

| Service | Background Color | Stencil color |
|---|---|---|
| Chilled Water | Green | White |
| Potable / Supply Water | Green | White |
| Non-potable water | Yellow | Black |
| Compressed Air | Blue | White |
| Condensate | Yellow | Black |
| Domestic Hot Water | Yellow | Black |
| Fire Protection | Red | White |
| Fuel Gas | Yellow | Black |
| Glycol | Orange | Black |
| Heating | Yellow | Black |
| Vent | Yellow | Black |

G. VALVES: Identify with brass tags bearing a system identification and the normal position. Use round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains, brass "S" hooks or one piece nylon ties around the valve stem, available from EMED Co., Seton Name Plate Company, or W. H. Brady. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device, located in another room or not visible from device. For balancing valves include balancing and detail the setting and flow set at time of balancing.

H. DUCTS: Identify ducts around air handling equipment and in mechanical rooms. Label with name and flow direction. Use one coat of black enamel against a light background or white enamel against a dark background. Minimum letter size 3".

| Service | Background Color | Stencil color |
|---|---|---|
| Exhaust Air | Brown | White |
| Tempered Exhaust Air | Brown | White |
| Outside Air | Blue | White |
| Tempered Outside Air | Blue | White |
| Supply Air | Green | Black |
| Return Air | Yellow | Black |

I. Label fire, smoke and combination fire smoke dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 1" height lettering reading, "SMOKE DAMPER" or "FIRE DAMPER". Utilize stencils or manufactured labels. All labels shall be clearly visible from the ceiling access point.

J. UNDERGROUND:

1. Provide all buried utilities, conduit and pipes with detectable underground warning tape, 5.0 mil overall thickness, 6" width, .0035" thick aluminum foil core with polyethylene jacket bonded to both sides. Color code tape and print caution along with name of buried service in bold letters on face of tape. Manufacturers: Thor Enterprises Magnatec or equal by Carlton, MSI Marking Services, Seton. Extend tape to surface at building entrances, meters, hydrants and valves. Where existing underground warning tape is broken during excavation, replace with new tape identifying appropriate service and securely spliced to ends of existing tape.
2. All underground non-metallic services/mains shall be provided with tracer wire installations. Tracer wire installations shall conform to code. Tracer wire shall be continuous solid copper or steel plastic coated with split bolt or compression-type connectors.
3. Underground Installation marking:
   a. Owner will perform own locating with GPS. Owner needs to be notified 3 business days prior backfill.
   b. Contractor will install marker balls at start, end, bends, at least every 20' and at other significant locations. Owner will mark up plans to determine ball locations. Balls shall not be installed deeper than 3' below final grade. Multiple lines in parallel (i.e. geothermal laterals) exceeding 3'in installation width shall receive markers at each side. Owner will verify proper marker function:

| Utility | Markertype | Ball |
|---|---|---|
| Power | Power red | 3M 1402-XR |
| Water | Water blue | 3M 1403-XR |
| Sanitary | Wastewater green | 3M 1404-XR |
| Storm | Wastewater green | 3M 1404-XR |
| Gas | Gas yellow | 3M 1405-XR |
| Fiber | Communication orange / black | 3M 1407-XR |
| Telephone | Telephone orange | 3M 1421-XR/iD |
| CATV | CATV orange / black | 3M 1427-XR/iD |
| Geothermal | General Purpose pink | 3M 1408-XR |

**2.2. SEALING AND FIRE STOPPING**

A. FIRE AND/OR SMOKE RATED PENETRATIONS:

1. Provide all fire stopping of fire rated penetrations and sealing of smoke rated penetrations in compliance with Division 07.
2. Provide sleeve required for fire dampers in fire-rated partitions and floors.

B. NON-RATED PENETRATIONS:

1. Pipe Penetrations Through Below Grade Walls: In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated pipe and the cored opening or a water-stop type wall sleeve. Assemble rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
2. Pipe Penetrations: At all interior walls and exterior walls, pipe penetrations are required to be sealed. At pipe penetrations of non-rated interior walls, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood walls where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.
3. Duct Penetrations: Annular space between duct (with or without insulation) and the non-rated walls or floor opening shall not be larger than 2". Where existing openings have an annular space larger than 2", the space shall be patched to match existing construction to within 2" around the duct. Pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4" sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

C. PIPE SLEEVES: Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Pipe sleeves shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve)

**2.3. MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

A. PERFORMANCE REQUIREMENTS

1. All motors must meet or exceed current NEMA premium efficiency requirements
2. Motors shall be sized to not operate into motor service factor when operating under design conditions.

3. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
5. All motors shall have a minimum service factor of 1.15.
6. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours.
7. Coordinate with electrical installer for electrical sizing. Scheduled motor data may not be correct and need to be verified and corrected prior ordering equipment.
8. Provide fuses sized for specific motor.

B. AC MOTORS:
1. Motor totally enclosed, fan-cooled (TEFC) with main dimensions to NEMA standard. Whenever available 3-phase motor shall be used as opposed to single-phase.
2. All single phase motors to have inherent thermal overload protection.
3. Motors for emergency smoke ventilation shall use insulation class F or H as noted below:
   a. F-rated: minimum of 5 hours of operation at 150 °C and 2 hours at 250°C
   b. H-rated: minimum of 4 hours of operation at 260 °C and 1 hours at 300°C
   c. Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized

C. MOTORS ON VFD
   a. Meet NEMA MG 1-2011, Part 30, performance standards for general-purpose motors used with VFDs. When operated under usual service conditions, no significant reduction in service life should occur if the peak voltage at the motor terminals is limited to 1,000 V and rise times equal and exceed 2 microseconds. If peak voltages are expected to exceed 1,000 V or rise times will be less than 2 microseconds, a definite-purpose, inverter-duty motor and/or harmonic suppression filter, load reactor, or other voltage conditioning equipment are required.
   b. Ground input and output of VFD
   c. All motors operated on variable frequency drives shall be rated for VFD operation and equipped with a maintenance-free, AEGIS SGR Conductive MicroFiber Shaft Grounding Ring (SGR) to meet NEMA MG-1, 3.4.4.4.3 requirements and to discharge damaging shaft voltages away from the bearings to ground. SGR's Service Life shall be equal or higher to service life of motor. SGR shall be factory installed inside the motors by the manufacturer wherever possible and label shall clearly indicate the presence of a grounding assembly. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
   d. Motors up to 100 HP shall have insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor with the exception of line contact bearings in the drive end of the machine. In this instance the line contact bearing must be electrically insulated and the AEGIS Bearing Protection Ring installed on the opposite drive end of the motor.
   e. Bond from the motor foot to system ground with a high-frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection. Provide AEGIS HF Ground Straps.

D. EC MOTORS (ECM):
1. Motor shall be electronic commutation (EC) motor specifically designed for applications.AC induction type motors are not acceptable.
2. Motors shall be permanently lubricated with heavy-duty ball bearings to match the load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

E. Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

F. Flexible Coupling: mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment and run-out of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub.

G. Belt Drive: Mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use laser-alignment tool to check alignment of the sheaves; reposition sheaves as necessary. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

H. Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use.

I. SHAFT GROUNDING:
1. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy to secure the screws in place.
2. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Clean with emery cloth or Scotch-Brite. If the shaft is visibly clean, a non petroleum based solvent may be used to remove any residue. Check the conductivity of the shaft using an ohm-meter. Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Maximum resistance shall 2 ohms. If the reading is higher, clean the shaft again and retest.

3. After motors with SGR are fully installed test for a conductive path to ground using an Ohm-meter. Place one probe on metal frame of SGR and one probe on motor frame. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.

**2.4. METERS AND GAGES**

A. PIPE WELLS:
1. Basis of Design: ACI A/2.5"
2. 0.26" bore diameter.
3. Stainless Steel 304SS with 1/2" NPT process thread, ½" NPS instrument thread
4. Intersection Length: 2.5"
5. Well shall not protrude into pip by more than 25% of pipe diameter. Install in Tee or weldolet as required

B. PIPE THERMOMETERS:
1. Basis of Design: Weiss 5VBM25, US Gauge ADJ-5-2.5
2. Stem Length 2.5" unless thermo-well requires different length
3. 5" adjustable Display; at owner's choice a smaller display may be allowed for locations clearly visible.
4. Stainless Steel Stem with ½" NPT connection
5. Dual Scale °F and °C

| Service | Scale Range °F | Scale Range °C | Increment °F |
|---|---|---|---|
| Hot Water | 0 - 200 | -15 - 90 | 2 |
| Chilled / Condenser / Geothermal | 0 - 120 | -15 - 50 | 2 |
| Solar Hot Water | 30 - 250 | 0 - 120 | 2 |

C. DUCT THERMOMETER
1. Basis of Design: Trerice BX9-9-012
2. 3-hole duct attachment
3. 12" insertion (6" acceptable in ducts <= 12")
4. 9 inch scale spirit filled
5. Dual Scale °F and °C

| Service | Scale Range °F | Scale Range °C | Increment °F |
|---|---|---|---|
| Outside Air | -40 - 110 | -40 - 40 | 2 |
| All other air | 30 - 130 | 0 - 55 | 1 |

D. P/T (PRESSURE/TEMPERATURE) TEST PLUGS
1. Basis of Design: Peterson Equipment Model 400, Watts LFTP-E
2. Stainless Steel plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

E. WATER PRESSURE GAUGES:
1. Basis of Design: Weiss TL45-4L
2. Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows or as relief valve range. At owner's choice a smaller display may be allowed for locations clearly visible.
3. Install with shut-off ball-valve to allow replacement without pipe-draining.
4. Install snubber for each gage.
5. Dual Scale psi and kPa

| Service | Scale Ranke psi | Scale Ranke kPa | Increment psi |
|---|---|---|---|
| Hot Water | 0 – 1.5 times relief valve setting | | 1 |
| Chilled Water | System pressure + maximum available pumphead | | 1 |
| Compressed Air | 0 - 200 | 0 - 1400 | 2 |

F. FILTER GAUGES:
1. Basis of Design: Dwyer, Series 2000
2. Direct reading, 4" dial type, Scale range 2 in-wg
3. Lettering shall be black figures on white background. Installed to be read from outside of device.

**2.5. HANGERS AND SUPPORT**

A. Overhead Supports Basis of Design:
1. Adjustable Clevis Hanger: Pipe Shields A1000 (hot fluid) or A 2000 (chilled Fluid) or FNW Figure 7005E (epoxy finish) for un-insulated pipe.
2. Adjustable Pipe Roll: Pipe Shields A3000 (hot fluid) or A 4000 (cold fluid)

B. Wall Support Basis of Design:
1. Carbon steel welded bracket with hanger. B-Line 3068 Series, Grinnell 194 Series. Perforated, epoxy painted finish, 16-12 gauge, min., steel channels securely anchored to wall structure, with interlocking, split-type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Grinnell type PS 200 H with PS 1200 clamps.

2. Flat Surface: Pipe Shields A1000 (hot fluid) or A 2000 (chilled Fluid)
3. Pipe Roll: Pipe Shields A3000 (hot fluid) or A 4000 (cold fluid)

C. Vertical Support Basis of Design:
1. Pipe Shields E100
2. Secure to structure below each floor

D. Floor Support: Carbon steel pipe saddle, stand and bolted floor flange. B-Line B3088T/B3093.

E. SUPPORT STRUCTURE:
1. Unistrut pre-galvanized P1000 or similar with electro-galvanized bolts, nuts and whashers.
2. In corrosive environments use hot-dipped galvanized channel and stainless steel bolts, nuts and washers.
3. Design and size for the loads.

F. BEAM CLAMPS
1. MSS SP-58 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 in thick for single threaded rods of 3/8, 1/2, and 5/8 inch diameter, for use with pipe sizes 4 inch and less. Furnish with hardened steel cup point set screw. Anvil fig. 86.
2. MSS SP-58 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter but limited in application to pipe sizes 8 inch and less without prior approval. Anvil figure 228.

G. CONCRETE INSERTS
1. Poured in Place:
   a. MSS SP-69 Type 18 wedge type to be constructed of a black carbon steel body with a removable malleable iron nut that accepts threaded rod to 7/8 inch diameter. Wedge design to allow the insert to be held by concrete in compression to maximize the load carrying capacity. B-Line B2505, Grinnell 281.
   b. MSS SP-69 Type 18 universal type to be constructed of black malleable iron body with a removable malleable iron nut that accepts threaded rod to 7/8 inch diameter. B-Line B3014N, Grinnell 282.
2. Drilled Fasteners: Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating, minimum tension load of 3200 pounds. Use drill bit of same manufacturer as anchor. Manufactured By: Hilti, Powers/Rawl, Redhead, Sammys

H. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not drill structural steel members unless approved by owner. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance.

I. WOOD INSERTS:
1. Carbon steel coach screw rods machine threaded on opposite ends, minimum 3/8" diameter. Anvil Figure 142.
2. Carbon steel side beam bracket with minimum 3/8" rod size and fastened with minimum ½" x 3" lag screws. Anvil Figure 207

J. STEEL HANGER RODS:
1. Basis of Design B-Line B3205 black finish. Provide adjusting and lock nuts.
2. Size rods for individual hangers and trapeze support as indicated in the following schedule. Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

| Maximum Load (Lbs.) | Rod Diameter (in.) |
|---|---|
| 600 | 3/8 |
| 1100 | 1/2 |
| 1800 | 5/8 |
| 2700 | 3/4 |
| 3800 | 7/8 |
| 4900 | 1 |
| 8000 | 1.25 |
| 11600 | 1.5 |

K. CORROSIVE ATMOSPHERE COATINGS: Factory coat supports and anchors used in corrosive atmospheres with hot dip galvanizing after fabrication, ASTM A123, 1.5 ounces/square foot of surface, each side. Mechanical galvanize threaded products, ASTM B695 Class 150, 2.0 mil coating. Field cuts and damaged finishes to be field covered with zinc rich paint of comparable thickness to factory coating. Corrosive atmospheres include Exterior locations, Washbays, Parking ramps, Swimming pool equipment rooms, Chemical storage and hazardous waste storage rooms, Wet wells, Sanitary pumping stations, Food service/kitchen areas, Walk-in coolers/freezers, Locker/shower rooms, Greenhouses, Meter Pits

L. ROOF MOUNTED SUPPORTS
1. Use for all pipe and ductwork on roof. Secure bottom of support flat on roof deck. Apply two coats of zinc rich paint to cut edges of all galvanized steel elements. Flash and Counterflash.
2. Use galvanized structural steel members supported by pipe supports and use pipe or duct rollers fastened to the structural member. Pipe supports to be secured to the roof structure and sealed per pipe penetrations through roof specifications as specified in this section.
3. For longest support member 36"and shorter: minimum support height 18"
4. For longest support member 36"and longer: minimum support height 36"

M. EQUIPMENT CURBS
1. Prefabricated Metal Curb: Constructed of not less than 18 gauge galvanized steel reinforced so it is structurally capable of supporting the intended load with no penetrations through the curb flashing, inside and outside corner sections that are mitered and continuously welded, filled with 3 pound density rigid fiberglass insulation, integral deck mounting flange, nominal two inch wood nailer, galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.
2. Wood Build Sleeper Curb: Constructed of wood blocking and anchored to the deck. The curb must be structurally capable of supporting the intended load with no penetrations through the curb flashing. Galvanized steel counter flashing. Do not use built-in metal base flashings or cants. Use 18 inch high equipment curbs where the curb completely surrounds the perimeter of the equipment and there is no roof exposed to the weather.

3. Secure bottom of support flat on roof deck. Secure equipment to curb in accordance with equipment manufacturer's instructions. Flash and Counter-flash. Fill the entire void space with compressible fiberglass insulation.

N. INSTALLATION OF PIPING SUPPORT

1. Multiple or Trapeze Hangers: Where several pipes are running parallel and pitching in the same direction, strut style support may be used. Steel channel, 12-gauge thickness, Dura-Green epoxy coating or electro-plated, B-Line B11.
2. Multiple Pipe Roof Penetrations: An 8" high (minimum) curb height is required. The coping cap shall be constructed from laminated acrylic clad thermoplastic (ABS) with graduated step boots to accommodate various size pipes, stainless steel fastening screws for cover, stainless steel band clamps for securing boots around the pipe, and stainless steel band clamp or mechanical locking seal for securing boots around the ABS coping cap flanges. Flash and Counterflash.
3. Single Pipe Roof Penetrations: A stack flashing penetration may be utilized for single pipe penetrations through built up roofs and single ply membrane roofs. Utilize high temperature sealant for all high temperature applications. This includes but is not limited to steam condensate vent piping, steam safety relief piping, and flues. A single pre-manufactured boot may be utilized for single pipe penetrations through single ply membrane roofs only. Flash and Counterflash.
4. Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item. Space Hangers as follows:

| Pipe Material | Pipe Size | Max. Hor. Spacing Spacing | Max. Vertical Sapcing |
|---|---|---|---|
| Steel | 0.5"- 1.25" | 6.5' | |
| Steel | 1.5"- 6" | 10' | |
| Steel | 8"- 12" | 14' | |
| Steel | 14"and over | 20' | |
| Plastic | All | 6' | |
| Copper | 0.5"- 1.25" | 5' | |
| Copper | 1.5" and larger | 8' | |

5. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
6. Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.
7. Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.

O. INSTALLATION:

1. Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.
2. Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.
3. Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.
4. Protect insulation at all hanger points
5. Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.
6. Piping supported by laying on the bottom chord of joists or trusses will not be accepted.
7. Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.
8. Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.
9. Hangers shall be insulated and a load distribution shield or pipe or sturdy insulation shall prevent insulation collapse.
10. Anvil, B-Line, Fee and Mason, FNW, Kindorf, Michigan Hanger, Pipe Shields, Unistrut, or approved equal.

## 2.6. VIBRATION AND SEISMIC CONTROL

A. PERFORMANCE REQUIREMENTS:

a. Isolate all motor driven mechanical equipment from the building structure and from the systems which they serve to prevent equipment vibrations from being transmitted to the structure. Consider equipment weight distribution to provide uniform isolator deflections.
b. For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.
c. Provide flexible piping connections for all piping to rotating or reciprocating equipment mounted on vibration isolators except do not use flexible piping connectors on any type of gas piping or with inline pumps. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers. Install flexible piping connections on the equipment side of shut-off valves. Pipe supports or hangers located between the flexible piping connection and the equipment shall also be provided with vibration isolation devices. Suitable for pressure, temperature, and fluid involved; minimum pressure rating for any system is 125 psig at the design temperature of the fluid. Use 12-inch minimum line length of flexible hose or length required to absorb 3/4" lateral movement, whichever is greater.
d. Select vibration isolation devices for minimum deflection as indicated below or to provide not less than 95% isolation efficiency, whichever is greater.

| Type of Equipment | On Grade | 20' floor Span | 30' Floor Span | 40' Floor Span | Note |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Refrigeration | 0.1” / Pad | 0.75” / Floor Mount | 1.5” / Floor Mount | 1.5” / Floor Mount | |
| Pump base-mounted | Bolt to Pad | 0.75” / Floor Mount | 1.5” / Floor Mount | 1.5” / Floor Mount | |
| Air-cooled Condenser | Bolt to Pad | 0.75” / Floor Mount | 1.5” / Floor Mount | 2.5” / Floor Mount | |
| AHU Floor mounted <= 5hp | 0.35” / Floor Mount | 0.75” / Floor Mount | 0.75” / Floor Mount | 0.75” / Floor Mount | Not required for internally isolated fans |
| AHU Floor mounted >= 5hp | 0.35” / Floor Mount | 1.5” / Floor Mount | 1.5” / Floor Mount | 1.5” / Floor Mount | |
| AHU suspended <= 5hp | | 1” / Spring Hanger | 1” / Spring Hanger | 1” / Floor M/ Spring Hanger ount | |
| AHU suspended >= 5hp | | 1.5” / Spring Hanger | 1.5” / Spring Hanger | 1.5” / Spring Hanger | |
| Compressor | 1” / Floor Mount | 1.5” / Floor Mount | 2.5” / Floor Mount | 3.5” / Floor Mount | |
| Fan <= 224 rpm | 0.35” | 3.5” | 4.5” | 4.5” | Floor Mount or Spring Hanger |
| Fan 225-299 rpm | 0.35” | 3.5” | 3.5” | 3.5” | |
| Fan 300-374 rpm | 0.35” | 2.5” | 2.5” | 3.5” | |
| Fan 375-499 rpm | 0.35” | 1.5” | 2.5” | 3.5” | |
| Fan >= 500 rpm | 0.35” | 0.75” | 1.5” | 2.5” | |

B. Procedures and material are based on Mason industries bulletin VCS-100-13
C. Coordinate the selection of devices with the isolator and equipment manufacturers.
D. MATERIALS:
   1. APPROVED MANUFACTURERS: Mason Industries, Amber/Booth Co., Vibration Mounting & Controls, Peabody Noise Control.
   2. Use materials that will retain their isolation characteristics for the life of the equipment served. Use industrial grade neoprene for elastomeric materials.
   3. Treat all isolators to resist corrosion. For isolation devices exposed to the weather or used in high humidity areas, hot dip galvanize steel parts, apply a neoprene coating on all steel parts, or use stainless steel parts; include limit stops to resist wind.
   4. Provide pairs of neoprene side snubbers or restraining springs where side torque or thrust may develop.
   5. Use isolators with a ratio of lateral to vertical stiffness not less than 1.0 or greater than 2.0.
   6. Provide rails and other material by same manufacturer.
E. PAD:
   1. BASIS OF DESIGN: Mason W-Neoprene Waffle Pad;
   2. Ni-Ntrile Waffle pad for locations with exposure to oil, grease or gasoline. Locations called out to be shops or to store such material require this type even if not called on plans.
   3. For concentrated loads provide Mason WMSW (cemented with friction pad) or Mason MBSW (bolted)
F. FLOOR MOUNT:
   1. BASIS OF DESIGN: Mason SLR
   2. INERTIA BASE: Rectangular structural beam or channel concrete form for floating foundation. Include support for suction and discharge base ells for split case pump bases. Use perimeter steel members with a minimum depth equal to 1/12 of the longest dimension of the base but not less than 6"; base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Include concrete reinforcements consisting of steel angles or 1/2" bars welded in place on 6" centers running in two layers perpendicular to each other and 1-1/2" above the bottom; provide additional steel if required by the structural conditions. Furnish form with steel bolting templates and anchor bolt sleeves to receive equipment anchor bolts where anchor bolts fall in concrete locations. Use height saving brackets in all mounting locations to maintain a base clearance of at least 1" above the floor or housekeeping pad. Mason type KSL or BMK
G. SPRING HANGERS:
   1. BASIS OF DESIGN: Mason PC30N
   2. Design hanger with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Pre-compressed to the rated deflection to keep the piping or equipment at a fixed elevation during installation.
   3. Applications not allowing horizontal movement: Mason HES
   4. Duct isolation hangers (where required): Mason 30N
H. VERTICAL PIPE ANCHOR AND GUIDE:
   1. All directional acoustical pipe anchor and guide consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum half inch thickness of heavy duty neoprene and duck or neoprene isolation material. Provide vertical restraints of similar material to prevent vertical travel in either direction. Design isolation materials for a maximum allowable load of 500 psi, balanced for equal resistance in any direction. Mason type ADA .
I. HORIZONTAL THRUST RESTRAINT:

1. Spring element in series with a neoprene pad as described for Type 3 mount with the same deflection as specified for the mounting or hanger. Design the assembly so the spring element is contained within a steel frame, so it can be preset for thrust at the factory, and adjusted in the field for a maximum of 1/4" movement at start and stop. Include threaded rod and angle brackets for attachment to both equipment and ductwork or equipment and structure. Mason type WB.

J. FLEXIBLE PIPE CONNECTORS:
1. Multiple plies of nylon tire cord fabric reinforced with an EPDM cover and liner. Do not use steel wire or rings as pressure reinforcement. Use soldered connections for sizes 2" and smaller and floating steel or ductile iron flanges for sizes 2-1/2" and larger; design the steel flange end so the steel flange is recessed to lock a steel wire bead ring in the raised face of the EPDM flange. Construct straight-through connections with twin spheres. Use control rods when recommended by the manufacture
2. Large Expansion: Mason VFL
3. Small Expansion: Mason CPSB, FFL or equivalent.

K. FLEXIBLE DUCT CONNECTORS:
1. BAIS OF DESIGN: Ventfabrics Ventglas (indoor) and Ventlon (outdoor)
2. Use on all duct connection to equipment with fans.
3. Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.
4. Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.
5. Use coated glass fiber fabric for all applications. Material for inside applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard. Material used for outdoor applications other than corrosive environments, fume exhaust, or kitchen exhaust to be double coated with Hypalon, air and water tight, suitable for temperatures between -10°F and 250°F, and have a nominal wight of 26 ounces per square yard.
6. For corrosive environments or fume exhaust applications indoors or outdoors, use a material coated with Teflon that is air and water tight, suitable for temperatures between -20°F and 500°F, and has a nominal weight of 14 ounces per square yard. Basis of Design: Ventfabrics Ventel.
7. Do not use connectors in kitchen exhaust ducts. Use upblast fans that are roof mounted on curbs and have no direct connection between the exhaust duct and the fan housing. Connectors that have the temperature properties that may be needed in this application will absorb the grease being conveyed; this could provide fuel to a fire if one developed.
8. Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets.
9. For applications in corrosive environments or fume exhaust systems, use a double layer of the Teflon¿ coated fabric when making the connector.

L. SUSPENDED FANS:
1. Install horizontal thrust restraint if air thrust exceeds 10% of weight. Attach horizontal thrust restraints at centerline of thrust and symmetrically on either side of unit. Thrust restraints are not required when fan section in not isolated from remainder of ductwork or AHU by means of duct flexible connections.

M. VERTICAL PIPE RISERS GREATER THAN 30 FEET IN HEIGHT:
1. Use type 7 hangers at the top of the riser and type AG with pipe clamps at intermediate points.

N. DUCTWORK IN MECHANICAL EQUIPMENT ROOMS:
1. Use type 8 hanger with .75" minimum deflection for all ducts with a cross sectional area greater than 2.0 square feet and, where either the air velocity is great than 3500 fpm or, the pressure class is 4" water column or higher.

O. ISOLATION DEVICES OUTDOORS OR IN HIGH HUMIDITY AREAS:
1. Use only hot dip galvanized, stainless steel, or neoprene coated steel parts.

P. PACKAGED AIR HANDLING UNITS AND CENTRIFUGAL FANS:
1. Attach horizontal thrust restraints at the centerline of thrust and symmetrically on either side of the unit. Thrust restraints are not required when the fan section in not isolated from the remainder of the air handling unit by means of duct flexible connections.
2. Do not allow installation practices to short circuit isolation devices.

**2.7. CONTROL OPTIONS**

A. All devices shall enable BACnet and shall include the required added cards or modules. This also applies if schedules and other specifications don’t specifically mention BACnet.

**2.8. PLEATED PANEL FILTERS**

A. MANUFACTURER: American Air Filter or approved equal
B. All equipment with filters shall be equipped with 4”filter rack. This may require custom solutions.
C. Pleated panels, 100% synthetic, self supported media fully bonded and sealed in cardboard frame.
D. 1” w.c. recommended final resistance
E. MERV 8 Filter:
1. Use for all air intake and space-circulated air to protect equipment
2. Basis of Design: Use 4" thick PerfectPleat Ultra, PerfectPleat HD M8, Perfect Pleat HC M8
3. Media nominal rating to be 500 FPM face velocity, 0.23 inch WG initial resistance

F. MERV 13 Filter:

1. Basis of Design: 4" thick AmAir 1300
2. Media nominal rating to be 500 FPM face velocity, 0.22 in-w.c. initial resistance

G. HEPA FILTERS
1. Use box type, ultra fine microglass pleated media, water-resistant, aluminum separators, fully bonded and sealed in a factory fabricated metal frame. Media pleats to be self-supporting under varying airflow conditions.
2. Media nominal rating to be 250 FPM face velocity, 1.0 inch WG initial resistance, 2.0 inch WG recommended final resistance, 99.97% dioctylphthalate (DOP) efficiency Filter cartridges to be listed or classified under UL 586 test standard including factory certification seal.

**2.9. ELECTRONIC AIR CLEANERS**

A. Meet UL 2998 for Zero Ozone Production
B. Ionization limited to 12 eV (below Oxygen ionization threshold of 12.07 eV)

**PART 3 - EXECTUTION**

**3.1. TESTING, ADJUSTING, AND BALANCING**

A. Contractor shall be an independent Firm specializing in the Testing and Balancing of HVAC systems for a minimum of 3 years. Contractor shall be a certified member of AABC or certified by NEBB or TABB in the specific area of work performed. Maintain certification for the entire duration of the project.
B. Technicians on this project must have satisfactorily completed work on a minimum of 3 projects of at least 50% in size, and of similar complexity. Size is defined as the quantity of each specific individual item requiring testing and balancing such as, but not limited to, equipment, devices, terminal devices, and grilles and diffusers.
C. Prior to beginning testing, adjusting and balancing, foreman shall meet with owner and the mechanical system contractors and provide TAB plan for the project. Indicate work required to be completed prior to testing, adjusting, and balancing and identify the party responsible for completion of that work. TAB Plan at minimum shall consist of:
1. Detailed step-by-step procedures for TAB work for each system: terminal flow calibration, diffuser proportioning, branch/sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc.
2. List of all airflow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used. Details of how total flow will be determined
3. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures.

D. Provide all required instrumentation to obtain proper measurements. Application of instruments and accuracy of instruments and measurements to be in accordance with the requirements of NEBB, AABC, or TABB Standards and instrument manufacturer's specifications.
E. All instruments used for measurements shall be accurate, and calibration histories for each instrument to be available for examination by owner. Calibration shall be per instrument’s manufacturer recommendation.
F. PRELIMINARY PROCEDURES:
1. Check equipment for proper rotation and belt tension. Verify controls system is complete.
2. Identify deficiencies preventing completion of testing, adjusting and balancing procedures. Do not proceed until systems are fully operational with all components necessary for complete testing, adjusting and balancing. Installing Contractors are required to provide personnel to verify system completion, readiness for balancing and assist TAB contractor in providing specified system performance.
3. Verify building openings and ceilings are complete.
4. Verify all connected equipment is started up and functioning properly.

G. PERFORMING TESTING, ADJUSTING AND BALANCING:
1. Cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary for adequate performance of procedures. Patch using materials identical to those removed, maintaining vapor barrier integrity and pressure rating of systems.
2. Account for Viscosity differences of different fluids.
3. Measure motor power draw and compare to design conditions.
4. Permanently mark equipment settings, including damper and valve positions, control settings, and similar devices allowing settings to be restored. Set and lock memory stops. Provide set values of balancing devices in balancing report.

H. HYDRONIC FLOW BALANCING
I. Balance after system has been cleaned, flushed and all strainers and dirt separators are cleaned and all flow restrictions removed. Verify correct strainer screensize is installed. Verify all valves work correctly.
J. Measure flow of coils, boilers, heatpumps and other devices with pressure drop over device. Contractor shall install standard ¼” pressure taps as required.
K. For coils in air streams determine flow by measuring air flow, EAT, ELT, EWT, LWT, and heat balance method.
L. Correct for varying viscosity based on fluid temperature, glycol type and glycol %.
M. Total system flow cannot be measured by pressure gain over pumps.
N. Final water system measurements must be within the following range of specified gpm:

Heating flow rates: -5% to +10%
Cooling flow rates: -5% to +10%

O. VARIABLE FLOW WITH PRESSURE INDEPENDENT CONTROL VALVES (PICV):
1. DETERMINE STATIC RESET SETPOINTS:
a. Operate Pump to maintain 50% of design pressure
b. Open all control valves 100%. Designer will provide information on diversity.

c. Measure all device flows and tabulate design flow vs. actual flow and determine the 5 critical zones that are at lowest % of design flow. Verify flow in critical zones is not deficient for other reasons (i.e. dirty strainer, wrong pressure-independent device installed).
d. If flow in critical zones is below design, increase system pressure setpoint. If all flows are at design flow, repeat above with lower pressure / pump speed
e. Re-iterate until the lowest pressure setpoint is found that still allows design flow in 5 critical zones. The final pressure is the actual maximum pressure and will be reported to Controls Contractor to set as maximum pressure for static pressure reset. The minimum pressure typically will be set at 25% of that.

2. VERIFY ZONE / DEVICE FLOW:
a. At upper static pressure reset pressure setpoint measure the flow in each device / zone. Note that if diversity was applied to determine the static pressure setpoint, some valves need to be closed to measure the flow in the other zones.
b. This is meant to determine if there are flow restrictions of the wrong type or size PICV is installed. If deviations are encountered, consult with engineer and manufacturer.

P. CONSTANT FLOW:
1. Operate pump at 50% speed.
2. Measure flow over device.
3. Adjust pump speed as required (or balancing valve if single speed pump)

Q. AIRFLOW BALANCING:

R. Measure flow in ducts by traversing with procedure (5x5 measurement points minimum) recommended by "TSI Airflow instruments" Application Note AF-106.

S. Measure flow in diffusers and grilles with flow hood. Alternatively measure flow in branch duct.

T. Verify filters are installed and clean. Verify all dampers work correctly.

U. Final air system measurements to be within the following range of specified cfm:

| | |
|---|---|
| Fans: | -1% to +5% |
| Supply grilles, dissuers: | -1% to +5% |
| Return/Exhaust frilles, registers: | -1% to -5% |
| Space pressurization: | -10% to +10% |

V. VAV SYSTEM:
1. VERIFY VAV TRMINAL READINGS:
a. In each zone verify read airflow vs. measured sum of all diffuser airflows. This test will determine if the wrong type of VAV device is installed, if there is a fault in the device, or if the controls system interprets the system incorrectly.
b. Consult engineer if there are significant discrepancies. Note that VAV devices are factory-calibrated and field measurements typically are less accurate. Adjustments to the device readings only should be done after consulting with engineer and manufacturer.

2. VERIFYING SYSTEM CAPACITY AND STATIC PRESSURE SETPOINT DETERMINATION:
a. Operate as many of the most remote zones at 100% design flow as needed to add up to system design flow.
b. Adjust Static pressure setpoint to allow design flow in critical boxes at 100% open damper. This is the maximum pressure in static-pressure-reset program.
c. The minimum pressure typically will be set at 25% of that.

W. SINGLEZONE CV SYSTEM:
1. Reduce fan speed to achieve design flow.
2. If applicable, If multiple air terminals should be balanced per procedure below.
3. Re-iterate fan speed adjustment to achieve 100% design flow with critical path damper 100% open.
4. Report final fan speed to Controls Contractor to be used as fan speed. This will be set in VFD or ECM controller.

X. BALANCE MULTIPLE AIR TEMRINALS IN ZONE:
1. Open all balancing dampers 100% to determine critical path (lowest Design flow / actual flow ratio).
2. Leave this damper 100% open and adjust the remaining dampers to balance flow in each zone.
3. Re-iterate measurements of all diffusers and adjust dampers again if needed. Note that the critical path damper always is 100% open.
4. Single air terminal zones should not have balancing damper or damper should be wide open.

**3.2. AIR DISTRIBUTION CLEANING**

A. SCOPE:
1. Clean all duct systems and devices that got dirty because of this project.
2. Clean existing duct systems that is no contaminated by this project only if plans indicate to do so.

B. Contractor must be a Regular Member in good standing of NADCA (National Air Duct Cleaners Association). Maintain membership for the entire duration of the project. Maintain a staff of at least one Certified Air System Cleaning Specialist (ASCS).

C. Verification of HVAC system cleanliness will be performed after cleaning and prior to application of biocides and encapsulants. The Contractor shall notify the Owner in advance of verification. Verification will consist of inspection by the Contractor and Owner. The Owner reserves the right to further verify system cleanliness through third party gravimetric or wipe testing analysis per NADCA standards.

D. CLEANERS, BIOCIDES AND ENCAPSULANTS:
1. Manufacturer: H.B. Fuller/Foster, Porter, or approved equal.

2. Cleaners, biocides and encapsulants shall be waterbase products specifically designed for application to HVAC duct interiors and capable of being applied with airless spray equipment. Biocides and encapsulants must be colored differently than substrate to be coated.
3. Biocidal agents to be formulated for long term fungicidal activity with no loss on aging. Biocidal agents must be registered with the U.S. Environmental Protection Agency for use on the interior of HVAC duct systems.
4. Cured biocides and encapsulants must provide tough washable elastic protective finish able to withstand light impact or abrasion without breaking down over time or releasing fibers.
5. Apply only after cleaning and verification have been completed and surfaces are dry. System fans are to remain off and critical barriers maintained to prevent migration of biocides and encapsulants from the HVAC systems.
6. Apply biocides to the following surfaces which are suspected of or have been tested and verified for microbial contamination:
   a. Plenums and ductwork around and 5' downstream of cooling coils and humidifiers.
   b. Cooling coil drain pans.
   c. Outdoor air intake drain pans.
7. Apply encapsulants to the following surfaces where microbial contamination is not suspected:
   a. Damaged fibrous glass thermal or acoustical insulation.
   b. Sheet metal where thermal or acoustical insulation has been removed.
8. Biocides and encapsulants to be directly sprayed (not fogged), brushed or rolled onto surfaces to achieve a continuous film of thickness recommended by manufacturer. Increase application rate on porous or rough surfaces. Protect coils, fan blades, bearings, damper linkages and seals, fire/smoke dampers, humidifiers, airflow sensors, pressure sensors, temperature sensors and humidity sensors during application of biocides and encapsulants. Clean any overspray from these components immediately. Allow products to fully cure prior to using HVAC systems. Operate systems during unoccupied hours flushing with fresh air to purge system prior to occupied use.

E. EQUIPMENT:
1. Particulate Collection Equipment: Fan/filter unit sized to create sufficient quantity of negative pressure for capture and filtration of air and contaminants dislodged during duct cleaning. Equipment to include prefiltration and HEPA final filtration with 99.97% collection efficiency for 0.3 micron size particles.
2. Portable pressure washers to be capable of 500 psig to 1000 psig operation.
3. Power brush systems designed specifically for duct cleaning.

F. DUCTCLEANING:
1. Clean ductwork systems and associated turning vanes, dampers, coils, VAV boxes, drain pans, plenums, diffusers, registers, grilles and louvers; air handling units and associated fans, coils, drain pans, plenums and dampers; fans; terminal units and other equipment. Systems and components to be cleaned includes existing duct work of modified systems, systems marked on plans, systems that got dirty due to contractor's installation, and systems that got dirty due to contractor's negligence. Typically these type of systems need to be cleaned:
   a. Supply Duct Systems
   b. Return Duct Systems
   c. Transfer Duct Systems
   d. Exhaust/Relief Duct Systems
   e. Outside Air/Mixed Air Duct Systems
   f. Air Handling Units
   g. Heat Recovery Units
   h. Packaged Air Conditioning Units
   i. Makeup Air Units
   j. Furnaces
   k. Exhaust Fans
   l. Relief Fans
   m. Transfer Fans
   n. Unit Ventilators
   o. Cabinet Heaters
2. Visually inspect systems and site prior to cleaning. Document and report damaged system components to Owner prior to cleaning. Mark damper and other component positions prior to cleaning and reset after cleaning to original position. Establish a specific, coordinated plan detailing how each area of the building will be protected during the various phases of work.
3. Protect building occupants, components and furnishings from cleaning activities. Use polyethylene sheeting covers and barriers where cleaning will disperse debris outside the HVAC systems. Install critical barriers within the building, at inlets/outlets and within the system to prevent migration of dust and debris to clean areas.
4. Use particulate collection equipment to remove and capture debris. Connect to system downstream of cleaning operations. Wherever possible, duct exhaust to the exterior of the building. Avoid discharge near air intakes and points of entry. Arrange source of makeup air to flow from clean area to work area negatively pressurizing work area. Take measures to control offensive odors and vapors during the cleaning process.
5. Clean systems using mechanical cleaning methods, such as vacuum cleaning, compressed air sweeping and mechanical brushing, designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. No cleaning methods are to be used which damage components of the system or negatively alter the integrity of the system.
6. Clean fibrous glass thermal or acoustical insulation with HEPA vacuuming equipment. Document locations of damage, deterioration, delamination, mold, fungus growth or excessive moisture which cannot be restored by cleaning or resurfacing with repair coating. Report locations and conditions to Architect/Engineer and Owner's Project Representative for determination of removal and/or replacement.

7. Where fibrous glass thermal or acoustical insulation is to be removed, scrape and brush metal clean. Remove loose fasteners, weld pins where required for cleaning work and sheet metal covers associated with insulation. Patch and seal fastener openings.
8. Coils must be cleaned free of foreign material and chemical residue. Cleaning methods used must not bend, erode or damage coil surfaces, fins or tubes. Clean coil drain pans and drain. Make drain fully operational. Where wet methods are used, thoroughly rinse coils and drains pans with clean water to remove latent residues. Provide temporary drain pans below coils without drain pans to capture water.
9. Where systems and equipment containing filters are cleaned, obtain replacement filters from owner and replace existing filters.
10. Install access doors where indicated on the drawings and in locations where access is required for cleaning or inspection. Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils if not existing. Reinsulate to existing condition.

**END OF SECTION**

# SECTION 23 07 00
# HVAC INSULATION



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment and applies to all sections in this Division. Included are Pipe Insulation, Duct Insulation, and Equipment Insulation

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.

B. ASTM - American Society for Testing and Materials

1. ASTM B209 Aluminum and Aluminum Alloy Sheet and Plate
2. ASTM C165 Test Method for Compressive Properties of Thermal Insulations
3. ASTM C177 Heat Flux and Thermal Transmission Properties
4. ASTM C195 Mineral Fiber Thermal Insulation Cement
5. ASTM C240 Cellular Glass Insulation Block
6. ASTM C302 Density of Preformed Pipe Insulation
7. ASTM C272 Water Absorption of Core Materials for Sandwich Constructions
8. ASTM C303 Density of Preformed Block Insulation
9. ASTM C355 Test Methods for Test for Water Vapor Transmission of Thick Materials
10. ASTM C449 Mineral Fiber Hydraulic Setting Thermal Insulation Cement
11. ASTM C518 Heat Flux and Thermal Transmission Properties
12. ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation
13. ASTM C534 Preformed Flexible Elastomeric Thermal Insulation
14. ASTM C547 Mineral Fiber Preformed Pipe Insulation
15. ASTM C552 Cellular Glass Block and Pipe Thermal Insulation
16. ASTM C553 Mineral Fiber Blanket and Felt Insulation
17. ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation
18. ASTM C591 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
19. ASTM C610 Expanded Perlite Block and Thermal Pipe Insulation
20. ASTM C612 Mineral Fiber Block and Board Thermal Insulation
21. ASTM C921 Properties of Jacketing Materials for Thermal Insulation
22. ASTM C1136 Flexible Low Permeance Vapor Retarders for Thermal Insulation
23. ASTM C1728 Standard for Aerogel Insulation
24. ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
25. ASTM D1000 Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
26. ASTM D1621 Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
27. ASTM D1622 Standard Test Method for Apparent Density of Rigid Cellular Plastics
28. ASTM D1940 Method of Test for Porosity of Rigid Cellular Plastics
29. ASTM D2126 Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
30. ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness
31. ASTM D5590 Test Method for Determining the Resistance of Coatings to Fungal Defacement
32. ASTM E84 Surface Burning Characteristics of Building Materials
33. ASTM E814 Standard Test Method for Fire Tests of Penetration Firestop Systems
34. ASTM E2336 Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems

C. MICA - National Commercial & Industrial Insulation Standards
D. NFPA – National Fire Protection Association
   1. NFPA 225 Surface Burning Characteristics of Building Materials
E. UL – Underwriters Labroatory
   1. UL 723 Surface Burning Characteristics of Building Materials

**1.3. SUBMITTALS**

A. Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, thickness and manufacturer's installation instructions.

**1.4. QUALITY ASSURANCE**

A. Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.
B. Within the past 5 years, the contractor shall be able to document the successful completion of a minimum of 3 projects of at least 50% of the size and similar scope of the work specified in this section.
A. Fluid-applied ductwork insulation is a roofing product that shall be applied only by qualified contractors. Contractor shall be recognized by the manufacturer of the Polyurea 2-part liquid membrane system as an “approved” or “authorized” applicator. Completed project requires installation inspection and approval by the manufacture of the Polyurea coating.
C. Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions.

**1.5. WARRANTY**

A. FLUID APPLIED INSULATION: Provide written manufacturer’s (NDL) no-dollar-limit warranty covering installation required under contract, to be watertight and free from defects in materials and workmanship of the Polyurea coating and other system components supplied by the manufacturer for a period of 15 years from date of installation.

**PART 2 - PRODUCTS**

**2.1. INSULATION PRODUCTS**

A. Manufacturers: Armacell, Certainteed, Manson, Childers, Dow, Extol, Fibrex, Halstead, H.B. Fuller, Imcoa, Johns Manville, Knauf, Owens-Corning, Partek, Pittsburgh Corning, Rubatex, VentureTape or approved equal.
B. Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less. Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.
C. FLEXIBLE FIBERGLASS INSULATION: Minimum nominal density of 0.75 lbs / $ft^3$., and thermal conductivity of not more than 0.3 at 75 °F, rated for service to 250 °F.
D. RIGID FIBERGLASS INSULATION: Minimum nominal density of 3 lbs / $ft^3$., and thermal conductivity of not more than 0.23 at 75 °F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 °F.
E. SEMI-RIGID FIBERGLASS INSULATION: Minimum nominal density of 3 lbs / $ft^3$., thermal conductivity of not more than 0.28 at 75 °F, minimum compressive strength of 125 PSF at 10% deformation, rated for service to 450 °F. Insulation fibers perpendicular to jacket and scored for wrapping cylindrical surfaces.
F. CALCIUM SILICATE INSULATION: Rigid hydrous calcium silicate, ASTM C533, Type I, minimum dry density of 12.5 lbs / $ft^3$, thermal conductivity of not more than 0.44 at 300 degrees F, maximum water absorption of 90% by volume, minimum compressive strength 140 psi at 5% deformation, rated for service range of 0 degrees F to 1,200 °F,. Material to be visually coded or marked to indicate it is asbestos free. Use Type II insulation for temperatures above 1,200°F.
G. ELASTOMERIC INSULATION: Flexible closed cell, minimum nominal density of 5.5 lbs/ $ft^3$., thermal conductivity of not more than 0.27 at 75 °F, minimum compressive strength of 4.5 psi at 25% deformation, maximum water vapor permeability of 0.17 perm inch, maximum water absorption of 6% by weight, rated for service range of -20 °F to 220 °F on piping and 180 °F where adhered to equipment.
H. POLYOLEFIN INSULATION: Flexible closed cell, minimum nominal density of 1.5 lbs / $ft^3$, thermal conductivity of not more than 0.24 at 75 °F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service range of -165 °F to 210 °F.
I. PHENOLIC INSULATION: Rigid closed cell, minimum nominal density of 2.2 lbs / $ft^3$, thermal conductivity of not more than 0.13 at 75 °F, minimum compressive strength of 31 psi parallel and 18 psi perpendicular, maximum water vapor permeability 0.117 perm inch, maximum water absorption of .5% by volume, rated for service range of -290 °F to 250 °F.
J. EXTRUDED POLYSTYRENE INSULATION: Rigid closed cell, minimum nominal density of 1.6 lbs / $ft^3$, thermal conductivity of not more than 0.285 at 75 degrees F, minimum compressive strength of 20 psi, maximum water vapor permeability of 1.5 perm inch, maximum water absorption of .5 % by volume, rated for service range of -290 °F to 165 °F.
K. URETHANE INSULATION: Rigid closed cell polyisocyanurate, minimum nominal density of 1.8 lbs / $ft^3$, thermal conductivity of not more than 0.19 at 75 degrees F aged 180 days, minimum compressive strength of 19 psi parallel and 10 psi perpendicular, maximum water vapor transmission of 4 perm inch, maximum water absorption of .2% by volume, rated for service range of -290 °F to 300 °F.
L. POLYISOCYANURATE INSULATION: Rigid closed cell polyisocyanurate, minimum nominal density of 2.0 lbs / $ft^3$, thermal conductivity of not more than 0.19 at 75 degrees F aged 180 days, minimum compressive strength of 24 psi parallel and 13 psi perpendicular, maximum water vapor permeability of 4 perm inch, maximum water absorption of 2% by volume, rated for service range of -290 °F to 300 °F.

M. CELLULAR GLASS INSULATION: Rigid closed cell, minimum nominal density of 8.5 lbs / ft³, thermal conductivity of not more than 0.36 at 50 degrees F, minimum compressive strength of 100 psi, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of .2% by volume, rated for service range of -450 °F to 900 °F.

N. MINERAL WOOL INSULATION: Rigid preformed mineral fiber, minimum nominal density of 8 lbs / ft³, thermal conductivity of not more than 0.29 at 200 °F, minimum compressive strength of 3 psi, maximum wicking of 1%, maximum water adsorption of 1% by volume, rated for service of -120 °F to 1200 °F.

O. MINERAL FIBER: Secure each 3' section with three stainless steel bands or five 16 gauge stainless steel or annealed copper tie wires evenly spaced and at ends. Twist wire ends, snip off excess and turn ends over into insulation. Stagger joints where more than one layer is used.

P. ELASTOMERIC AND POLYOLEFIN: Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyeolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 °F with vapor barrier mastic.

Q. EXTRUDED POLYSTYRENE AND POLYISOCYANURATE: Fittings, valves, unions, flanges, couplings and specialties shall be insulated with factory molded insulation of the same thickness as adjoining insulation. Secure insulation sections with two wraps of nylon filament tape 9"-12" on center. On single insulation layer systems and on the outer layer of double insulation layer systems, apply a thin coat of elastomeric joint sealant rated for system operating temperatures to all longitudinal and butt insulation joints covering entire face of joint. Allow sealant to fully cure before applying protective covering. For piping service below 0oF, use two layers of insulation with inner and outer butt and longitudinal joints staggered and offset 90 degrees. Where two layers of insulation are used, do not use sealant on the inner layer or adhere the inner layer to the outer layer. Apply vapor stop bead of joint sealant between pipe and insulation on both sides of valves, expansion/contraction joints, flanges, thermometers/gauges, attached vent and drain lines. Insulate attached non-circulated lines, control lines, vents, etc. for a minimum distance of 6" from pipe. Cover insulation with a protective jacket as specified below. Do not penetrate protective covering or insulation with mechanical fasteners.

R. FIREPROOFING INSULATION: Mineral fiber with nominal density of 8 lbs / ft³, flame spread index of 25, fuel contribution index of 0, and smoke developed index of 0, thermal conductivity of not more than 0.23 at 75 degrees F, rated for service of -120 °F to 1200 °F. Use rigid or semi-rigid board for duct insulations.

S. VAPOR BARRIER: maximum permeance of .02 perms. Provide a continuous unbroken moisture vapor barrier on insulation applied to systems requiring vapor barrier. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

T. FIRE-STOP INSULATION: Noncombustible, non-asbestos, non-ceramic fiber, high temperature blanket or board fireproofing insulation, constructed of calcium silicate or calcium/magnesium/silica amorphous wool with 2-hour (or as required by application) ASTM E814 "F" and "T" fire ratings, UL or equivalent third party listed, labeled and specifically evaluated for such purpose in accordance with ASTM E2336. Foil-scrim-polyethylene fiberglass reinforced factory applied jacket.

U. FIRE RATED INSULATION: Noncombustible, non-asbestos, non-ceramic fiber, high temperature blanket or board fireproofing insulation, constructed of calcium silicate or calcium/magnesium/silica amorphous wool with required ASTM E814 "F" and "T" fire ratings, UL or equivalent third party listed, labeled and specifically evaluated for such purpose in accordance with ASTM E2336. Foil-scrim-polyethylene fiberglass reinforced factory applied jacket.

**2.2. PIPE INSULATION**

A. Provide insulation on new and existing remodeled piping as per following schedule. If code requires added thickness, this shall be included at no added cost to owner. Include asbestos-abated existing pipes:

| Service | Insulation | Vapor | Jacket | Insulation Thickness by Pipe Size | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | <= 1.25" | 1.5" | 2"- 4" | 4"- 6" | >=8" |
| Warm Water | Rigid Fiberglass | | ASJ | 1.5" | | 2" | | |
| Heating Hot Water | Rigid Fiberglass / polyiso (outdoors or in wet conditions)) | | ASJ | 1.5" | | 2" | | |
| Chilled Water / Geothermal Fluid | Polyiso./Polystyrene | X | VRJ or SAJ | 1.5" | | 2" | | |
| Refrigerant Suction | Ext Polystyrene/Polyiso | X | VRJ or SAJ | 1" | | | | 1.5" |
| Remote Generator Radiator Piping | Rigid Fiberglass (indoors) / Polyiso (outdoors) | | ASJ | 1.5" | | | | |
| Storage Tanks (hot) | Semi-Rigid Fiberglass | | ASJ/FMJ | 2" | | | | |
| Storage Tank (chilled or geothermal) | Elastomeric/Polyolefin | | ASJ | 2" (unless manufacturer supplies factory-made insulation for application) | | | | |
| R.P.B.P | Elastomeric | | ASJ | 0.5" | | | | |
| Generator exhaust pipe | Calcium Silicate / | | PMJ | 3" | | | | |

| | | | | |
|---|---|---|---|---|
| and muffler | Fireproofing | | (exposed locations) | |
| Hot Water Air separators; Buffertanks, Heat Exchangers | Semi-Rigid Fiberglass | | ASJ/FMJ | 2” |
| Chilled Water and Geothermal Air separators; Buffertanks, waterboxes, evaporator shell, condenser shell, Heat Exchangers, Pumps, Balancing valves, valves | Elastomeric/Polyolefin | X | None | 2” (unless manufacturer supplies factory-made insulation for application) |

B. INSULATION INSERTS AND PIPE SHIELDS:
   1. Manufacturers: B-Line, Pipe Shields, Value Engineered Products
   2. Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer’s installation instructions. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

C. Insulate elbows and other corners with 22.5° pieces or use factory made insulation fittings. Use factory-made fittings for Tee, and other fittings.

D. FITTINGS AND VALVES: Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation.

E. Pipe insulation shall be performed in 2 half cylinder sections. Cut V-groove sheet insulation is not acceptable. Provide 3 stainless steel bands for each section of insulation.

**2.3. DUCT INSULATION**

A. Provide duct insulation on new and existing remodeled ductwork in the following schedule. Air ducts with temperatures of the space equal to the air (i..e return air in plenum) don’t require insulation unless noted elsewhere:

| Service | Insulation Type | Jacket | Insulation Thickness |
|---|---|---|---|
| Outside air ducts between control damper and Heating/Cooling device inc. ERV | Rigid Fiberglass | FSJ | 3” |
| Mixed and supply ducts within conditioned space | Rigid Fiberglass | FSJ | 2” |
| Flex ducts for diffuser connection | Flexible Fiberglass | FSJ | 1” |
| All Ducts located in unconditioned attics/crawl spaces | Rigid Fiberglass | FSJ | 3” |
| Exhaust, Air intake and relief duct from outdoor opening to control damper | Rigid Fiberglass | FSJ | 4” |
| All ducts exposed to weather | Ext. Polystyrene or fluid Applied | SAJ | 3” |
| Exhaust ducts downstream of heat recovery units and desiccant dryers | Rigid Fiberglass | FSJ | 2” |
| Grease ducts serving Type I Kitchen hoods | Fire-Stop | As required for hourly rating | As required for hourly rating |
| Breech. and boiler wind boxes | Fireproofing | As required for hourly rating | 3” |
| Louver blank-off panels | Poly-iso | SAJ | 3” |
| AHU unit casing (unless factory-insulated) | Rigid Fiberglass | ASJ | 2” |

B. Secure flexible duct insulation on sides and bottom of ductwork over 24" wide and all rigid duct insulation with weld pins. Space fasteners 18” on center or less as required to prevent sagging.

C. Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3” from each edge and spaced no greater than 12” on center.
D. Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4” tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed.
E. Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.
F. Provide 4” overlap of external insulation over ends of acoustically lined sections.
G. Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.
H. Where insulated low temperature (below 45ºF) ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.
I. Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor barrier jacketing to encapsulate the support channels.
J. Where ductwork exposed to the weather is insulated with any product other than fluid-applied ductwork insulation, the top surface of the insulation shall be sloped a minimum of ¼” per foot to eliminate ponding and create positive drainage off of insulation. Refer to fluid-applied ductwork insulation section below for slope requirements.
K. BREECHING: Fasten insulation over weld pins and secure with washers. Space fasteners not less than 3” from edge or corner and 12" on center longitudinally and 9" on center in the transverse direction. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4” tape of same material as jacket. Seal tape with plastic applicator and secure with staples.
L. GREASE DUCTS: Strictly adhere to manufacturer’s installation instructions and rating requirements for application of fire-stop insulation. Cover all exhaust ducts serving Type I kitchen hoods with fire-stop insulation from a point prior to penetration of ceiling, wall, floor or concealment through building to termination at outside of building. Extend fire-stop insulation through roof curbs. Enclose from the point of penetration of a ceiling, wall or floor to the outlet terminal in a 2-hour rated enclosure vented to the outside and constructed with 6”-12” clearance to the duct.

**2.4. JACKETS**

A. PVC FITTING COVERS AND JACKETS (PFJ): White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02” indoors/.03”outdoors for piping 12” and smaller, .03” indoors/.04” outdoors for piping 15” and larger. PVC covers and jackets have limited ability to resist water vapor transmission. On systems operating below 50 degrees F which use PVC covers or jackets, insulation must first be covered with low permeance vapor barrier mastic/fabric or vapor barrier tape. Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2” band of mastic over ends, throat, seams and penetrations.
B. ALL SERVICE JACKETS (ASJ): Heavy duty, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.
C. FOIL SCRIM ALL SERVICE JACKETS (FSJ): Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.
D. PROTECTIVE METAL JACKETS (PMJ): .016 inch thick aluminum or .010 inch thick stainless steel with safety edge.
E. Lap seams a minimum of 2 inches. Secure with metal bands for end to end joints, and rivets or sheet metal screws for longitudinal joints. Rivets, screws, and bands to be constructed of the same material as the jacket. Locate seams on bottom for exterior applications.
F. SELF-ADHERING JACKETS (SAJ): 5-ply, self-adhering multiple laminated waterproofing material with reflective aluminum foil, high density polymer films and cold weather acrylic adhesive providing zero (0.0) permeability. Minimum 6 mils material thickness, 35lb puncture resistance when tested in accordance with ASTM D1000 and flame spread/smoke developed rating of 10/20 when tested in accordance with UL 723. Vapor retarding tape shall be specifically designed and manufactured for use with the self-adhering jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with self-adhering jackets shall have a maximum permeance of 0.0 perms. Cut allowing minimum 4” overlap on ends and 6” on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges. Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.
G. FABRIC REINFORCED MASTIC JACKETS (FMJ): Glass fiber reinforcing fabric imbedded in weather barrier mastic as per manufacturer’s recommended procedure for 2 coat application. Glass fiber fabric shall be fitted without wrinkles. Glass fiber fabric shall be sized immediately upon application with lagging adhesive and shall be capable of drying within 6 hrs. Apply adhesive and coating in accordance with manufacturer’s recommendations. All seams shall overlap not less than 2”.

H. VAPOR RETARDING JACKETS (VRJ): Polyvinylidene chloride (PVDC) vapor retarding jacket material with minimum 6 mils material thickness and maximum permeance of 0.01 perms. Material shall not support the growth of mold or mildew. Dow Saran or equivalent. Vapor retarding tape shall be specifically designed and manufactured for use with the vapor retarding jacket specified above. Tape shall be provided by the same manufacturer that provides jacketing. Vapor retarding tapes used with vapor retarding jackets shall have a maximum permeance of 0.01 perms. Piping with vapor retarding (VRJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the vapor retarding (VRJ) jackets may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

I. METAL JACKETS: .016 inch thick aluminum or .010 inch thick stainless steel with safety edge.

J. Protective jackets shall be used for pipe insulation exposed in food handling/kitchen areas, cold rooms, wet areas, exterior installations or where insulation is subject to physical abuse.

K. Provide a protective PVC jacket (PFJ) for the following insulated piping:
   1. Chilled water piping and valves in walk-thru tunnels and valve pits
   2. Exposed piping in kitchens
   3. Piping exposed in finished locations
   4. Outdoors

L. Provide PFJ or FMJ jacket for all piping within mechanical rooms

M. Provide PMJ or SAJ jacket for the following insulated piping for Exterior refrigeration piping

N. Provide PMJ for the following insulated piping: Steam and condensate piping and fittings in walk-thru tunnels and pits

**2.5. EQUIPMENT INSULATION**

A. Do not insulate over equipment access manholes, nameplates or ASME stamps. Bevel and seal insulation at these locations.

B. PROTECTIVE JACKETS: Provide a protective metal jacket (PMJ) for the following: Generator exhaust pipe (that is not concealed in a shaft) and muffler.

C. SEMI-RIGID FIBERGLASS: Apply insulation to equipment shells using weld pins, bonding adhesive, banded and wired in place. Fill all joints, seams and depressions with insulating cement to a smooth, even surface. Cover with reinforcing fabric and 2 coats of mastic (FMJ). Use vapor barrier mastic on systems requiring a vapor barrier.

D. ELASTOMERIC/POLYOLEFIN: Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.

E. REMOVABLE COVERS: Provide insulated easily removable galvanized steel metal boxes for routine service access on the following equipment:
   1. VAV boxes on both sides of heating coil

F. Equipment in ducts and pipes insulate with same insulation material and thickness as the connecting duct or pipe

**2.6. FLUID-APPLIED DUCTWORK INSULATION (FDI)**

B. Manufacturers: Technical Roofing Solutions, Inc; Volatile Free Inc.; BASF Corp.; Gaco Western Inc. or equal.

C. Coatings shall be U.L. Listed to retain existing system UL ratings when applied as specified in this project.

D. Polyurea: (approved polyurea coating) A two-component 1:1 ratio polyurea-urethane hybrid with excellent strength and weathering characteristics.

E. Performance Values:

| PHYSICAL PROPERTY | ASTM TEST METHOD | TYPICAL VALUE |
|---|---|---|
| Tensile Strength | D 412 | >1,600 psi |
| Elongation | D 412 | >300% |
| Shore A Hardness (inst-5 sec.) | D 2240 | 85 - 90 Shore A |
| Tack-Free Time | | 10 to 30 Seconds |
| Service Temperature | | -40°F to 300°F |
| Application Temperature | | 40°F to 150°F |
| Tear Resistance | D 264 Die C | 125 Pli |
| Spread of Flame | ASTM E-84 | <75 (Smoke<450) |

F. Performance Values:

| PHYSICAL PROPERTY | ASTM TEST METHOD | TYPICAL VALUE |
|---|---|---|
| Density (nominal) | ASTM D-1622 | 2.5 pcf |
| Compressive Strength (min) (parallel to rise) | ASTM D-1621 | 40 psi |
| K Factor (Initial) | ASTM C-177 | 0.15 btu.in/ft2.hr. °F |
| Closed Cell Content | ASTM D-1940 | 90% |
| Dimensional Stability (aged 28 days, % volume change) | ASTM D-2126 | <2.5 @ 158ºF/98% RH |
| Moisture (Perm/Inch) | ASTM C-355 | 0.8 |
| Spread of Flame (2" thick sample) | ASTM E-84 | <75 (Smoke<450) |

G. Final coating shall be a polyurea compatible, fire retardant coating (Flame spread <25 Smoke <50).

H. Primer, Cleaner, mastic and coating shall be approved by manufacturer.

**2.7. INSULATION INSERTS AND PIPE SHIELDS**

A. Manufacturers: B-Line, Pipe Shields, Value Engineered Products.

B. Construct inserts polyisocyanurate minimum 140 psi compressive strength. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

**2.8. ACCESSORIES**

A. All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.
B. Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.
C. Insulation bands to be 0.75" wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.
D. Tack fasteners to be stainless steel ring grooved shank tacks. Staples to be clinch style.
E. Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool. Finishing cement to be ASTM C449.
F. Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.
G. Bedding compounds to be non-shrinking and permanently flexible.
H. Vapor barrier coatings to have maximum applied water vapor permeance of .05 perms.
I. Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.
J. equipment/piping, mastic must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF), water vapor permeance shall be less than 0.013 perms at 43 mils dry film thickness per ASTM E 96 Procedure B: Foster 30-80AF Vapor Safe Mastic or equal.
K. WEATHER BARRIER BREATHER MASTIC: Above ambient equipment/piping. permeance shall be greater than 1.0 perms at 1/16" dry film thickness per ASTM E96. Foster 46-50 Weatherite, Childers Vi-Cryl CP-10/CP-11, Vimasco WC-5.
L. LAGGING ADHESIVE / COATINGS: Indoors applications used in conjunction with canvas/glass cloth: Foster 30-36, Childers CP-50 AMV1, Vimasco 713.
M. For all indoor applications, coating must be anti-fungal and shall meet ASTM D 5590 with 0 growth rating (AF): Foster 30-36 AF Seal Fas, Childers CP-137 AF Chil-Seal.
N. REINFORCING MESH: Foster 42-24 Mast A Fab, Childers Chil Glas #10 or Pittsburgh Corning PC 79.
O. METAL JACKETING SEALANT FOR ALL ALUMINUM JACKETING: Foster 95-44 Elastolar, Childers CP-76 Chil-Byl, Pittsburgh Corning 727.
P. INSULATION JOINT SEALANT: (cellular glass, polyisocyanurate, phenolic) Used on all below ambient piping to prevent moisture ingress. Foster 95-50 Flextra, Childers CP-76 Chil-Byl, Pittsburgh Corning CW Sealant.

## PART 3 – EXECUTION

**3.1. INSTALLATION**

A. Install in accordance with manufacturer's instructions and all code requirements.
B. Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed. Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.
C. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations.
D. Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.
E. Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.
F. Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.
G. Use full length material wherever possible. Scrap piecing of insulation or pieces stretched to fit will not be accepted.
H. All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.
I. Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive. Additionally secure with staples along seams and butt joints. Coat staples with vapor barrier mastic on systems requiring vapor barrier.
J. For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

**END OF SECTION**

**SECTION 23 09 00**
**INSTRUMENTATION AND CONTROL FOR HVAC**



## PART 1 – GENERAL

### 1.1. SCOPE

A. Furnish all labor, materials, equipment, and service necessary for a complete operating BAS, utilizing DDC as shown on the diagramatic drawings and as described in Sequence of Operation. Provide Integration of system into existing WEBs supervisor per owner instructions. Provide all hardware and software compatible for owner's existing system.

B. Assist mechanical contractor in selection of control dampers.

C. Enclosures shall meet the requirements of other equipment specified in the same space. All enclosures shall be suitable for the environment.

D. Acronyms used in this specification are as follows:

1. BAS Building Automation System
2. BTL BACnet Testing Labroatory
3. DDC Direct Digital Controls
4. GUI Graphical User Interface
5. IBC Interoperable BACnet Controller
6. IDC Interoperable Digital Controller
7. LAN Local Area Network
8. NAC Network Area Controller
9. OOT Object Oriented Technology
10. PICS Product Interoperability Compliance Statement
11. PMI Power Measurement Interface
12. POT Portable Operator's Terminal
13. WAN Wide Area Network
14. WBI Web Browser Interface

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
1. DIVISION 26 — ELECTRICAL

B. ANSI – American National Standards Institute - www.ansi.org
1. ANSI/IEEE 519-2014 Guide for Harmonic Control and Reactive Compensation of Static Power Converters

### 1.3. SUBMITTALS

A. Complete wiring and schematic diagrams, software descriptions, sequences of operation, protocol documentation, point lists, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function. Terminal identification for all control wiring shall be shown on the shop drawings. Include a trunk cable schematic diagram depicting control panel locations and a description of the communication type, media, and protocol.

B. Drawings indicating location and type of sensor, cabinet, user device etc. in each space.
C. WIRING: Load and voltage drop calculations inc. proposed wiring lengths and sizes. Provide transformer and fuse box data.
D. Include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation.
E. Complete set of electronic 'as-built' drawings and application software. Drawings shall be provided as dwg.
F. For VFD provide harmonic distortion analysis of total service to prove variable frequency drives proposed do not exceed the latest version of IEEE 519 voltage and current distortion limits as shown in Table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.
G. VALVE SCHEDULE: Valve sizing shall be performed, and a schedule created by the valve manufacturer. Include valve Identification Tag, Location, Valve Type, Valve Size, Pipe Size, Configuration, Flow Characteristics, Capacity, Valve CV, Calculated CV, Design Pressure Drop, Actual Pressure Drop, Fail Position, Close-off Pressure, Actuator Identification Tag, and Actuator Type.
H. DAMPER SCHEDULE: Include Damper Identification Tag, Location, Damper Type, Damper Size, Duct Size, Arrangement, Blade Type, Velocity, Pressure Drop, Fail Position, Actuator Identification Tag, Actuator Type, and Mounting.

**1.4. QUALITY ASSURANCE**

A. BASIS-OF-DESIGN: Honeywell WEBs-AX™ based on a hierarchical architecture incorporating the Niagara AX Framework™.
B. Contractor shall be certified and trained by BAS manufacturer and shall be ACI (Authorized Controls Integrator) Honeywell Contractor. The firm must be specializing and experienced in DDC control system installation for no less than 10 years.
C. All engineering and commissioning work shall be done by qualified employees of this contractor, or qualified employees of an Authorized Representative of that manufacturer. Installation of electrical components and wiring can be done by this contractor or contractor meeting requirements of Division 26.
D. The contractor must have a service office within 20 miles of the building location. This requirement applies to the actual office location the individuals working on controls work out of. Response Time During warrantee period must be four (4) hours or less.
E. All products of the BAS shall have the following agency approvals:
   1. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
   2. CSA (LR95329-3) Listed
   3. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
   4. Meets Canadian standard C108.8 (radiated emissions).
   5. Conforms to the following requirements per European Consortium standards:
      a. EN 61000-6-1; 2001 (EU Immunity)
      b. EN 61000-6-3; 2001 (EU Emissions)
F. Equipment must be capable of operation within expected conditions of the environment it is located in.

**1.5. PERFORMANCE REQUIREMENTS**

A. BAS shall be comprised of:
   1. NAC within each facility shall connect to the owner's LAN network. Access to the system shall be via standard Web browsers and secure password.
   2. Peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™, LonWorks™ technology, MODBUS ™, OPC, and other open and proprietary communication protocols into one open, interoperable system.
   3. platform shall be designed specifically to control HVAC Equipment and if available be specific to that type of equipment. The controller shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation". Standard controller is Honeywell Spyder or most current model capable of providing required control sequences and points.
B. COMMUNICATION PROTOCOLS: BACnet IP shall be the priority protocol. Any other protocol shall only be used if a device is not available with BACnet IP. Contractor shall coordinate with all equipment providers to allow BACnet IP operation. All devices shall be BTL certified.
C. SPEED: A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data. Maximum acceptable response time from any alarm occurrence (at the point of origin) shall not exceed 5 seconds.
D. ALARMS:
   1. Alarm annunciation and acknowledgement shall indicate: in alarm, Return to normal, Fault condition
   2. Allow a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: fire, HVAC
   3. Provide timed (schedule) routing of alarms by class, object, group, or node.
   4. Provide alarms from "runtime" and/or event counts for equipment maintenance.
   5. Controller and network failures shall be treated as alarms and annunciated.
   6. Show acknowledge time, date, and user who issued acknowledgement.
   7. Number of occurrences since last acknowledgement.
   8. Provide a "query" feature to allow review of specific alarms by user defined parameters.
   9. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided.
   10. Users shall have the ability to inhibit alarm reporting for each point. User shall also be able to define conditions under which point changes need to be acknowledged by an operator and/or logged for analysis at a later date.
   11. Provide the ability to route and email alarms based on Day of week, Time of day, Recipient. Show Graphic with flashing alarm object(s), Location (building, floor, zone, office number, etc.), Equipment (air handler #, access way, etc.)

E. LOGGING AND BACKUP CAPABILITY:
   1. All log data shall be available as HTML, XML, Plain Text., Comma or tab separated values, PDF
   2. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) for review by the user.
   3. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
   4. Archive log data locally and/or on server frequently and automatically
   5. A Audit Log that tracks all activities performed on the NAC. For each log entry, provide the Time and date, User ID and Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
   6. The database shall be backed up frequently. Copies of the current database and, at the most recently saved database shall be stored in the NAC.

F. TRENDING:
   1. Measured and calculated analog and binary data shall be assignable to user definable trends for the purpose of collecting operator specified performance data over extended periods of time.
   2. Sample intervals of 1 minute to 24 hoursshall be provided. Data shall be stored at the supervisory controller and frequently up-loaded to the server.

G. GRAPHICS: The graphic shall provide a geographical overview of the multiple-site buildings.
   1. All points shall be displayed including but not limited to the actual value, set-value and alarms.
   2. Log of each value shall be accessible from the read value on display. All values shall be logged.
   3. The graphic shall provide an accurate dimensional layout of the building floor(s); including all rooms, room numbers, walls, elevators, doors, entrances, hallways, and stairwells. Room numbering and naming conventions shall be provided by the architect/engineer.
   4. Display and animate systems as 3-D objects including all sensors, heat exchangers, heating and cooling coils, dampers, piping and pumps, humidifiers, flow directions, safety devices, and limit devices with fan, pump, damper, and valves.
   5. For each device and zone the set point and actual value shall be displayed
   6. The desired mode (i.e. winter occupied) shall be displayed
   7. Temporary Override shall have a drop-down menu and provide timed override to allow automatic fall-back of overridden value. Time intervals shall be 1-hour (default), 2 hours, 4-hours, 24 hours, 48 hours, and permanent.

H. ENERGY MANAGEMENT:
   1. Current electric power draw of devices shall be totaled and displayed including data of sub-meters, VFD-data and other device-data. Categorize in system types (i.e. chiller system). In addition, display:
      a. Peak demand, with date and time stamp
      b. 24-hour demand log
      c. Accumulated KWH and therms for day
      d. Sunday through Saturday KWH and therm usage
      e. Demand KW annual history for past 12 periods
      f. KWH and therm annual history for past periods
   2. Heating degree days and heating fuel consumption comparison will be logged and a relationship developed. Based on this, an indication in if the building performs as expected will be derived.
   3. If shown elsewhere contractor shall arrange with the project electric utility for providing an isolation relay at the service meter to allow independent pulse signals to be monitored by the DDC control system for electric utility KWH power usage, natural gas usage, and peak KW demand. Owner will pay for utility fee, contractor shall pay for isolation relay and associated wiring and provide power to meter as required.

I. The Owner shall be the named license holder of all software associated with any and all incremental work. In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, BAS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

J. POINTS:
   1. Analog Points shall allow linear input and output of 2-10V. Other voltage ranges are acceptable if specific device cannot use 2-10V. 4-20 mA is acceptable if 2-10V not available.
   2. Digital Points shall allow 24VAC input and output

### 1.6. WARRANTY

A. VFD: Manufacturer warrants that Variable Frequency Drives, AC VFD Panels and Harmonic Filters, Soft Starters and their options to be free from defects in material and workmanship for 18 months from date of shipment.

## PART 2 - PRODUCTS

### 2.1. TEMPERATURE SENSORS

A. SPACE TEMPERATURE WALL MODULE: Temperature sensing modules mounted on the wall in occupied spaces.
   1. Manufacturers: Honeywell
   2. User Adjustable: TR 71
   3. Not adjustable in finished spaces: TR23
   4. Not adjustable unfinished spaces: C7772
      a. Refer to thermsotat schedule. Typically garages, shops, storages and similar rooms.

b. In wet areas seal sensor.
5. Wall module shall have a thermistor temperature sensor with operating range of 25 to 99 °F designed for mounting on a standard electrical switch box. Accuracy shall be +/- 0.5 °F at 77 °F.
6. Where specified, wall module shall also have an after-hours override pushbutton and LED override indicator.

B. MECHANICAL THERMOSTAT:
1. Manufacturer: honeywell
2. Select heating or cooling only type based on application
3. Install an electronic thermostat next to mechanical thermostat to MONITOR space temperature and provide alarms.

C. DUCT MOUNT, PIPE MOUNT, AND OUTSIDE AIR TEMPERATURE SENSORS:
1. Manufacturers: Alerton, ACI, Honeywell, Johnson Controls, Novar, Siemens Building Technologies, Trend
2. 20kΩ
3. Outside air sensors shall include an integral sun shield.
4. Temperature sensors shall have an accuracy of plus or minus 1.0 °F over the entire operating range.
5. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths.
6. PIPE SENSOR:
a. separable well same size and type as for Thermometers.
b. Basis of Design: ACI A/20K-INW-2.5”-BB
c. Use 4X option in areas rated as wet location. Refer to electrical plans.

D. TEMPERATURE LIMIT SWITCHES:
1. Manufacturers: Honeywell, Johnson Controls, Siemens Building Technologies, TAC
2. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.
a. Low Limit Setpoint shall be adjustable between 20 and 60 °F. (-5 and 15 °C.)
b. Ambient Temperature range -20 to 125 °F. (-11 to 52 °C.)
3. Safety high limit (fire stats) shall be manual reset type.
a. High Limit Setpoint shall be adjustable between 100 and 240 °F. (38 and 116 °C.)
b. Ambient Temperature range -20 to 190 °F. (-28 to 88 °C.) at case, and 350 °F (177 °C.) at the sensor.

E. LOCATION:
1. Temperature sensors shall be placed to obtain a representative temperature value. Fluid dead spots shall be avoided. Coordinate exact location with engineer.
2. Coil discharge sensor: Locate sensor in center of cross-section of coil. Mount sensor in reasonable distance to coil to allow an average temperature reading. Sensor shall be sufficiently far away from downstream mixing boxes (e.g. outside air cooling coil stream before it mixes with return air) in order to not be influenced by mixed-in fluid.

**2.2. PRESSURE SENSORS AND SWITCHES**

B. MANUFACTURERS: ACI, Honeywell, RIB, Inc., Veris Industries
C. SENSING RANGE: 2 times of expected pressure.
D. Operating Temperature 5-104 °F ( -15 – 40°C), Operating Humidity 0-95% non-condensing
E. PRESSURE SWITCHES: operates when the pressure exceeds the adjustable trip point. Integral LED for trip indication.
F. PRESSURE SENSORS: Solid state, split core linear current sensors shall be provided where specified.
1. Scale sensors so that average operating current is between 20-80% full scale.
2. Accuracy plus or minus 1.0% (5-100% full scale)
G. WET PRESSURE DIFFERENTIAL SENSORS:
1. Basis of Design: ACI WPR2
2. Unid-directional
3. LCD display

**2.3. CURRENT SENSORS AND SWITCHES**

A. MANUFACTURERS: ACI, Honeywell, RIB, Inc., Veris Industries
B. SENSING RANGE: 2 times of expected current.
C. Operating Temperature 5-104 °F ( -15 – 40°C), Operating Humidity 0-95% non-condensing
H. CURRENT SWITCHES: operates when the current exceeds the adjustable trip point. Integral LED for trip indication.
D. CURRENT SENSORS: Solid state, split core linear current sensors shall be provided where specified.
1. Scale sensors so that average operating current is between 20-80% full scale.
2. Accuracy plus or minus 1.0% (5-100% full scale)

**2.4. FLOW MEASURING DEVICES**

A. AIR FLOW:
1. BASIS OF DESIGN: Accutrol
2. Vortek airflow device:
3. Probe Sensor Density per manufacturer recommendation.
4. Airflow Sensor Accuracy: ±2% of reading
5. Calibrated Range: 0-5000 FPM for duct applications
6. Temperature Sensor Accuracy: ±0.15°F
7. Temperature: -20°F to +140°F
8. Relative Humidity: 0 to 95% (non-condensing)

9. Provide access panels for cleaning of screen and probe.
10. If a suitable duct location cannot be found, a fan-inlet flowstation can be used upon approval by engineer. Basis of Design: Electra Flo FI series

B. WATER FLOW:
1. Manufacturer: Onicon
2. Hot-swap with ballvalve and hot-tap installation kit
3. Calibrate for expected design flow
4. Pipe sizes <= 2":
   a. Ultrasonic type F4600 series
   b. Accuracy 2% at 100:1 turndown
   c. Install flanged shut-off valves for replacement.
5. Pipe size >= 1.25":
   a. Electromagnetic Type F3500 series
   b. Accuracy 1% at 2-20 ft/s
   c. Minimums Flow: 0.1 ft/s
6. Install in design pipe size (no transition to smaller pipe excepted). Install in vertical or horizontal straight pipe with 20 pipe diameters straight pipe upstream and 5 pipe diameters downstream.

**2.5. GAS SENSORS**

A. MANUFACTURERS: ACI, Honeywell, TelAire, Vaisala
B. Sensor shall have an LCD display that displays the sensor reading and status.
C. Drift: <5% per year
D. Sensor Lifespan: > 4 years
E. Sensor element shall be replaceable
F. Temperature Range: -4°F - 122°F
G. CO2 SENSORS:
1. Carbon Dioxide sensors shall, with employ corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting. Utilize non-dispersive infrared (NDIR) technology.
2. Internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 25 PPM accuracy at full scale.

H. CO/NO2 SENSORS:
1. Accuracy: 2%
2. Basis of Design: ACI Q5

I. O2 SENSORS:
1. Accuracy: 0.1%

J. REFRIGERANT:
1. Accuracy: nearest ppm

K. Select number required and locations based on manufacturer placing requirements. Typically the entire room requires coverage.

**2.6. HUMIDITY, DEWPOINT AND ENTHALPY SENSORS**

A. Provide temperature, humidity, enthalpy, dewpoint and calculate all 4 values based on two measured values
B. MANUFACTURER: ACI, Kele, Honeywell, Siemens Building Technologies
C. HUMIDITY: +/- 3% between 20-95% RH NIST traceable calibration
D. DRY BULB: +/- 0.5°f
E. ENTHALPY: +/- 2 btu/lb
F. DEW POINT: +/- 1.8°F

**2.7. MOTION, DOOR AND WINDOW SENSORS**

A. Motion Sensors:
1. Manufacturers: WattStopper
2. Adjustable time-delay (standard set to 30 seconds)
3. Finished spaces: CI-200
4. Unfinished and large spaces: CX-100
5. Isolated relay rating 1A @ 24VDC, 0.5A @ 120V
6. Warranty 5 years

B. Overhead Door Sensor:
1. Manufacturer: GE 2315 series; Sentrol 2300 series

C. Window and Door Sensor:
1. Manufacturer: Honeywell 943WG
2. Color to match frame

**2.8. ACTUATORS**

A. MANUFACTURERS: Belimo, Honeywell
B. Size to operate loads with sufficient reserve power to provide smooth modulating or two-position action and tight close-off.

C. On/Off actuators shall include 2 end-switches
D. Modulating Actuators shall provide feedback and allow automatic calibration. Floating control is not acceptable.
E. Field-reversible spring return shall be provided on actuators scheduled to fail on open or closed position.
F. Manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action. Upon power restoration after gear lock, normal operation shall automatically recur.
G. Clutch shall enable operation of controlled device without actuator activation.
H. Actuator shall be stand-alone device (e.g. not controller integrated) to allow easy replacement.

**2.9. VARIABLE FREQUENCY DRIVES**

A. Manufacturer: Danfoss FC 100 series or other Danfoss product if required for the application. Equivalent ABB devices will be accepted.
B. MOTOR PROTECTION:
   1. If lead lengths exceed 500', an LC filter shall be included
   2. If peak voltages are expected to exceed 1,000 V or rise times will be less than 2 microseconds, a dV/dt filter shall be included
   3. Include properly sized fuses in VFD
C. VFD shall measure motor torque and shall detect failures of belt or other parts downstream of VFD.
D. VFD shall communicate via BACNet all measured values to BAS.
E. The unit shall be U.L. listed, solid state, micro-processor-based with a pulse width modulated (PWM) output wave form. The VFD shall employ a full wave bridge rectifier, to prevent line notching, with DC output bus choke, capacitors to minimize the ripple of the rectified voltage to maintain near constant DC voltage. Insulated gate bipolar transistors (IGBT's) shall be employed as the output switching device.
F. PERFORMANCE:
   1. Minimum Efficiency: 92% @ 50%; 99% @ 100% speed.
   2. Power Factor: 0.95 through speed range.
   3. Power Line Noise: Voltage distortion factor of 5% or less and a line notch depth of 25% or less. FCC compliant.
   4. Ride through a momentary power outage of 15 cycles,
   5. Start into a rotating load without damage to drive components or motor,
   6. Capable of automatic restart into a rotating load after a preset, adjustable time delay following a power outage.
   7. Full load output current available from drive shall not be less than motor nameplate amperage as required by NEC.
G. FEATURES:
   1. Automatic under voltage reset with adjustable time delay.
   2. Over temperature protection.
   3. Under voltage/over voltage protection.
   4. Local speed control at the VFD
   5. Adjustable acceleration and deceleration rate to adjust time period from start to full speed and from full speed to stop
   6. Illuminated display keypad, display.
   7. Fused Disconnect
H. DIAGNOSTICS: Provide an English character display (no error codes) with indicators for Phase loss, Ground fault, Overcurrent, Over-voltage, Under-voltage, Over temperature, Overload, DC bus status, Earth ground, Emergency stop, System (component failure), Under voltage, Heat sink under temperature, Heat sink over temperature, Motor stalled, Motor over temperature, Motor under load, Cooling fan failure, Inverter bridge over temperature, Analog input control under current, Keypad failure, Other product unique monitored conditions
I. BYPASS SWITCH: Provide VFD manufacturer-supplied bypass switch
   1. Selector for "Drive", "Off", and "bypass" and indicator light for bypass mode.
   2. Tie into VFD to allow VFD to recognize mode selected
   3. VFD shall perform soft-start after bypass switches back to "Drive"

**2.10. WIRING**

A. Line Voltage Wiring shall comply with Electrical Specifications.
B. All BAS wiring in exposed locations shall be in the conduit types specified in the Project Electrical Specifications. Only wiring behind closed ceilings is allowed to be installed without conduit. Wire in plenums has to be plenum-rated and comply with ASTM E 84. All conduit shall be factory-white. All box covers shall be white and labeled "BAS". Coordinate with Division 26 conduit coloring schemes before ordering conduit.
C. LABELING: All wiring and conduit shall be labeled to show points and device they are connected to.
D. WIRE: use #18AWG or larger
   1. Size to provide at least 22V at device served under full design load unless devices require higher minimum voltage.
   2. Limit distance from transformer to controller to 30 feet (60 'total circuit length) on loads not exceeding 100 VA. If longer distances are required, lower connected load and/or increase wire size to meet above voltage drop requirement.
   3. Size wire from controller to field devices (actuators/ sensors etc.) to limit full load voltage drop to values acceptable by manufacturer of such device. Take into account lower voltage at controller from upstream voltage drop.
E. DATA WIRING: Use manufacturer's most strict recommendations for data and signal wiring. Typically use twisted pair and shielded wire. Meet the requirements of the bus-standards. Shielding shall be 100 percent type, 1.35-mil luminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.

**2.11. POWER SUPPLIES**

A. Size power supplies to not exceed capacity of connected devices design VA-rating.
B. Over current Protection: Circuit Breaker on Low-Voltage side, Fuse on Line Voltage Side sized to 200% of design Current.
C. AC POWER SUPPLIES (TRANSFORMERS):
   1. Open type. Transformers shall be installed outside cabinet to limit heat generation in cabinet.
   2. Locate transformer near supplied controller or device. Electrical contractor shall provide line voltage to the required locations.
   3. Transformer shall have ambient temperature rating of at least 140°F
   4. Dual Threaded Hub Mount to separate line and low-voltage
   5. CONNECTED LOADS UP TO 100 VA: Use one 100 VA Class 2 transformer. Basis of Design RIB TR100VA002 (120 V primary) or RIB TR100VA004 (Multi primary voltage).
   6. CONNECTED LOADS OVER 100 VA: Use 300 VA Transformer and install fuse box on low voltage side with 4A fuses limiting each line to Class 2. Basis of Design RIB TR300VA002. Install in Box.
D. DC POWER SUPPLIES:
   1. Performance:
   2. Output voltage nominally 25-V dc within 5 percent.
   3. Output current up to 100 mA.
   4. Input voltage nominally 120-VAC or 277 VAC per plans, 60 Hz.
   5. Load regulation within 0.5 percent from zero- to 100-mA load.
   6. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
   7. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

**2.12. CABINETS**

A. Provide cabinets to house controllers, power supplies and other items. Cabinets shall meet NFPA 79 requirements.
B. SIZE:
   1. Use 24”Wx36”H cabinet. Where space is an issue, and only very few controllers are used, a smaller cabinet may be permissible.
   2. Leave one spot for future upgrades. Out of 6 possible spots only a maximum of 5 should be used. If larger controlelrs are used, fewer should be installed per cabinet
   3. Add cabinets to accommodate more controllers. Larger cabinets can be used.
C. Cabinet shall have hinged door with latches.
D. Field cable shall enter through cable gland or conduit and pass through Landing strip.
E. Plans show approximate location. Coordinate location to allow efficient wiring and maintainability.

**2.13. CONTROL VALVES**

A. PRESSURE INDEPENDENT CONTROL VALVES
   1. BASIS OF DESIGN: Belimo EPIV.
   2. Valves shall be controlled by integrated flow-meter. Flow rate shall be read in BAS. Design (maximum) flowrate shall be settable in BAS without proprietary tools.
   3. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.
   4. Valves shall be tagged with Cv rating and model number.
   5. Design pressure drop: 5 psi
   6. Read and display actuator position.
B. ISOLATING AND DIVERTING VALVES
   1. BASIS OF DESIGN: Honeywell VBN2, VBN3, VBF2, VBF3, VBF50
   2. Sizes 4”and up shall be flanged.
   3. Stem: stainless-steel stems and spring loaded Teflon packing
   4. Valves shall be line size unless noted otherwise
   5. Below model numbers include standard base. Where space is restrictive, use low-profile option.
   6. Select valve with highest available Cv-value:

| Size | Min. Cv | Min Cv |
|---|---|---|
| 0.5” | 11.7 | 8 |
| 0.75” | 29 | 11 |
| 1” | 54 | 31 |
| 1.25” | 102 | 34 |
| 1.5” | 172 | 61 |
| 2” | 266 | 109 |
| 2.5” | 202 | 100 |
| 3” | 145 | 100 |
| 4” | 254 | 327 |
| 5” | 400 | 400 |
| 6” | 650 | 650 |

C. MIXING VALVES
   1. Use above Diverting valves with a Cv value to yield approximately 5 psi pressure-drop at design flow.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels.
B. Network infrastructure shall conform to published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. Number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.
C. Install all sensors and devices in dustproof and moisture-proof enclosures.

**3.2. ACCEPTANCE TESTING**

A. Perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
B. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
C. Upon successful completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner.

**3.3. OPERATOR INSTRUCTION, TRAINING**

A. Operator training of the systems shall include, but not be limited to:
   1. overall operation program, equipment functions, commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
   2. A review of the as-built drawings and O&M manuals, a walk-through of the facility to identify control panels and device locations.
   3. Every screen shall be completely discussed, allowing time for questions.
   4. The trainings will be tailored to the needs and skill-level of the trainees.
B. First Training shall take place after commissioning and startups are successfully completed and the system operates as specified.
C. Deferred On-Site Training will be conducted on-site 6 months after occupancy and consist addressing specific topics that trainees need to discuss and to answer questions concerning operation of the systems. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

**3.4. CONTROL SEQUENCES**

A. Detailed points, schematics and sequences are given elsewhere in addition to these guidelines.
B. All control points and sequences describe the overall functionality. It is the contractor's responsibility to know what equipment is required. Contractor shall coordinate with the equipment manufacturers and other contractors what options the equipment need to be ordered with. This applies to and is not limited to required Modbus, BACNET or Lon cards, and controllers that may be required to perform the appropriate control and monitoring functions. Cost of such required devices shall be part of this contract and typically be responsibility of the contractor providing the equipment.
C. OPTIMIZED START/STOP: Provide a start-stop time optimization to provide capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Stop equipment before the scheduled un-occupancy time just far enough ahead to take advantage of the building's thermal capacity.
   1. Average zone temperature may be 1°F outside deadband
   2. Actual OAT is taken into account
   3. Past days' performance is taken into account
   4. No ventilation during morning warmup or cool-down
D. ANTI-CYCLING: Prevent frequent cycling of equipment while maintaining reasonable conditions. Prevent excessive demand situations during start-ups by automatically introducing time delays between successive start commands to electrical loads.
E. DEADBANDS: shall prevent hunting of output signals and simultaneous or alternating heating and cooling.
F. LOOPS: employing PID loops and other techniques equipment shall ramp up and down to prevent over-and undershoot, cycling, discomfort and excessive wear.
G. MINIMUM SPEED: motors and other equipment shall operate at manufacturer-provided minimum speed. For example, pump minimum speed may be 25% (15Hz) and fan speed may be 20% (12 Hz) depending on manufacturer.
H. LEAD/LAG: equipment to lead/lag shall switch lead device once a month on a Tuesday or Wednesday morning. Upon failure of lead equipment or it not being able to achieve a given setpoint for a period of time, the lag equipment shall be activated automatically. Time settings to fail over shall be set to avoid lag equipment operation if lead equipment is functional.
I. INTERLOCKS: equipment requiring action of another equipment before activation shall be interlocked to prevent such device to operate before that required device operates. Examples include fans requiring dampers to open.
J. SCHEDULING: per owner, provide adjustable schedule for equipment and systems to schedule setpoints, equipment operation etc. Typically, there will be occupied and unoccupied setpoints and ventilation only during occupied time.
K. FILTER ALARM: Measure pressure drop over filter, display dP, and allow user to set an alarm threshold.
L. LOAD SHEDDING: If shown elsewhere, provide a demand-limiting object that is capable of controlling demand for any selected energy type. Monitor a demand value and predict the demand at the end of the user defined interval period. Upon a prediction that demand will exceed the demand limit, issue shed commands to either turn off user specified loads or modify equipment set points to shed load. Equipment will be shut off or limited based on priority list. Allow selection of priorities, rotation, and maximum/minimum shed

times. Upon suitable demand reduction, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed.

M. CONSTANT SPEED MOTORS: Energize motor upon demand and measure current. Provide alarm when motor current is outside user adjustable parameter for minimum and maximum current.

N. VARIABLE SPEED MOTOR: Enable and adjust speed to meet the setpoint via VFD (AC) or inverter (DC). Read out and display all available data including but not limited to current, torque, speed, failure, status etc.

O. ANALOG ACTUATOR: modulate to meet setpoint. Provide alarm when feedback signal deviates by a user-adjustable %

P. DIGITAL ACTUATOR: Activate to open or close and provide alarm when endswitch doesn't activate as required.

Q. FAN AND PUMP CONTROL: Modulate motor speed to meet the measured value (pressure and/or flow)

R. SCHEDULES: Allow operators to set a schedule. Tie schedules to owner's holiday schedule to allow enabling or disabling based on time of day, and type of day (weekday, weekend and holidays)

**END OF SECTION**

# SECTION 23 11 00
# FACILITY FUEL PIPING



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to fuel systems for facilities equipment, heating, plumbing and combustion engines.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. ANSI – American National Standards Institute
   1. ANSI B16.3 Malleable Iron Threaded Fittings
   2. ANSI B31.9 Pipe Material Requirements
C. ASTM - American Society for Testing and Materials
   1. ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
   2. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
D. NFPA - National Fire Protection Association
   1. NFPA 54 National Fuel Gas Code

### 1.3. SUBMITTALS

A. Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.
B. TYPE E OR S STEEL PIPE: Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stenciled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.
C. TYPE F STEEL PIPE: Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

### 1.4. QUALITY ASSURANCE

A. Install gas pressure gauges at downstream of gas pressure regulators.
B. Comply with NFPA 54
C. Copper is not allowed due to potential hydrogen sulfide contamination.
D. Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.
E. Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.
F. Construct all piping, valves and piping devices for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.
G. Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.
H. Order all tube and pipe with each length marked with the name or trademark of the manufacturer and type of tube; with each shipping unit marked with the purchase order number, metal or alloy designation, temper, size, and name of supplier

## PART 2 - PRODUCTS

### 2.1. FUEL GAS PIPING

A. All items rated for natural gas applications.
B. PIPING INDOOR:
   1. < 1 psig: Schedule 40 ASTM A53, type E or S, standard weight black steel pipe with ASTM A197/ANSI B16.3 class 150 black malleable iron threaded fittings or ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
   2. > 1 psig and larger: ASTM A53, type E or S, standard weight black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.
C. EQUIPMENT CONNECTION: Steel Pipe as above or Corrugated Stainless Steel Tubing (CSST) by Ward or approved equal. Install with same-manufacturer fittings and bond per manufacturer recommendations.
   1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
   2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
   3. Corrugated stainless-steel tubing with polymer coating.
   4. Operating-Pressure Rating: 0.5 psig (3.45 kPa).

5. End Fittings: Zinc-coated steel.
6. Threaded Ends: Comply with ASME B1.20.1.
7. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance and regulator.

D. PIPING UNDERGROUND:
1. Polyethylene Iron Pipe Size Tubing (IPS) by Gastite
2. All fittings and transitions designed and recommended by pipe manufacturer.
3. Transition to steel pipe before entering building. Bury at least 24” deep.

E. CORRUGATED STAINLESS STEEL TUBING (CSST):
1. Allowed for device connection (limit to 3’ from steel pipe to device)
2. Gastite Flashshield or approved equal
3. Tubing: ASTM A240 Type 304, Annealed Stainless Steel. Minimum 0.01” wall thickness
4. Jacket: UV resistant Polyethylene complying with requirements of ASTM E84 25/50 Index for Flame and Smoke.
5. Meet ICC-ES PMG LC1027

F. SHUT-OFF VALVES:
1. 2” and smaller: Apollo 50GB with 1/8” side-tap
2. 2.5 - 3": Apollo 80-100
3. Install line size gas valve and union at each gas appliance connection upstream of regulator, Provide valved connection at main and where shown on plans.
4. Install gas pressure tap upstream.

G. Y-PATTERN STRAINERS:
1. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS
4. 1/2 (DN 65) and larger.
5. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50
6. percent free area.
7. CWP Rating: 125 psig (862 kPa).

H. EXTERIOR BELOW GRADE SHUT-OFF VALVES: Plug or ball valve, body of same polyethylene type as piping system, pipe stub ends, high strength plastic stem and operating nut, position indicator, polyethylene plug or polypropylene ball, Buna-N seats and double stem seals, rated for 96 psi natural gas service (150 psi non-lethal service).

I. GAS PRESSURE REGULATORS:
1. Ventless
2. Maxitrol 325 series or approved equal
3. Install upright to allow operation of the ball check vent limiting device
4. Provide gas pressure measurement ports up and downstream of each regulator.
5. Provide regulator with appropriate turn-down to accommodate low-fire on modulating and staging equipment.
6. Include Overpressure Protection Device for systems 2 psi and greater

J. GAS PRESSURE GAUGES:
1. Manufacturers: Kunkle, Taylor or Taylor.
2. Trerice No. 860 with 3-1/2 face, stainless steel case, bronze bushing movement, white background and black figures. On higher pressure side, scale range from 0 – 5 PSIG with 0.05 PSIG minor division. On low pressure side, scale range from 0 – 30 inch WC with 0.50 inch WC minor division.
3. Install gas pressure gauges as shown on Drawings so face is readable by a person standing at floor level.

K. DIELECTRIC FITTINGS:
1. Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   c. End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
   a. Standard: ASSE 1079.
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solderjoint copper alloy and threaded ferrous.

L. THREAD SEALANT:
1. Teflon (PTFE) based thread lubricant and Teflon tape (use both)
2. Must be listed for use with the fuel gas.
3. No hard setting pipe thread cement or caulking will be allowed.
4. Manufacturer: Blue Monster BIG PTFE Thread Seal Tape, Blue Monster Industrial Grade PTFE thread Sealant

M. FLANGES:

1. 2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.
2. 2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.
3. Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

N. LABELING AND IDENTIFYING: Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Remove all foreign material from interior and exterior of pipe and fittings.
B. Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.
C. Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.
D. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
E. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
F. Prime and paint all piping and support located exterior or in wet environments.
G. Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment
H. WELDED PIPE JOINTS:
   1. Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.
   2. Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
I. THREADED PIPE JOINT:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1. Cut threads full and clean using sharp dies.
   2. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   3. Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
   4. Apply joint compound and tape to male end and leave first 2 threads bare to prevent contamination of pipe with debris.
J. PIPING SYSTEM LEAK TESTS
   1. Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.
   2. Provide all piping, fittings, blind flanges, and equipment to perform the testing.
   3. Conduct pressure test with air at a pressure of 5 times the working pressure for 24 hours. Test will start one hour after system was pressurized and re-pressurized to allow equilibrium of temperature. For duration of test pressure shall not drop by more than 1%. Alternatively test can be performed at 10 times the working pressure for 2 hours.
   4. If leaks are found, repair the area with new materials and repeat the test. Examine all joints and connections with a non-corrosive leak detecting fluid and an electronic leak detector.
   5. Small repairs can be tested by applying non-corrosive leak detecting fluid and electronic leak detector.
K. On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Test final connection with leak-detecting fluid and electronic detector
L. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
M. Pitch horizontal piping down 1" in 60 feet in the direction of flow. Install a 4" minimum depth dirt leg at the bottom of each vertical run and at each appliance. When installing mains and branches, cap gas tight each tee or pipe end which will not be immediately extended. All branch connections to the main shall be from the top or side of the main.
N. Use only long radius elbows with having a centerline radius of 1.5 pipe diameters.
O. Piping through a roof shall be run through an approved roof penetration with flashing and counter flashing.

P. Clean all piping before all regulators and control valves. Test by placing target cloth over piping and blow with compressed air. Clean piping until target cloth is clean and free of debris.

Q. Install 6" dirt traps before regulators and devices. Pipe shall run downward vertically and Tee off to device (horizontal). Trap shall be straight end of Tee below the takeoff.

**END OF SECTION**

# SECTION 23 31 00
# HVAC DUCT AND CASINGS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to ductwork and associated equipment and applies to all sections in this Division.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
   1. 23 05 29 – HANGERS AND SUPPORT FOR HVAC PIPING AND EQUIPMENT
   2. 23 05 48 – VIBRATION AND SEISMIC CONTROL FOR HVAC
   3. 23 07 00 – HVAC INSULATION
   4. 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC
   5. 23 09 13.43 - CONTROL DAMPERS
   6. 23 37 13 – DIFFUSERS, REGISTERS AND GRILLES
   7. 23 41 00 – PARTICULATE AIR FILTRATION

B. Abbreviations of standards organizations referenced in other sections are as follows:

C. AMCA - Air Movement and Control Association
   1. AMCA 203 - AMCA Fan Application Manual - Troubleshooting
   2. AMCA 210 - Laboratory Method of Testing Fans for Rating
   3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans

D. ANSI – American National Standards Institute
   1. ANSI SS-EN 485-2 - Aluminum and Aluminum Alloys-Sheet, Strip and Plate-Part 2: Mechanical Properties

E. ARI - Air Conditioning and Refrigeration Institute
   1. ARI - ADC Standard 880

F. ASHRAE – American Sicety of Heating, Refrigeration and Air Conditioning Engineers
   1. ASHRAE - Standard 70, 113, 130

G. ASTM - American Society for Testing and Materials
   1. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
   2. ASTM A90 - Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
   3. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
   4. ASTM A623 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
   5. ASTM A527 - Specification for Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
   6. ASTM 924 - Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method
   7. ASTM C 1071 - Specification for Fibrous Glass Duct Lining Insulation
   8. ASTM C 411 - Test Method for Hot Surface Performance of High Temperature Thermal Insulation
   9. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials
   10. ASTM C 1338 - Test Method for Determining Fungal Resistance of Insulation Materials and Facings

11. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
12. ASTM C 916 - Standard Specification for Adhesives for Duct Thermal Insulation

H. NAIMA – North American Insulation Manufacturers Association
   1. NAIMA - Fibrous Glass Duct Liner Standard

I. NFPA - National Fire Protection Association
   1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems
   2. NFPA 80 - Fire Doors & Other Opening Protectives
   3. NFPA 101 – Life Safety Code.

J. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
   1. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

K. UL – Underwriters Laboratory
   1. UL 181 - Standard for Safety for Factory Made Air Ducts and Air Connectors.
   2. UL 214 - Standard Test for Flame Propagation of Fabrics and Films
   3. UL 705 - Underwriters Laboratory for emergency smoke control systems
   4. UL 762 - Underwriters Laboratory for restaurant grease exhaust
   5. UL 555 - Standard for Fire Dampers and Ceiling Dampers
   6. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems

**1.3. SUBMITTALS**

A. All submittal requirements listed elsewhere in this contract.
B. Fabrication and installation drawings inc. floor plans, sections and 3D-views.
C. Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
D. Duct sealant and gasket material.
E. Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.
F. Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.
G. Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.
H. Submit manufacturer's color charts where finish color is specified to be selected by the Architect/Engineer.

**1.4. QUALITY ASSURANCE**

A. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.
B. Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:
   1. HVAC Duct Construction Standards, Metal and Flexible, Newest Edition
   2. HVAC Air Duct Leakage Test Manual, Newest Edition
   3. HVAC Systems - Duct Design, Newest Edition
   4. Rectangular Industrial Duct Construction Standard, Newest Edition
   5. Round Industrial Duct Construction Standards, Newest Edition
   6. Thermoplastic Duct (PVC) Construction Manual, Newest Edition
C. Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.
D. Where inlet and outlet ductwork is field modified from that shown on Drawings, Adjust all required fans, motor, drive and wiring required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.
E. Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.

**1.5. PERFORMANCE REQUIREMENTS**

A. All duct design and installation is based on SMACNA “HVAC Duct Construction Standards” ANSI/SMACNA 006-2006.
B. Refer to plans for duct pressure classification. If no duct pressure classifications are given, design for the following pressures:
   1. Main supply trunk up to Variable Air Volume devices or balancing dampers (in constant volume systems): + 4” w.c.
   2. Main supply trunk without dampers and control (i.e. MAU direct discharge): + 2”w.c.
   3. Duct downstream of above VAV or balancing dampers: + 1” w.c.
   4. Return or exhaust duct: - 2”w.c.
   5. Transfer ducts: +/- 1” w.c.
C. Seal all duct regardless of pressure class in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.
D. Leakage Classes shall be:
   1. Round and Oval Duct Duct: 2
   2. Rectangular Duct: 4
E. Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.
F. Ductsizes indicated and calculated pressuredrops are based on using the below low-pressure design criteria. Plans may or may not indicate the specific type of fitting and transition. For all fittings and transitions the available type with lowest pressure drop shall be used. Upon approval by engineer contractor may use large ductsizes to make up for deficiencies in use of low-loss fittings and transitions.
G. FITTINGS: Types are listed in order of priority. If the more efficient type is not available in the size, use next type in list upon approval by engineer. Refer to SMACNA HVAC systems duct Design appendix a for details. Fittings not listed shall follow the overall idea of low pressure drop.

1. OFFSETS AND TRANSITIONS: 15°
2. ROND FITTINGS (and oval as applicable):
    a. ELBOW: R/D >=2; Die-stamped for available sizes (typically up to 14”); 7 (or more if available) piece gored for larger sizes.
    b. TEE: Two 90° elbows meeting above requirements
        i. BRANCH TAKEOFF: ASHRAE SD5-12 Lo-Loss Fitting; Conical wye (<=45° to main)
3. RECTANGUALR FITTINGS:
    a. ELBOW: R/W >=2: Smaller R/W allowed. If R/W>= 1 use splitter vanes per SMACNA Duct Design guidelines; Mitered Elbow with turning vanes
    b. TEE: WYE, Dovetail: R/W >= 2; 90° elbows meeting above elbow criteria; Turning Vanes
    c. BRANCH TAKEOFF:
        i. Rectangular: Large Radius Wye; Tee 45° to 90° Branch.
        ii. Round: Lo-Loss fitting (s. round fittings); WYE: 15°: larger angels allowed if space requires.

H. OBSTACLES: Transitions to run duct around obstacles cannot reduce cross-sectional area. If space allows cross-sectional area shall be increased by 20%. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Pipes or similar obstructions may not pass through any ductwork.

## PART 2 - PRODUCTS

### 2.1. DUCTWORK

A. MANUFACTURER: Ajax, Semco, United Sheet Metal, Sheet Metal Connectors or approved equal

B. Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.

C. GALVANIZED STEEL SHEET: Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide “Paint Grip” finish or galvanneal sheetmetal for ductwork that will be painted. Unless noted otherwise, use this for all ducts.

D. ALUMINUM SHEET: Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture. 22 gauge or heavier. Button punch snaplock construction will not be accepted on aluminum ductwork.

E. STAINLESS STEEL SHEET: Use ASTM A167, Type 304 or 316 stainless steel sheet as specified, 316L if welded ductwork, with No. 2B finish for concealed work and No. 3 finish for exposed work.

F. POLYVINYLCHLORIDE COATED STEEL SHEET:
1. Use hot-dipped galvanized steel sheet with prime coat and a polyvinyl chloride film on both sides. Thickness of coating to be a minimum of 4 mils on each side.
2. Where any duct surface is scratched, marred, or otherwise damaged, paint with PVC aerosol spray.
3. All couplings shall be slip-joint construction with a minimum 2 inches insertion length. Seal all couplings with sealants as specified.

G. TURNING VANES:
1. Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.
2. Construct turning vanes and runners in accordance with SMACNA. Use only airfoil type vane as shown in figure 4-3

H. FLEXIBLE DUCT:
1. Basis of Design: THERMAFLEX M-KE
2. Use for all flexible duct applications
3. Underwriters Laboratories listed as Class 1 air duct, UL Standard 181 and CUL S110. Compliant with NFPA 90A and B.
4. Flame spread <25; smoke developed <50
5. Perm rating of 0.05
6. GREENGUARD Level 4 highly microbial resistant
7. R 4.2 Insulation where installed in space conditioned similar to space served (inc. above the ceiling of the space served). R8 if installed in in spaces conditioned more than 5°F (for either heating or cooling) different than space served.
8. Length shall be no greater than 3’ and have no more than one 90° bend of a radius of at least 2 duct diameters.
9. Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.

### 2.2. KITCHEN HOOD EXHAUST DUCT CONSTRUCTION

A. Furnish double wall, factory built, insulated grease duct which conforms to requirements of NFPA-96. Products shall be listed by BOCA Evaluation Services and by SBCCI PST & ESI as a 2-hour fire rated assembly with 0” clearance to combustibles for installation in multi-story buildings without fire-rated enclosure when penetrations of fire-rated partitions are firestopped with Model PICPPK Firestop.

B. Inner wall shall be 20 gauge Type 304 (316) stainless steel. Outer wall shall be aluminized steel. Grease duct shall incorporate 4” of high temperature ceramic fiber insulation between inner and outer wall.

C. Safety and Professional Services SPS 364/IMC 506.3.4 requires that duct systems serving Type 1 grease hoods be sized to provide a duct air velocity of not less than 500 fpm. Size ductwork accordingly.

D. In concealed locations use minimum 16 gauge black steel or minimum 18 gauge stainless steel with all joints welded liquid tight or prefabricated grease duct, Underwriters Laboratory, Inc listed with aluminized steel shell

E. Factory prefabricated duct may still require a 2-hr fire rated enclosure or fire stop insulation where concealed and serving a Type I hood (grease vapors or smoke). As of the date of the updated version of this specification section, grease duct manufacturers do not have a product that is Ul listed for grease vapor and smoke application.

F. In exposed areas, use 18 gauge or heavier stainless steel with a number 3 finish and with all joints welded liquid tight or prefabricated Underwriters Laboratory, Inc listed duct with stainless steel shell. Grind and polish all welded joints and seams to a number 3 finish.
G. Provide expanded take-offs for branch duct connections or 45 degree entry fittings. Square edge 90 degree take-off fittings or straight taps will not be accepted.
H. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits shall be used wherever possible. Shorter radius elbows may be used in areas with limited space with prior approval of the Architect/Engineer.
I. No turning vanes may be used in kitchen exhaust duct.
J. Supporting steel and hangers shall not be lighter than the duct gauge.
K. Where welded joints are used with black steel duct, coat all external welded joints and seams with paint. Grind and polish to #3 finish all exposed stainless steel joints and seams.
L. Apply bracing and reinforcement to the outside of the duct to prevent breathing, rattling, vibration or sagging of duct.
M. Install without forming dips, sag or traps which might collect residue by supporting at not greater than 5 foot intervals; fasteners at hangers shall not penetrate the duct. Do not use sheet metal screws on supports; use bolted, riveted or welded connections. Where ductwork is listed, install in accordance with listing.
N. Construct grease tight access doors of the same material and thickness as the duct and as large as possible, up to 24 inches in any dimension. Locate on duct sides for ease of inspection and cleaning at each change in direction, not less than every 10 lineal feet of duct, including risers, and not less than 1-1/2 inches from the bottom of the duct.
O. Insulation or fire protection enclosure shall be removable at each access door and clean out.
P. Pitch horizontal ducts back to hood at 1 inch per foot.

**2.3. DISHWASHER EXHAUST DUCT CONSTRUCTION**

A. Use 18 gauge or heavier stainless steel with all seams and joints welded and ground smooth. In exposed areas, joints and seams to be polished to a #3 finish (minimum).
B. Use elbows and tees as specified for the appropriate duct pressure class.
C. Provide expanded take-offs for branch duct connections or 45 degree entry fittings. Square edge 90 degree take-off fittings or straight taps will not be accepted.
D. Provide water tight drain pan at low points or at locations where moisture may collect. Pipe drain pan to nearest floor drain.
E. Pitch duct to drain back to equipment or exhaust grille.

**2.4. EXHAUST DUCT FOR MOISTURE LADEN AIR**

A. The following is a non-exhaustive list of moisture laden air:
   1. Shower Rooms
   2. Cloth dryers
B. Exhaust ducts conveying moisture laden air, other than dishwasher exhaust, construct to same standards as Dishwasher Exhaust Duct except:
   1. Construct of sheet aluminum in accordance with SMACNA standards.
   2. Seal all joints and seams watertight

**2.5. FUME EXHAUST DUCT CONSTRUCTION**

A. Select appropriate materials from among the following items:
   1. Use PVC coated steel or stainless steel duct and fittings. Use stainless steel for all exposed installations below suspended ceilings.
   2. Use 316 stainless steel for flanged gasketed connections.
   3. Use 18 gauge or heavier 316L stainless steel sheet for externally welded ductwork. Grind and polish joints and seams to a #3 finish minimum.
   4. Exhaust terminal duct assembly shall be constructed from a minimum of 24 gauge stainless steel and damper blade constructed from a minimum of 22 gauge stainless steel.
   5. Stainless steel damper blade shall be mounted to a stainless steel shaft having self-lubricated bearings. Shaft end shall be marked to indicate damper position and shall have a built-in stop to prevent over stroking. Damper blade shall close off against a butyl gasket to limit leakage to 10 cfm at 6.0 inches of differential static pressure. Damper linkage shall be sized to accept at least 40 inch-pounds of torque to the damper shaft. Damper shaft shall be provided with a marking indicating damper position.
B. For all rectangular duct and round duct 36 inch diameter and larger, apply a bead of PCD sealant at the corrosive side of the gasket. For round duct less than 36-inch diameter, use slip coupling connection sealed with PCD sealant.
C. Apply duct sealer on male end connectors before insertion, and afterwards to cover the entire joint.
D. Use 316 stainless steel fasteners to provide mechanical strength at all couplings; galvanized mechanical fasteners will not be accepted. Maximum screw spacing shall be 12 inches o. c. with a minimum of 3 equally spaced screws per joint. Do not locate screws, rivets, or bolts on the bottom of the duct. Condensation can form in some fume exhaust systems. Since the fumes being conveyed can be very corrosive, the condensation would be more likely to leak at a fastener location on the bottom of the duct. Fasteners are acceptable "near" the bottom but should never be located at the six o'clock position.
E. Repair any damage to the PVC coating with a PVC aerosol spray or similar PVC product as soon as installation of the piece with a damaged coating is completed.

**2.6. DUST COLLECTION EXHAUST DUCT**

A. Use material thickness and reinforcements for the static pressure classification and duct system classification specified.
B. Provide (partial/complete) penetration welds at all seams and joints.
C. All flanged connections shall be gasketed. Caulking is not allowed.
D. All flanges and stiffeners will be of compatible material to that of the attached ductwork.
E. Provide access doors and clean out doors where necessary for routine maintenance and replacement of parts or inspection of items concealed in the ductwork. Construct access and cleanout doors of the same material and thickness as the duct. Size as large as possible, up to 0.5 times the diameter of the ductwork, as measured along its circumference and a maximum of 24 inches. Locate on

duct sides for ease of inspection and cleaning at each change in direction, at junctions with vertical ducts, and at devices requiring periodic inspection and maintenance. Locate not less than every 10 lineal feet of duct, including risers. Removable caps may be installed at termination ends on ducts less than 12 inch in diameter.

**2.7. DUCT SEALANT**

A. Manufacturer: 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal. Silicone sealants are not allowed in any type of ductwork installation.

B. Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

**2.8. ACCESS DOORS**

A. BASIS OF DESIGN: Ductmate FD-H-GA and DR-GA, Kees ADL-R,
   1. Acceptable substitute manufacturers subject to meeting all requirements: AJ (www.ajdoor.com)

B. Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Piano hinged style access doors shall be installed with the piano hinges located ½ above the bottom of the duct to allow the access door to swing down toward the floor. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted. Access doors shall be sealed with ¼" closed cell butyl gasketing permanently bonded on all four sides and no fewer than two draw latches with strike plates. The strike plates shall match the duct/access door material. The bolts and springs shall be constructed from the same material as the access door. The knobs shall be constructed from polypropylene with threaded metal inserts and able to be fastened without the use of wrenches.

C. Use insulated, 1-1/2 hour UL 1978 listed and labeled access doors in kitchen exhaust ducts.

D. For duct pressure class positive or negative up to 10 in. wg. Access doors shall be the sandwich type and constructed from two layers of stamped 22 gauge stainless steel for fume exhaust ducts and 22 gauge galvanized steel for general or return ducts.

E. Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.

F. Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, or as large as square of duct-with minus 2", whichever is greater. Maximum size typically is 18"x18". Should the scheduled access door not physically fit provide equivalent opening approved by engineer at no cost to owner.

G. Install access doors near fire-and smoke dampers, both inlet and outlet sides of reheat coils as well as other duct mounted coils and devices requiring service. Install in location that allows easy maintenance of the device. Plans may indicate location and size, but contractor shall increase size and adjust location if actual field situation requires for good access.

H. Man Access Door: Kees AD2-K. thickness to be thickness of adjacent insulation or thicker. Provide supporting frame.

**2.9. DUCT LINING**

A. Manufacturer: Manville, Owens-Corning, Knauf, Titus or approved equal.

B. 1 inch thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.

C. Meet erosion and mold growth testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250 deg F. ASTM E84 flame spread less than 25 and smoke developed less than 50.

D. Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.

E. Install liner using adhesive conforming to ASTM C 916.

F. Do not apply lining to the following ductwork:
   1. Outside air ductwork.
   2. Kitchen exhaust ductwork.
   3. Dishwashing exhaust ductwork.
   4. Shower exhaust ductwork.
   5. Pool ventilation ductwork.
   6. Supply, return and exhaust ductwork associated with shop ventilation systems where air handling units are located in the shops.
   7. Fume hood exhaust ductwork.

G. Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

**2.10. DUCT PRESSURE RELIEF DOORS**

A. Install wherever fan is able to create pressure 0.5"w.c. above (or -0.5"w.c. on suction side) the associated pressure class at 0 airflow. Size per manufacturer recommendations for that fan.

B. MANUFACTURER: Greenheck PRAD (positive) or VRAD (negative)

C. Construct with 12 gage galvanized [stainless] steel frame and hinged door with polyurethane or neoprene gasket. Provide springs to automatically return door to closed position when pressure is relieved. Provide with release mechanism, springs and parts out of the air stream. Provide sizes and pressure settings as indicated on the drawings.

**2.11. FIRE AND SMOKE DAMPERS**

A. FIRE DAMPERS:
   1. BASIS OF DESIGN:
      a. 1.5 hour: Greenheck DFDAF (airfoil) and DFDR Dynamic rated
      b. 3 hour: Greenheck DFDAF (airfoil)
   2. Dampers shall meet requirements for fire dampers in accordance with:
      a. NFPA 80, 90A and 101.
      b. CSFM Fire (Dynamic) Damper Listing #3225-0981:103.
      c. New York City MEA Listing 260-91-M Vol.III.
      d. Dampers shall be tested, rated, and labeled in accordance with:
      e. UL 555 (Seventh Edition), Listing R13317
   3. Damper blades must be 100% out of air stream; dampers with blades in air stream will not be accepted. Damper fire rating to be compatible with rating of building surface in which damper is used.
   4. Damper shall resist differential pressure per UL 555 of 4 in. w.c.or as noted on plans
   5. Dampers shall have minimum UL 555 velocity rating of 2,000 fpm or 3,000 fpm for dampers larger than 30”x30” or as noted on plans.
   6. Provide fusible link at 165°F rating or as noted on plans.
   7. Provide closure springs and latches for horizontal damper installations.
   8. Fire dampers installed in stainless steel or aluminum duct systems shall be constructed of stainless steel.
   9. Factory provided integral damper sleeves are not acceptable. Install damper sleeves with retaining angles on both sides of rated partition. Connections of ductwork to fire damper assemblies to be as specified on the installation instructions. Where it is necessary to set dampers out from the rated wall, install a sleeve extension encased in two hour rated fire proofing insulation. Install an access door at each fire damper, located to permit resetting the damper replacing the fusible link.
   10. Manually test each fire damper for proper operation by removing the fusible link. Repair or replace any fire damper that does not close completely. Re-install fusible link after test.

B. SMOKE DAMPERS:
   1. BASIS OF DESIGN: Greenehck SMD and SMDR
   2. Dampers shall meet requirements for smoke dampers in accordance with:
      a. NFPA 92A, 92B, and 105.
      b. CSFM Leakage (Smoke) Damper Listing.
      c. New York City MEA Listing 260-91-M Vol. III.
      d. Applicable Building Codes.
      e. UL 555S (Fourth Edition), Listing R13317
      f. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance in accordance with AMCA 511.
   3. Unless ratings are indicated elsewhere, dampers should be rated for minimum 2,000 fpm air velocity and 4” static pressure.
   4. Damper shall have UL555S leakage rating of Class I unless noted differently on plans.
   5. Dampers shall have UL555S elevated temperature of 250°F unless noted differently on plans.
   6. Dampers shall have minimum UL 555S velocity rating of 2,000 fpm and 3,000 fpm for sizes 30”x30” or larger unless noted differently on plans.
   7. Provide 2-Posiion 24VAC actuator
   8. Provide Momentary Testswitch for local testing
   9. Provide no-flow smoke detector for velocities below 3,000 fpm or detector for higher velocities if required. Provide access door.
   10. Install connections to electric actuators.

C. COMBINATION FIRE/SMOKE DAMPERS
   1. BASIS OF DESIGN: Greenheck FSD
   2. Meet all requirements listed under Fire and Smoke Dampers.
   3. Install dampers in accordance with manufacturer’s UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer’s UL Installation Instructions must be approved prior to installation.

D. Install dampers in accordance with manufacturer’s UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer’s UL Installation Instructions must be approved prior to installation.

E. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

F. Install dampers square and free from racking.

G. Provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

H. Do not compress or stretch the damper frame into the duct or opening.

I. Attach multiple damper section assemblies together in accordance with manufacturer’s instructions. Install support mullions as reinforcement between assemblies as required.

J. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

K. Attach multiple damper section assemblies together in accordance with manufacturer’s instructions. Install support mullions as reinforcement between assemblies as required.

L. Provide Quick-Connect universal breakaway

**2.12. BALANCE DAMPERS**

A. BASIS OF DESIGN: Greenheck MBD and MBDR
   1. Subject to meeting all requirements contractor shall shop-fabricate sizes not available from manufacturer
B. FRAME AND SLEEVE: The damper frame and sleeve shall be of one-piece design, made with 20 ga. galvanized steel and a groove for added strength.
C. BLADES: Galvanized steel. 20 ga.
D. AXLES: Minimum ½ inch dia., material is plated steel.
E. BEARINGS: Axle bearings shall be synthetic (acetal) sleeve type.
F. ACTUATOR: Manual Quadrant with lever
G. Dampers must be accessible to allow inspection, adjustment, and replacement of components.
H. Install dampers square and free from racking.
I. Furnish bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
J. Do not compress or stretch the damper frame into the duct or opening.
K. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

**2.13. BACKDRAFT DAMPERS**

A. BASIS OF DESIGN: Tamco 7000 CW;
B. counterweigths adjusted per engineer's specifications

**2.14. CONTROL DAMPERS**

A. Coordinate selection and installation with Controls Contractor. Controls Contractor shall provide required pressure drop for modulating dampers. On/off dampers shall have lowest possible pressure drop.
B. Dampers shall be tested in accordance with ANSI/AMCA Standard 500-D and licensed to bear the AMCA Certified Rating Program seal for air performance and leakage in accordance with AMCA publication 511.
C. BASIS OF DESIGN:
   1. Insulated Dampers:
      a. Tamco 9000 BF-ECT series (thermally broken frame and silicone seal); flanged installation
      b. Install where damper closes off to outdoor air
   2. Low-Leakage Dampers:
      a. Tamco Series 1500
      b. Install where systems get separated during operation
   3. Standard Dampers: Tamco Series 1000
      a. Install where mixing of systems occurs
D. Combine dampers for duct larger than maximum damper size. Adjust duct aspect ratio if needed to allow damper size. Designer shall review aspect ratio changes to ensure no added pressure-drop.
E. CONSTRUCTION:
   1. Bearings are composed of a Celcon inner bearing (fixed around a 7 /16" (11.11 mm) aluminum hexagon blade pivot pin) rotating within a polycarbonate outer bearing inserted in the frame.
   2. Adjustable 7 /16" (11.11 mm) hexagonal drive rod, U-bolt fastener, and hexagonal retaining nuts are zinc-plated steel. These provide a positive connection to blades and linkage.
   3. Aluminum and corrosion-resistant zinc-plated steel linkage hardware is installed in the frame side, complete with cup-point trunnion screws for a slip-proof grip.
   4. Flange for installation in duct.
   5. Rated for operation -40°F – 212°F. Use higher rated version for high-temp applications
F. All insulated and low-leakage control dampers shall be leakage Class 1A. Blade and frame seals are extruded silicone, for reduced air leakage at colder temperatures. Blade and frame seals are secured in an integral slot within the aluminum extrusions and are mechanically fastened to prevent shrinkage and movement over the life of the damper.
G. All dampers shall be maintenance free (except cleaning)
H. All dampers shall be produced to exact size without blank-off.
I. Dampers used for directed mixing of airstreams, i.e. outside air and return air, to be parallel blade type and blades shall be arranged so that the air streams are directed at one another to facilitate mixing.
J. Dampers used for throttling or modulating applications other than air stream mixing to be opposed blade type. Two position dampers shall be parallel blade type and shall be located far enough from coils to allow proper flow development over entire coil surface.
K. Dampers mounted with blades vertically shall be designed for vertical blade orientation.
L. Dampers at discharge of centrifugal fans shall have damper blades perpendicular to the fan shaft to minimize system effect.
M. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Use Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints

B. Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.
C. Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.
D. Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.
E. Install at least 7" above suspended ceiling
F. Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.
G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
H. Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
I. SLEEVES: Provide galvanized sheet metal sleeves for pipe or duct penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Pipe sleeves shall be schedule 40 steel pipe (sized to allow insulated pipe to run through sleeve) and duct sleeves shall be equivalent rectangular material. Provide sleeve required for fire dampers in fire-rated partitions and floors.
J. Duct penetrations shall be filled with fiberglass insulation and sealed with at least 1"foam around the duct perimeter to air-seal the penetrations. A 4"sheet metal escutcheon shall cover both sides of the penetration.
K. Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.
L. Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.
M. Install prefabricated grease ductwork assemblies in accordance with manufacturer requirements and NFPA 96.
N. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

**3.2. TESTING**

A. LEAKAGE TEST:
   1. Test all ductwork upstream of variable volume devices in accordance with test methods described in SMACNA "HVAC Air Duct Leakage Test Manual" ANSI/SMACNA 016-2012. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
   2. If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.
   3. Leakage rate shall not exceed more that 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.
   4. Submit a signed report to the Project Manager, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.
B. STRUCTURAL TEST
   1. Random test all ductwork per owner direction. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.
   2. Deflection limits shall not exceed those listed in accordance with Chapter 11 of SMACNA HVAC Duct Construction Standards, 3.0 Performance Requirements.
   3. Submit a signed report to the Division's Construction Representative, indicating test apparatus used, results of the structural test, and any remedial work required.

**END OF SECTION**

# SECTION 23 34 00
# HVAC FANS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Axial Fans.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. AMCA - Air Movement and Control Association
   1. AMCA Standard 99-10, “Standards Handbook”
   2. AMCA Standard 204-05, “Balance Quality and Vibration Levels for Fans”
   3. AMCA 203 AMCA Fan Application Manual - Troubleshooting
   4. AMCA 210 Laboratory Method of Testing Fans for Rating
   5. AMCA Publication 211-05, “Certified Ratings Program – Product Rating Manual for Fan Air Performance”
   6. AMCA 300 Reverberant Room Method for Sound Testing of Fans
   7. AMCA 311-05 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
   8. AMCA 99-0401-86 - Classification for Spark Resistant Construction
   9. AMCA 99-2408-69 - Operating Limits for Centrifugal Fans
C. ABMA – American Bearing Manufacturer Association
   1. ABMA - Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999).
A. ANSI ANSI – American National Standards Institute
   2. ANSI/AMCA 204-05 - Standard Balance Quality and Vibration Levels for Fans
   3. ANSI/AMCA 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
   4. ANSI/AMCA 500-D-12, "Laboratory Methods of Testing Dampers for Rating"
D. OSHA – Occupational Safety and Health Administration
   1. OSHA guideline 1910.212 – General requirements for Machine Guarding. (www.osha.gov)
   2. OSHA guideline 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus.
   3. OSHA guideline 1926.300 – General requirements for safe operation and maintenance of hand and power tools.
E. UL – Underwriters Laboratory
   1. UL/cUL Standard 705, “Power Ventilators”

### 1.3. SUBMITTALS

A. Submit shop drawings including the following information: specific manufacturer and model numbers, submittal equipment identification corresponding to project drawings and schedules, unit dimensional and weight data, materials of construction, capacities and ratings, fan curves, fan type, drive and motor information, vibration isolation, coil performance data, sound power levels, filter information, information for all accessories.
B. Indicate fan class, fan performance and motor electrical characteristics. Provide fan curves with specified operating point clearly plotted. Include efficiency data for the design airflows, drive loss and bhp.
C. Provide calculated 8 octave maximum sound power levels at unit discharge and return connections, and maximum casing radiated sound power levels.
D. Mounting and vibration isolation details

### 1.4. QUALITY ASSURANCE

A. MANUFACTURERS: Greenheck or approved equal.
B. The manufacturer shall have been designing and producing air handling units for a minimum of ten years.
C. Fans shall be tested in accordance with ANSI/AMCA Standard 210 and licensed to bear the AMCA Certified Ratings Program seal for air performance, efficiency and sound in accordance with AMCA Publication 211.
D. Fans shall be tested in accordance with ANSI/AMCA Standard 300, be licensed to bear the AMCA Certified Ratings Program seal for sound performance in accordance with AMCA Publication 311 and shall comply with ANSI/AMCA Standard 301 for calculating fan sound ratings from laboratory test data.
E. Fans shall be tested, rated and certified in accordance with ARI Standard 430 (AHU) and Standard 1060 (ERV).
F. Fans shall conform to NFPA 70, 90A, and 90B.
G. The unit(s) shall bear the ETL label and/or ISO-9000 certified
H. The unit(s) shall contain only UL listed components.

I. All fans handling flammable or explosive vapors shall be AMCA Type A spark resistant construction conforming to ANSI/AMCA Standard 99.
J. For applications in heat and/or smoke removal, fan shall be UL/cUL listed for such.
K. All fans handling grease laden vapors shall meet the requirements of UL 762 and NFPA 96.
L. Base fan performance shall be measured at standard conditions (density 0.075 Lb. /ft3).
M. Each fan shall be direct driven in AMCA arrangement 4 with propeller secured to the motor shaft.
N. Propeller shall be statically and dynamically balanced in accordance with AMCA Standard 204-05
O. The propeller and fan inlet will be aligned and shall have precise running tolerances for maximum performance and operating efficiency
P. Any revisions made by the contractor or manufacturer to the inlet and outlet ductwork conditions from that shown on the drawings shall not increase system effect and/or static pressure and shall not decrease mixing efficiencies. Contractor is responsible for upgrading fan and motor to overcome above system effect.
Q. Any motors for use on VFD shall be equipped with shaft-grounding (e.g. AEGIS band etc.)
R. All fans shall have extensions for grease lines to allow remote-greasing

## PART 2 - PRODUCTS

### 2.1. AXIAL FANS

A. BASIS OF DESIGN: Greenheck AX
B. Provide the proper number and type of blades. Install in correct blades with correct pitch.
C. FAN HOUSING
   1. Fan housing shall be aerodynamically designed with integral punched flanges.
   2. Fan housing shall be constructed of rolled steel with a continuous seam weld.
   3. Housing shall be coated with a minimum of 3 mils of Permatector, an electrostatically applied and baked polyester urethane. Finish color shall be gray. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.
   4. Motor support framework to be constructed of structural steel that is suitable to handle the weights of the motor and propeller. Motor supports within the fan housing to be welded to the fan casing. Bolted construction is not acceptable. All support framework to be coated with a minimum of 3 mils of Permatector, an electrostatically applied and baked polyester urethane. Finish color shall be RAL 7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.
   5. Include Vane section.
   6. Include inspection door for motor and propeller.
   7. If plans indicate open inlet, provide inlet bell and inlet guard.
D. FAN IMPELLER:
   1. A taper lock bushing shall be used to mount the propeller to the motor shaft.
   2. Fan propeller shall use cast aluminum airfoil blades. Blades to be adjustable within a cast aluminum hub to allow for performance changes. The propeller shall be both statically and dynamically balanced.
   3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
E. MOTORS:
   1. Motors must be standard NEMA T-Frame designs that are readily available from motor vendors.
   2. Motors shall be TEFC type and have insulation rating required for the application.
   3. Extend any bearing lubrication points to the outside of the fan casing.

### 2.2. WALL FANS

A. BASIS OF DESIGN: Greenheck AER
B. Propeller constructed of cast aluminum tapered airfoil blades and cast aluminum hub
C. Housing shall include OSHA approved motor guard

## PART 3 – EXECUTION

### 3.1. INSTALLATION

A. Install unit to provide for adequate service access. Provide access door up and downstream of fan for inspection and repair.
B. Install with enough straight duct up and downstream of fan to avoid “fan effect”. Typically this requires 3 duct diameters of straight duct.
C. Install flexible fan duct connection and mount fan on factory-provided spring isolators.
D. Coordinate with other trades to assure fan does not infringe upon access or service clearances of other equipment.
E. Lubricate fan bearings. Verify fan isolators have proper deflection.
F. Upon completion of installation, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning components, then retest to demonstrate compliance.
G. Provide flexible connection and thrust restraints at fan discharge connection to casing.
H. Statically and dynamically balance all fans so they operate without objectionable noise or vibration.
I. Provide a corrosion resistant coating on all surfaces exposed to fume and other corrosive exhaust air.

**END OF SECTION**

# SECTION 23 37 00
# AIR OUTLETS AND INLETS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Diffusers, grilles and other air oulets and inlets.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
B. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers - www.ashrae.org
   1. ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy
   2. ASHRAE Standard 70 – Method of Testing the Performance of Air Outlets and Air Inlets
C. ASTM - American Society for Testing and Materials - www.astm.org
   1. ASTM 610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
   2. ASTM 714 – Test Method for Evaluating Degree of Blistering of Paints
   3. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
   4. ASTM D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
   5. ASTM D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
D. NFPA - National Fire Protection Association - www.nfpa.org
   1. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems
E. UL - Underwriters Laboratory - www.ul.com
   1. UL181 – Standard for Factory-Made Air Ducts and Air Connectors

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation.
C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication.
D. Certificates: Certify that air capacities, pressure drops, and selection procedures meet or exceed specified requirements.
E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

### 1.4. QUALITY ASSURANCE

A. Company specializing in manufacturing the type of products specified in this section, with minimum 10 years of documented experience.

## PART 2 - PRODUCTS

### 2.1. HIGH CAPACITY DRUM LOUVER

A. BASIS OF DESIGN: Price industries HCD or AHCD (whichever is scheduled)
B. If scheduled size and number of diffusers cannot be mounted on duct due to space constraints, install more smaller diffusers. Size those to not increase originally designed pressure drop.
C. CONSTRUCTION:
   1. The outlets shall have steel (HCD) or aluminum (AHCD) frame construction, and extruded aluminum drum and vanes.
   2. The outlets shall consist of individually adjustable spread control vanes housed within a rotatable drum.
   3. The drum pivot mechanism shall incorporate a positive positioning detent device to hold field adjusted drum angles of up to thirty degrees off-center. Adjustable vanes shall pivot and maintain blade setting.
   4. The outlet mounting frame shall be constructed of formed steel with welded, reinforced corners for added strength.
   5. The mounting frame shall be supplied with countersunk screw holes for aesthetic appeal.
D. PAINT SPECIFICATION:
   1. Paint finish shall be standard white for unpainted ductwork. In case ductwork is painted, match duct color.
   2. All components shall have a baked-on powder coat finish.
   3. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.

4. The paint film thickness shall be a minimum of 2.0 mils.
5. The finish shall have a hardness of 2H.
6. The finish shall withstand a minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
7. The finish shall have an impact resistance of 80 inch-pounds.
8. All components shall have a custom finish in a color to match a customer supplied sample.

E. FRAMING:
1. Provide appropriate frame for duct mounted to (spiral or rectangular)

F. STAINLESS STELL OPTION:
1. Where stainless steel duct and/or diffuser is specified, use Price DLSS model without paint
2. The outlets shall have type 304 stainless steel frame, drum, and vane construction.
3. The outlet mounting frame shall be constructed of stainless steel with welded, reinforced corners for added strength.
4. The mounting frame shall be supplied with countersunk screw holes for aesthetic appeal.
5. The outlet shall have a mill finish.

G. Balance by adding partial blank-off for diffusers with excess flow close to air supply. Alternatively adjust the blades in opposed-blade fashion and arrest in place. Discuss specifics with engineer.

**2.2. BELL-MOUTH INLETS**

A. Install for all open air inlets

B. Where a fan is at the air-inlet, use fan-manufacturer provided bell-mouth. Where that is not available, use alternate model fabricated similar to bell-mouth inlet for plenums shown on plan sheet details.

**END OF SECTION**

**SECTION 23 73 39**
**INDOOR DIRECT GAS-FIRED HEATING AND VENTILATION UNITS**



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to indoor direct gas-fired systems.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. ANSI – American National Standards Institute
   1. ANSI Z83.4 - Direct Gas Fired Makeup Air Heaters

### 1.3. QUALITY ASSURANCE

A. ASME Compliance: Units must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment."
B. Entire unit shall be ETL Certified per ANSI Z83.4 or ANSI Z83.18 and bear an ETL mark.
C. Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, “Laboratory Methods of Testing Fans for Rating.”
D. Engage a factory authorized service representative to perform startup service.

## PART 2 - PRODUCTS

### 2.1. DIRECT FIRED MAKE-UP AIR UNITS

A. MANUFACTURERS: Greenheck.

### 2.2. CABINET

A. MATERIALS: Formed, double wall insulated metal cabinet. Underside of unit shall have formed metal panels covering base panel insulation.
B. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvaneal steel. Base rail is 12 gauge, galvazined (G90) steel.
C. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum14 gauge galvanized (G90) steel.
D. CABINET INSULATION: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
   1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
   2. Thickness: 1 inch (25 mm)
   3. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
   4. Location and application: Full interior coverage of entire cabinet to include walls and roof of unit shall be semi-rigid type and installed between inner and outer shells of all cabinet exterior components Full interior coverage from Heating section all the way to air-intake.
E. ACCESS PANELS: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Turnable handles shall allow for easy operation. Access panels shall be fabricated of 18 gauge galvanized G90 steel. Specific type of steel and finish should match “Cabinet Materials” above.

### 2.3. BURNER

A. Unit shall be factory assembled, piped and wired. Direct gas-fired system will be 92% efficient while supplying a burner that is capable of providing 25:1 turndown. Unit will utilize a draw through design and incorporate adjustable burner baffles plates for filed adjustments. Unit will have a direct spark ignition system.
B. Burner construction shall consist of a cast aluminum burner manifold and 400 series stainless steel mixing plates. No air from the inside space shall be allowed to pass across the burner at any time. Flame sensing shall be provided by ultra-violet scanner. A flame safeguard display shall be included. Burner control shall have a digital coded fault indicator capable of storing the last five faults.

C. Shall be equipped for operation on natural gas with a maximum rated inlet gas pressure that is available at location. Provide pressure regulator as required per specification elsewhere in this division.
D. Burner control options to include the following External signal for burner modulation with integral discharge temperature limits using an external 2 - 10 VDC signal.
E. Shall include the following safety controls:
F. Manual Reset, High Limit Switch: Main gas valve closes if high-limit temperature is exceeded.
G. Include high and low gas pressure switches and visual indication gas valves-when applicable.
H. Hydraulic proof of close valves(s) shall be included.
I. Visual indication: Clear visual signal demonstrating the position of the main gas safety shutoff valves.

**2.4. FAN**

A. Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower and must have [neoprene vibration isolation devices, minimum of 1 – 1/8 inches thick]
B. Extend any bearing lubrication points to outside of unit.
C. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators.
D. TEFC premium efficiency motor

**2.5. CONTROLS**

A. Unit shall be controlled by Building Automation System (BAS) unless noted differently.
B. BAS will measure DAT and modulate burner.
C. BAS will control fan speed.
D. Provide separate electrical circuit for controls. This circuit shall be from same source and voltage as scheduled for the motors. Replace or adjust transformers as required.

**2.6. FILTERS**

A. Provide 4” MERV 8 filters unless plans require higher MERV rating.
B. Filters shall meet requirements specified elsewhere in this division.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Provide factory approved spring-isolation of the unit.
B. Isolate Ductwork

**END OF SECTION**

# SECTION 26 05 00
# COMMON WORK RESULTS FOR ELECTRICAL



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to electrical work and applies to all sections in this contract. Provide all electrical work required for all trades in this contract. This work includes but is not limited to:
   1. Temporary power and lighting.
   2. Controls power included in equipment listed elsewhere. This includes but is not limited to HVAC controls.
   3. Power for motors and other electricity-requiring devices in equipment furnished and/or installed by contractor
   4. De- and re-energizing of areas to be demolished, cleaned or abated.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. ANSI – American National Standards Institute - www.ansi.org
   1. ANSI A13.1 – Standard for Pipe Identification
   2. ANSI C2 – National Electrical Safety Code
      a. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
         i. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
         ii. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
         iii. ANSI/NFPA 70 National Electrical Code.
   3. ANSI Z535.4 – Standard for Product Safety Signs and Labels
C. NFPA – National Fire Protection Agency
   1. NFPA 70 National Electrical Code.
D. NECA - National Electrical Contractors Association
   1. NECA "Standard of Installation."
E. NEMA - National Electrical Manufacturers Association
   1. NEMA FB 1 Fittings and Supports for Conduit and Cable Assemblies.
   2. NEMA FU 1 Low Voltage Cartridge Fuses
   3. NEMA OS 1 Sheet steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   4. NEMA OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
   5. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. NEMA ICS 1 General Standards for Industrial Control Systems.
   7. NEMA ICS 2 Standards for Industrial Control Devices, Controllers and Assemblies.
   8. NEMA ICS 6 Enclosures for Industrial Controls and Systems.
   9. NEMA KS 1 Enclosed Switches
   10. NEMA ST 1 Standard for Specialty Transformers (Except General Purpose Type.)
   11. NEMA TC 2 Electrical Plastic Tubing (EPT) and Conduit (EPC 40 and EPC 80).
   12. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   13. NEMA WD 1 General Purpose Wiring Devices.
   14. NEMA WD 6 Wiring Device Configurations

F. UL – Underwriters Laboratory
   1. UL 198C High Interrupting Capacity Fuses; Current Limiting Type.
   2. UL 198E Class R Fuses.

**1.3. SUBMITTALS**

A. AFFIDAVITS: The contractor shall execute the standard State Electrical Affidavit of Compliance with the Electrical Code and safe practices. Notarize and file with the appropriate utility. Provide owner with copy.
B. GROUNDING ANDBONDING:
   1. Provide data for grounding electrodes and connections.
   2. Provide samples of ground labels.
   3. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
   4. Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

**1.4. QUALITY ASSURANCE**

A. Furnish products listed and classified by Underwriters Laboratories, inc. as suitable for purpose specified and shown.
B. INSTALLERS: Electrical contractor with at least 5 years of experience performing similar work. This contractor shall employ a Master Electrician to oversee work and obtain permits.
C. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum 3 years' experience.
D. The following restrictions detail methods and material that are not acceptable even if allowed under NEC:
   1. Aluminum or aluminum-clad conductors are not acceptable.
   2. Shared Neutrals between different branch circuits or other wiring are not acceptable. All single-phase branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductors.
   3. Field-marking of cables is not acceptable. All wires need to be in manufactured color.
   4. Combining lighting and other loads in one branch circuit is not acceptable.
   5. Use of grounded circuit conductors metal conduit, raceway or cable trays as sole grounding conductor is not acceptable. A separate grounding wire is required.
   6. Omission of bonding jumpers in boxes, and omission of grounding/bonding wires in metal raceways and conduit is not acceptable.
   7. Underground wiring without conduit or raceway is not acceptable.
   8. Underground wiring less than 24" deep regardless of concrete pads is not acceptable.
   9. Exposed insulation is not acceptable.
   10. Electric Nonmetallic Tubing (ENT) is not acceptable.
   11. Overhead wiring without messenger support is not acceptable.
   12. Use of circuit breaker as device disconnect is not acceptable. Devices need separate disconnects.
   13. Cast metal, split or gland type fittings are not acceptable.
   14. Combining lighting and other loads in one branch circuit is not acceptable.
   15. Underground wiring without conduit or raceway is not acceptable.
   16. Underground wiring less than 24" deep regardless of concrete pads is not acceptable.
   17. Overhead wiring without messenger support is not acceptable.
E. Install in accordance with NECA "Standard of Installation."
F. Contractor to provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stub outs due to carelessness with construction equipment.
G. EMERGENCY CIRCUITS
   1. All Emergency, Legally Required Standby and Optional Standby system wiring shall be installed in separate raceways after their associated transfer switches. The wiring shall be separate from each other and from all normal system wiring.
   2. All emergency wiring serving fire pumps, requiring minimum 2 hour fire rating shall comply with NEC 695.6(B).
   3. All emergency wiring serving NEC 700 loads, requiring minimum 2 hour fire rating shall comply with NEC 700.10(D)(1).
   4. All generator control conductors installed between transfer equipment and the emergency generator serving Emergency, Legally Required Standby and Optional Standby systems shall be kept entirely independent of all other wiring. This shall require a dedicated conduit system between each transfer switch and the emergency generator. If a Fire Pump is served off the emergency generator, a separate conduit shall be provided between fire pump controller and generator.

**1.5. PERFORMANCE REQUIREMENTS**

A. Size wire for a voltage drop <= 2% for branch circuits and for feeders
B. Do not use wire smaller than 12 AWG for power and lighting circuits.
C. All phase, neutral and ground conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductors for 20 ampere, 120 volt branch circuit home runs longer than 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).
D. Ground conductor size shall be increased per NEC 250.122(B) when phase and phase/neutral conductors are increased in size.
E. Grounding System Resistance: 10 ohms maximum at building service entrance.

**PART 2 - PRODUCTS**

**2.1. ELECTRICAL IDENTIFICATION PRODUCTS**

A. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

B. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

E. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

F. Aluminum, Wraparound Marker Bands: 1" in width, .014 inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

G. Brass or aluminum Tags: 2" by 2" by .05-inch metal tags with stamped legend, punched for fastener.

H. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label, minimum of 3/4” high x 9/16” wide, with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

I. NAMEPLATES AND SIGNS:

1. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners. Engraving legend shall be as follows:
   a. Black letters on white face for normal power.
   b. White letters on red face for emergency power.
   c. White letters on green face for grounding.
   d. Black letter on yellow face for Caution or UPS.
2. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼" grommets in corners.
3. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with .0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting ¼" grommets in corners.
4. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
5. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

J. Conduit shall be factory color coded as follows:

| | |
|---|---|
| Normal Power 277V/480V | Clear. Labeled as “277/480Y” |
| Normal Power 120V/208V | Clear. Labeled as “120/208Y” |
| Emergency Power | Green, Labeled per Voltage used |
| Optional Standby | Blue, Labeled per Voltage used |
| Fire Alarm | Red |
| DC Voltage (Solar etc.) | Orange. Labeled as “600VDC” or per system rating |
| Building Automation System | White. Labeled as “BAS” |
| Communication (CAT6. Fiber, Access System, Radio, etc.) | Purple. Labeled “COM”, “FIBER” or as directed by owner |
| Security System | Yellow |

**2.2. HANGERS AND SUPPORT**

A. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit.

B. Space and size support sufficiently to avoid sagging or improper support of all conduits, raceways, fixtures and equipment.

C. ANCHORS AND FASTENERS:

1. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
2. Concrete Structural Elements: Use precast insert system, expansion anchors and preset inserts.
3. Steel Structural Elements: Use beam clamps. Do not use spring steel clips and clamps.
4. Concrete Surfaces: Use self drilling anchors and expansion anchors. Do not use powder actuated anchors.
5. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
6. Solid Masonry Walls: Use expansion anchors and preset inserts.
7. Sheet Metal: Use sheet metal screws.
8. Wood Elements: Use wood screws.

D. STEEL CHANNEL / STRUT

1. Manufacturer: Allied, B-Line, Kindorf. UniStrut,
2. Galvanized

E. HANGERS AND SUPPORT:

1. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
2. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
3. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

4. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

**2.3. LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE**

A. BUILDING WIRE:
   1. MANUFACTURERS: Carol, Triangle, Southwire.
   2. Conductor: Copper only (aluminum or aluminum-clad conductors are not allowed).
   3. Insulation Voltage Rating: 600 volts.
   4. Insulation:
      a. ANSI/NFPA 70, Type THHN/THWN-2, XHHW-2
      b. Single conductor rated for 90°
B. SERVICE ENTRANCE CONDUCTORS
   1. Description: Single conductor or multi-conductor insulated wire. 90°C.
   2. Insulation: Type USE-2, XHHW-2 insulation for service entrance conductors routed from exterior source to exterior termination location.
   3. Type XHHW-2 insulation for services entrance conductors routed from exterior source to interior termination location.
C. EXTERIOR LOCATIONS ABOVE GROUND:
   1. Description: Single conductor insulated wire, 90°C.
   2. Insulation: Type XHHW-2 insulation.
D. EXTERIOR LOCATIONS BELOW GROUND
   1. Stranded single or multiple conductor insulated wire, 90°C.
   2. Insulation: Type USE-2, XHHW-2, RHW-2 insulation.
   3. This wiring shall be used in all underground feeder and branch circuit applications, except THHN/THWN-2 is permitted when run in a concrete-encased ductbank.
E. EMERGENCY CIRCUITS (2-HOUR RATED) (where required)
   1. Power cable assembly for fire pump circuits and emergency circuits requiring a minimum 2-hour rating.
   2. Horizontal and Vertical Installations:
      a. Insulation: Type MI mineral insulated cable installed as a listed electrical circuit protective system with a minimum 2-hour fire-resistive cable rating per Factory Mutual testing. UL 2196 and ULC-S139-00 approved.
      b. Insulation: Type MC Two-Hour Fire Resistive Multi- Conductor Cables with listed connectors, splices and boxes, installed as a listed electrical circuit protective system with a minimum 2-hour fire-resistive cable rating per Factory Mutual testing. UL 2196 and Electrical Circuit Integrity System (FHIT) No 50 identified.
   3. Horizontal Installations:
      a. Insulation: Type RHW-2 or RW90 Two-Hour Horizontal, insulated cable installed as a listed electrical circuit protective system with a minimum 2-hour fire-resistive cable rating per Factory Mutual testing. UL 2196 and Electrical Circuit Integrity System (FHIT) No 25B identified.
      b. Install and support cabling system per manufacturer's requirements.
F. VARIABLE FREQUENCY DRIVE (VFD) WIRE
   1. All power wiring from the VFD output to the motor shall be type XHHW-2 insulation, single conductor wire.
   2. Install VFD input wiring and output wiring in separate conduit systems. Do not mix VFD input power and output power, or control wiring in a common raceway.
G. METAL CLAD CABLE
   1. BASIS OF DESIGN: Atkore AFC Cable Systems
      a. Install neatly and per NEC 330.10 and NEC 330.30.
      b. Only use for lighting retrofit projects in inaccessible locations if code allows and where not exposed to damage. Locations include grid ceilings and drywall ceilings.
H. Pull all conductors into raceway at same time.
I. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
J. Protect exposed cable from damage.
K. Support cables above accessible ceiling, using spring metal clips. Do not rest cable on ceiling panels.
L. Neatly train and lace wiring inside boxes, equipment, and panelboards.
M. Clean conductor surfaces before installing lugs and connectors.
N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

**2.4. WIRING CONNECTORS**

A. MANUFACTURERS: Burndy, T&B, Blackburn, Panduit.
B. Split Bolt Connectors: Not acceptable.
C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment terminals. Not approved for splicing.
D. Twist Type Wire Connectors: Solderless twist type spring connector (wire-nut) with insulating cover for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller. The manufacturer's wire fill capacity must be followed. Use Silicone filled twist type spring connectors in all wet location areas.
E. Mechanical Spring Actuation Connectors: Toolless type spring actuation connector (push-in) with spacers for copper wire splices and taps. Use for conductor sizes 12 AWG and smaller. The manufacturer's wire fill capacity must be followed. Use in interior, dry locations only.

F. All wire connectors used in underground or exterior pull boxes or hand holes shall be gel filled twist connectors or a connector designed for damp and wet locations. Gel filled twist type connectors can be used for copper conductor sizes 6 AWG and smaller for site lighting applications. The manufacturer's wire fill capacity must be followed.
G. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
H. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps. Connector must be installed with a crimper tool listed for use with the manufacturer and type of compression connector.
I. Insulation Piercing Connectors: Molded insulated body, copper teeth, wrench tightened, UL 486B Listed. May be used only for connection of a tap conductor in run and tap type applications when main conductor is 8 AWG and larger.
J. SPLICES:
    1. Splice only in accessible junction boxes.
    2. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.
    3. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
    4. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.
K. Use solderless twist type spring connectors (wire nuts) with insulating covers for copper wire splices and taps, 10 AWG and smaller or toolless type actuation connectors (push-in) with spacers for copper wire splices and taps, 12 AWG and smaller. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the wiring.
L. Thoroughly clean wires before installing lugs and connectors.
M. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
N. Provide suitable strain relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

**2.5. RACEWAY FOR ELECTRICAL SYSTEMS**

A. GENERAL:
    1. MANUFACTURERS: Alflex Corp., Electri-Flex, Republic Steel
    2. All steel fittings and conduit bodies shall be galvanized.
    3. All conduit transitional fittings shall be listed for installed application.
    4. Condulet fittings shall be threaded rigid entering condulets.
    5. No cast metal or split-gland type fittings permitted.
    6. All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.
    7. Mogul-type condulets 2 inch (50 mm) and larger, shall be permitted.
    8. C-condulets shall not be used in lieu of pull boxes.
    9. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.
B. RIGID METAL CONDUIT (RMC) AND FITTINGS:
    1. Conduit: Heavy wall threaded, galvanized steel.
    2. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.
    3. Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.
C. PVC COATED RIGID METAL CONDUIT:
    1. PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.
    2. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.
D. INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS:
    1. Conduit: Galvanized Steel, threaded.
    2. Fittings and Conduit Bodies: Use all Steel threaded fittings and conduit bodies.
    3. Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.
E. ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS:
    1. Conduit: Steel, Unthreaded thin wall galvanized tubing.
    2. Fittings: All steel, compression or set screw type. No push-on or indenter types permitted.
    3. Transitional fitting: ½-1": All steel and malleable iron; 1 ¼" and above: All steel, Malleable iron and Die cast where not subjected to physical damage.
    4. Conduit Bodies: All steel conduit bodies.
F. FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS:
    1. Conduit: steel, galvanized, spiral strip.
    2. Fittings and Conduit Bodies: All steel, galvanized or malleable iron.
G. LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS
    1. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

2. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

H. ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS:
1. Conduit: ENT (smurf tube), UL listed and NEC recognized.
2. Fittings: One piece quick connect fittings for 1/2 inch to 1 inch size and schedule 40 cemented fittings for larger size. When installed in concrete, fittings shall be suitable for damp locations and shall be concrete–tight, stub-ups and stub-downs kits shall meet manufacturer's recommendations.

I. RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS:
1. Conduit: Rigid non-metallic conduit, Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90°C conductors. Schedule 80 for locations exposed to physical damage or as required.
2. Fittings and Conduit Bodies: NEMA TC 2, Listed.

J. WET AND DAMP LOCATION RIGID CONDUIT
1. MANUFACTURERS: KorKap.
2. PVC Coated schedule 40 Rigid Steel Conduit: ANSI C80.1, UL 6, ETL PVC-001 3072346-004, CSA Certified C22.2 No. 45.
3. The PVC-coated, threaded conduit system is specifically designed to prevent corrosive conditions from causing early replacement of the conduit. All the conduit, fittings, and supporting products shall be provided by the same manufacturer.
4. PVC and Zinc coating must be UL-listed as providing primary corrosion protection for the rigid metal conduit.
5. Conduit must be hot dipped galvanized inside and out including threads.
6. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.
7. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
8. Form 8 Condulets shall have a V-Seal tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws.
9. Urethane coating of nominal 2 mil thickness shall be uniformly and consistently applied to the interior of all conduit and fittings. Conduit or fittings with thin or no coating shall be unacceptable.
10. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C). The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.
11. All female threads on fittings and couplings shall be protected by urethane coating.
12. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U-bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.
13. All clamping, cutting, threading, bending, and assembly instructions from the manufacturer shall be rigorously followed.

K. SURFACE METAL RACEWAY
1. MANUFACTURERS: Hubbell, Wiremold V200, V500, V700, 4000
2. Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
3. Finish: White or Ivory scuffcoat.
4. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories.
5. Run surface raceway in a neat and workman like manner. Surface raceway will only be allowed on existing or non-accessible walls where recessed devices can not be cut in.

L. WIREWAY
1. MANUFACTURERS: Hoffmann, Square D, Wiegmann
2. General purpose type wireway.
3. Knockouts: Manufacturer's standard or none.
4. Fittings: Lay in type with removable top, bottom, and side; captive screws, drip shield for wet locations.
5. Finish: Rust inhibiting primer coating with gray enamel finish.

M. POWER/DATA POLE
1. MANUFACTURERS: Wiremold 30TP-4.
2. Sheet metal channel with fitted cover, suitable for use as metal raceway.
3. Finish: Standard finish.
4. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories.

N. CONDUIT WATER SEALANT:
1. Description: Conduit sealant used to prevent water from entering buildings via conduits.
2. Sealant shall seal conduits against water and gas intrusion, such as Polywater® FST™-250 Foam Duct Sealant, Raychem RDSS Rayflate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).

**2.6. BOXES FOR ELECTRICAL SYSTEMS**

A. PULL AND JUNCTION BOXES:

1. Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot-welded joints and corners.
2. Interior Sheet Metal Boxes larger than 12 inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover. Boxes 9 square-feet or larger shall have hinged covers and a single cover shall not exceed 10 square-feet.
3. Interior Sheet Metal Boxes connected to an exterior underground raceway, shall have a drain fitting located in the bottom.
4. Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat flanged, surface mounted junction box, UL listed as rain-tight. Box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
5. Boxes installed in Parking Ramps shall be Type 4X, flat-flanged, surface-mounted junction box, ETL listed as rain-tight. Box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
6. Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.
7. Junction boxes 6 inch-by-6 inch or larger size shall be without stamped knock-outs.
8. Wireways shall not be used in lieu of junction boxes.

B. OUTLET BOXES:
1. SHEET METAL OUTLET BOXES: NEMA OS 1, welded, galvanized steel, 4" square minimum. Drawn boxes will not be accepted.
2. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
3. Concrete Ceiling Boxes: Concrete type.
4. Cast Boxes: Cast ferroalloy or aluminum, deep type, gasketed cover, threaded hubs.
5. Outlet Box Extenders: Non-Metallic, adjustable depth.

C. FLOOR BOXES:
1. NEMA OS 1, fully adjustable, 1 1/2 inches deep or as shown on drawings.
2. MATERIAL: Cast metal, Formed steel or PVC per drawing.
3. SHAPE: Round, or rectangular as shown on drawings.
4. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
5. Set floor boxes level.
6. Adjust floor box flush with finish flooring material.

**2.7. GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

A. ROD ELECTRODE
1. Manufacturers: Appleton, Crouse-Hinds, Burndy.
2. Material: Copper clad steel.
3. Diameter: 3/4 inch .
4. Length: 10 feet (driven at least 9'6" deep)

B. CONCRETE-ENCASED GROUNDING ELECTRODE FOR BUILDINGS: Fabricate per NFPA 70, Article 250.52 (A)(3)(2) using 20 feet (6m) of bare copper wire not smaller than bare seven-strand #4 AWG. Metallic components shall be encased by at least 2 in. of concrete and shall be located horizontally with in that portion of a concrete foundation or footing that is in direct contact with earth or within vertical foundations or structural components or members that are in direct contact with the earth.

C. CONCRETE-ENCASED GROUNDING ELECTRODE FOR POLE BASES: Fabricate per NFPA 70, Article 250.52 (A)(3)(2) using 20 feet (6m) of bare copper wire not smaller than bare seven-strand #4 AWG. If concrete foundation is less than 20 feet (6m) long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts.

D. MECHANICAL CONNECTORS: Material: Bronze.
1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be two hole, two bolt type.
2. Split bolt connector types are NOT allowed. Exception: the use of split bolts is acceptable for grounding of wire-basket type cable tray, and for cable shields/straps of medium voltage cable.
3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

E. EXOTHERMIC CONNECTIONS: Manufacturer: Erico Cadweld, Harger Ultraweld

F. WIRE: Stranded copper.

G. Grounding Electrode Conductor: Size to meet NFPA 70 or local requirements.

H. Connect ground to:
1. Metal underground water pipe.
2. Metal frame of the building.
3. Reinforcing steel in foundation footing where indicated. Bond steel together.

I. Provide grounding electrode conductor and connect to Bond together metal siding not attached to grounded structure; bond to ground.

J. Bond together reinforcing steel and metal accessories in pool and fountain structures.

K. Provide isolated grounding conductor for circuits supplying electronic equipment.

L. Equipment Grounding Conductor: Provide separate, insulated conductor within each raceway. Terminate each end on suitable lug, bus, or bushing. Use of grounded metal conduit, raceway or cable trays as the sole grounding conductor is not acceptable.

M. Use 4 AWG minimum copper conductor to ground communications service.

N. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

O. Use suitable test instrument to measure resistance to ground of system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall of potential method. Record overall resistance to ground.

P. Accurately record actual locations of grounding electrodes.

Q. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground. Verify that final backfill and compaction has been completed before driving rod electrodes.

**PART 3 – EXECUTION**

**3.1. ELECTRICAL DEMOLITION**

A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

B. Coordinate utility service outages with the User Agency, Owner Construction Manager, Architect/Engineer, and Utility.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations and follow the safe working practice requirements of NFPA 70E.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the User Agency and Owner Construction Manager before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Obtain permission from the User Agency, Owner Construction Manager and local Authority Having Jurisdiction before partially or completely disabling system. Minimize outage duration. If required, make temporary connections to maintain service in areas adjacent to work area.

F. Existing Communication/Data System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the User Agency, Owner Construction Manager and local Telephone Utility. If required, make temporary connections to maintain service in areas adjacent to work area.

G. All disconnected wiring shall be removed from all raceway systems, panels, enclosures pull boxes, junction boxes etc. irrespective of whether the removal is specified in the construction documents or not. The empty raceway systems shall be tagged spare on both ends of each termination.

H. DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

1. Remove, relocate, and extend existing installations as necessary, to accommodate new construction and to meet all requirements of these specifications. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
2. Remove abandoned wiring to source of supply.
3. Remove exposed abandoned conduit and abandoned conduit above accessible ceiling finishes, unless noted otherwise on drawings. Cut conduit flush with walls and floors, and patch surfaces. If certain conduits and boxes are abandoned but not scheduled for removal, they shall be shown on the "As Built Drawings".
4. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit and wiring servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
5. Disconnect and remove abandoned panelboards and distribution equipment.
6. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
7. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
8. Provide revised typed circuit directory in panelboards that have circuits removed.
9. Repair adjacent construction and finishes damaged during demolition and extension work.
10. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
11. Provide supplemental support for conduits that are routed through demolition area, and are to remain. Supplemental support shall be added to meet the support requirements in this Division.

**3.2. INSTALLATION**

A. The contractor shall be responsible for the proper location of roughing in and connections by other trades.

B. INTERFERENCES:

1. Locations: Locations of conduit, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated or encountered. Devices specifically dimensioned on the drawings are critical dimensions and shall installed as shown. The contractor shall determine the exact route and locations of each conduit prior to installation.
2. Offsets: Offsets and changes in direction in conduit shall be made as required to maintain proper head room and not interfere with pitch of sloping lines whether or not indicated on the drawings.

C. Location of lighting switches, outlets and equipment as shown on drawings is approximate and exact locations will be verified. Minor modifications in location of switches, outlets and equipment is considered incidental up to a distance of 10 feet with no additional compensation.

D. Existing Conditions:

1. Move or remove electrical connections, devices or equipment necessary for completion of project and reconnect reused existing equipment or wiring removed to accommodate new work.
2. Existing electrical equipment indicated on the drawings as being reworked or relocated shall be wired the same way new equipment would be wired.
3. Work involving shutdown of present service and equipment now functioning in present area shall be done at such time as to provide the least amount of inconvenience to the owner at times established by the owner.

4. Locations and elevations of utilities have been obtained from utility maps or other sources and are offered as a general guide only without guarantee as to accuracy. The Contractor shall verify the location and elevation of utilities and their relation to the work before beginning work.

E. PENETRATIONS (RATED): Install as specified elsewhere in this contract (Division 7)

F. PENETRATIONS (NON RATED):
1. Conduit Penetrations Below Grade: In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or water-stop type wall sleeve.
2. Conduit and Cable Tray Penetrations Above Grade: At through-wall conduit and cable tray penetrations of non-rated interior and exterior walls, and floors, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

G. WET RATED LOCATIONS:
1. Use appropriate flexible or rigid liquid-tight conduit.
2. Where possible, terminate conduit in bottom of fixture or device to avoid water in conduit running into that device.

**3.3. FIELD QUALITY CONTROL**

A. Control circuits, branch circuits, feeders, motor circuits and transformers:
1. Megger check of phase-to-phase and phase-to-ground insulation levels. Do not megger check solid state equipment.
2. Continuity.
3. Short circuit.
4. Operational check.
5. Inspect wire and cable for physical damage and proper connection.
6. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
7. Verify continuity of all conductors.

B. Wiring devices: Test receptacles with Hubbell 5200, Woodhead 1750 or equal tester for correct polarity, proper ground connection and wiring faults.

**3.4. IDENTIFICATION**

A. Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Install identification devices in accordance with manufacturer’s written instruction and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

D. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape or Brother self-laminating vinyl label, or permanent magic marker (color coded), neatly hand printed. In rooms that are painted out, provide labeling on inside of cover.

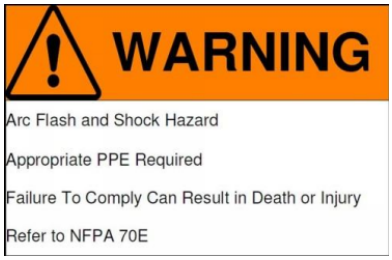
E. Circuit Identification: Tag or label conductors as follows:
1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

F. Apply warning, caution and instruction signs as follows:
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

I. Install ARC FLASH WARNING signs on all switchboards, panelboards, industrial control panels, and motor control centers. Sign at a minimum shall contain:




J. Circuits with more than 600V: Identify raceway and cable with "DANGER—HIGH VOLTAGE" in black letters 2” high on orange background at 10'-0 foot intervals.
   1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to conduits concealed within wall.
   3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8” below grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16” overall, use a single marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

L. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

M. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches above conduit.

N. SWITCH AND RECEPTACLES:
   1. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (i.e. “C1A #24”).
   2. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters in normal size “Swiss 721 Bold” font. Letter and number size to 3/16-inch high. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

O. BOX LABELING:
   1. All junction, pull, and connection boxes shall be identified as follows:
      a. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, 1LA1-3,5,7”).
      b. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).
   2. Box covers shall be painted same color as associated conduit.

P. CONDUCTOR COLOR CODING:
   1. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
   2. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.
   3. All Wire and cables smaller shall be color coded along the entire length by the manufacturer.
   4. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
   5. Switch leg shall have same color as their associated circuit.
   6. Conductors shall be color coded as follows:

| | 480Y/277 System | 208Y/120V System |
|---|---|---|
| Phase A | Brown | Black |
| Phase B | Yellow | Red |
| Phase C | Orange | Blue |
| Neutral | Gray | White |
| Travelers | | Yellow |
| Equipment Ground | Green | Green |

Q. ELECTRICAL GEAR
   1. Exterior electrical gear shall be identified with vinyl label names and numbers to be visible on the exterior of the gear. The labels shall correspond to the 1-line nomenclature and identify each cubicle of multi-section gear.

R. CONTROL EQUIPMENT IDENTIFICATION
   1. Provide identification on the front of all control equipment, such as disconnect switches, starters, VFDs, contactors, motor control centers, etc. Nameplate text shall be a minimum of 1/4” high.
   2. Labeling shall include:
      a. Equipment type and contract documents designation of equipment being served.
      b. Location of equipment being served if it is not located within sight.
      c. Voltage and phase of circuit(s).
      d. Panel and circuit number(s) serving the equipment.
      e. Method of automatic control, if included ("AUTO CONTROL BY BAS").

| |
|---|
| EXHAUST FAN EF-1 (Located on roof)<br>480V 3-PHASE<br>FED FROM H02 |

S. POWER DISTRIBUTION EQUIPMENT IDENTIFICATION:
1. Provide identification on the front of all power distribution equipment, such as panelboards, switchboards, etc. The identification material shall be engraved plastic-laminated labels. Text shall be a minimum of 1/4" high, Swiss 721 Bold.
2. Labeling shall include:
   a. Equipment type and contract documents designation of equipment.
   b. Voltage of the equipment.
   c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
   d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

| |
|---|
| DISTRIBUTION PANEL H-2<br>480V 3-PHASE<br>FED FROM SWITCHBOARD SB-1 |

3. A separate nameplate for the service entrance equipment shall be labeled with the MAXIMUM AVAILABLE FAULT CURRENT and DATE of calculation given on the one-line diagram.
4. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1").
5. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals.

T. TRANSFORMER EQUIPMENT IDENTIFICATION
1. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label. Text shall be a minimum of 1/4" high.
2. Labeling shall include:
   a. Equipment type and contract documents designation of equipment
   b. Name of the upstream equipment.
   c. Voltage and rating of the equipment.
   d. Location of the upstream equipment if it is not located within sight.

| |
|---|
| TRANSFORMER TR-2<br>480V: 208Y/120 20 kVA<br>FED FROM SWITCHBOARD SB-1 (located in Rm 100) |

U. EXTERIOR LIGHTING IDENTIFICATION:
1. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24" above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

**3.5. CONDUIT INSTALLATION**

A. GENERAL:
1. Arrange conduit to maintain 6'-8" clear headroom and present a neat appearance.
2. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
3. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
4. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
5. Group conduit in parallel runs where practical and use conduit rack (lay in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
6. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
7. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.
8. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.
9. Conceal all conduits except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.
10. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
11. For indoor and exposed exterior conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.
12. Support conduit using coated steel or malleable iron straps, lay in adjustable hangers, clevis hangers, and split hangers.
13. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
14. Do not attach conduit to ceiling support wires.
15. Route conduit parallel and perpendicular to walls.

16. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104° F.
17. Cut conduit square using saw or pipe cutter; de burr cut ends. Bring conduit to shoulder of fittings; fasten securely.
18. Join nonmetallic conduit using cement as recommended by manufacturer.
19. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
20. Install no more than equivalent of three 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate factory elbows for bends in metal conduit larger than 2 inch size.
21. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
22. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and expansion joints.
23. Provide suitable pull string in each empty conduit except sleeves and nipples.
24. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
25. All conduit to be concealed, except in mechanical rooms. Surface wiring to be used only were absolutely necessary.
    a. In existing buildings with exposed masonry walls or exposed structural ceilings, surface installation is allowed.

B. INSTALLATION:
1. Cut conduit square; de-burr cut ends.
2. Conduit shall not be fastened to the corrugated metal roof deck nor drywall or suspended ceiling grids.
3. Bring conduit to the shoulder of fittings and couplings and fasten securely.
4. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.
5. Threads cut in the field, and factory threads of conduit and nipples not coated with corrosion protection, shall be coated with an approved electrically conductive compound per NEC 300.6.
6. Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).
7. Provide bushings for the ends of all conduit not terminated in box walls. Provide insulated bushings where raceways contain 4 AWG or larger conductors.
8. Communication and Low Voltage systems conduits shall terminate in horizontal plane.
9. Use pendants supported from swivel hangers in exposed ceiling/ structure locations where necessary to mount boxes supporting luminaires and wiring devices. Installation method shall comply with NEC 314.23 (H).
10. Install no more than the equivalent of the following for building:
    a. Three 90 degree bends between boxes for electrical systems.
    b. Two 90 degree bends between boxes for communications and other low voltage systems. Note: Offsets shall be considered 90 degrees.
    c. No single bend may exceed 90 degrees.
11. Use hydraulic one shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
12. Bend conduit according to manufacturer's recommendations. Torches or open flame shall not be used to aid in bending of PVC conduit.
13. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
14. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
15. Install listed expansion deflection fitting or other approved means shall be used where a raceway crosses a structural joint for expansion, contraction or deflection, used in buildings, bridges, parking garages or other structurers.
16. Install expansion joints where direct-buried conduit is subject to Earth Movement by settlement or frost per NEC 300.5(J), especially where conduit exits the ground exposed and enters a box, cabinet, or enclosure attached to a building or structure.
17. Install expansion fitting in exterior PVC conduit runs per NEC table 352.44 utilizing a minimum temperature change of 120 degree F.
18. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.
19. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide condulet or box with duct seal or other means to prevent the passage of moisture and water vapor through the conduit.
20. Route conduit through roof openings for piping and ductwork where possible.
21. Where communication cabling is to be installed in conduit to the wiring hub (e.g. Telecom Room), multiple conduits may be consolidated into fewer, larger conduits. Capacity of shared conduits shall equal the capacity of the individual conduits unless otherwise noted.
22. Use NRTL listed metallic grounding clamps when terminating conduit to cable tray.
23. Ground and bond conduit.
24. Conduit is not permitted in any slab topping of two inches (50 mm) or less.

C. CONDUIT SCHEDULE:
1. Underground Installations That Penetrate Foundation Walls: Rigid metal conduit within five feet (1.5 m) of the foundation wall. Conduit may transition to PVC conduit five feet (1.5 m) from the foundation walls.
2. Underground Installations That Do Not Penetrate Foundation Walls: Rigid metal conduit, or PVC conduit.
3. Underground Installations Emerging from Grade: Buried conduit emerging from grade shall be Rigid metal conduit extending from the minimum cover distance of 24 inches below grade to the conduit termination point above grade. Refer to DFD detail.
4. Underground Installations Under Concrete Slab: Rigid metal conduit or Schedule 40 PVC conduit.
5. Underground Installations Emerging through Concrete Slab: Rigid metal conduit.

6. Concealed in Poured Concrete Walls: Rigid Metal Conduit, PVC conduit, or Electrical Nonmetallic Tubing (ENT).
7. Concealed in Concrete Block Walls: Electrical metallic tubing, PVC conduit. Electrical Nonmetallic Tubing (ENT).
8. Within Concrete Slab: Rigid Metal conduit or PVC conduit.
9. Emerging from Within Concrete Slab: Rigid Metal conduit.
10. Exposed Outdoor Locations: Rigid Metal conduit, Intermediate Metal conduit.
11. Wet Interior Locations:
    a. Where physical damage can occur: Wet and damp location Rigid Conduit
    b. Where no physical damage can occur: Liquid tight flexible Metal Conduit
12. Concealed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing, PVC conduit (Ground conductor).
13. Interior Building Grounding Electrode Conductor: Schedule 80 PVC.
14. Exposed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing.
15. Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) in all locations except in Mechanical equipment plenum spaces where Flexible Metal Conduit (FMC) shall be utilized. Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
16. Exposed Dry Interior Locations for HVAC control devices with Conduit Connections: Electrical metallic tubing, Flexible Metal Conduit (FMC). For FMC installations, Minimum length shall be one foot (300 mm), Maximum length shall be three feet (900 mm). Minimum size FMC of 3/8".
17. Exposed Dry Interior Locations for HVAC control devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed Class 2 wiring may be extended to complete the final connections in dry locations, provided it does not exceed 18 inches in length.
18. Plenum Spaces: Installation shall comply with requirements of NEC 300.22.
19. Use flat head screws, clips, and straps to fasten raceway channel to surfaces. Mount plumb and level.
20. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
21. Verify surface raceway routing in field. All surface raceway routing shall be approved by the owner. Installation shall follow molding or floor wherever possible. Vertical runs to be located at corners of walls or sides of columns wherever possible. Coordinate location with other trades.

**3.6. BOX INSTALLATION**

A. COORDINATION OF BOX LOCATIONS:
1. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
2. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough in.
3. No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
4. Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8 inch off the lowest part of the metal roof decking material, per NEC 300.4 (E).
5. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.
6. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.
7. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12" from edge of the access door.
8. Locate and install to maintain headroom and to present a neat appearance.
9. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.
10. Boxes installed in the building envelop shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and locations per IEC 502.4.3.

B. PULL AND JUNCTION BOX INSTALLATION:
1. Pull boxes and junction boxes shall be minimum 4 inches square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum junction box size shall be 4 11/16 inches square by 2 1/8 inches deep.
2. Where used with raceway(s) containing conductors of 4 AWG or larger, pull box shall be sized as required unless otherwise noted on the drawings.
3. Where used with raceway(s) containing conductors on systems over 600V, size pull box per NEC 314 Part IV unless otherwise noted as larger on the drawings.
4. Size pull boxes for communications per ANSI/TIA-568-C
5. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.
6. Provide Pull and Junction boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).

7. Support pull and junction boxes independent of conduit.

C. OUTLET BOX INSTALLATION:
1. Do not install boxes back to back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic rated walls.
2. Power:
   a. Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.
   b. Shallow 4 inch square by 1 1/2 inch deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.
3. Low Voltage:
   a. Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction or drywall shall be minimum 4 11/16 inch square by 2 1/8 inch deep with single gang device ring (unless noted otherwise on drawings or in companion specifications). Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
   b. Provide one conduit from each communications Equipment Outlet box. Conduit runs between outlet boxes for communications are not allowed. Terminate conduit above accessible ceiling or on cable tray or as detailed on drawings.
4. Provide knockout closures for unused openings.
5. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.
6. Use multiple gang boxes where more than one device are mounted together; do not use sectional boxes. Sectional boxes may only be used for remodeling applications where it is impractical to install multi-gang boxes. Provide non-metallic barriers to separate wiring of different voltage systems.
7. Install boxes in walls without damaging wall insulation.
8. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
9. Ceiling outlets shall be 4 inch square, minimum 2 1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.
10. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.
11. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
12. Align wall mounted outlet boxes for switches, thermostats, and similar devices.
13. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.
14. Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.
15. Outlet Box adjustable ring and depth device applications:
16. Provide box extenders for boxes that are set too far back in the wall due to un-anticipated wall finishes. Place the box extender over the existing box face to make the box face flush with the wall finish.

D. FLOOR BOX INSTALLATION:
1. Set boxes level and flush with finish flooring material.
2. Serve communications compartments (Tele/Data and AV) in Floor Boxes with conduit(s) dedicated to each compartment. Conduit runs between floor boxes for communications are not allowed. Conduit shall be part of path that allows for cable to be terminated at wiring hub (e.g. Telecom Room) on same floor on which floor box appears unless noted otherwise.

E. GENERAL INSTALLATION:
1. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
2. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
3. Do not install flush mounting box back to back in walls; provide minimum 6” separation. Provide minimum 24” separation in acoustic rated walls.
4. Use stamped steel bridges to fasten flush mounting outlet box between studs.
5. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
6. Use adjustable steel channel fasteners for hung ceiling outlet box.
7. Do not fasten boxes to ceiling support wires.
8. Support boxes independently of conduit.
9. Use gang box where more than one device is mounted together. Do not use sectional box.
10. Use gang box with plaster ring for single device outlets.
11. Adjust flush mounting outlets to make front flush with finished wall material.
12. Install knockout closures in unused box openings.
13. Clean interior of boxes to remove dust, debris, and other material.
14. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
15. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
16. Use flush mounting outlet box in finished areas.

17. Use cast outlet box in exterior locations exposed to the weather and wet locations.

**3.7. CLEANING, INSPECTION, AND TESTING**

A. GENERAL INSEPCTION AND CLEANING:
   1. Verify proper auxiliary device operation and indicators.
   2. Check tightness of accessible bolted electrical joints. Use torque wrench/ screw driver method.
   3. Remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.
   4. Clean All Equipment:
      a. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, bus ducts, MCC's, and the exterior of all Communications and Electronic Safety and Security hardware and equipment.
      b. Loosen attached particles and vacuum them away.
      c. Wipe all insulators and insulator grooves with a clean, dry, lint free rag.
   5. Inspect equipment anchorage.
   6. Inspect equipment and bus alignment.
   7. Check all heater elements for operation and control.
   8. Lubricate nonelectrical equipment per manufacturer's recommendations.

B. 600 Volt CABLE:
   1. Visually inspect cables, lugs, connectors and all other components for physical damage and proper connections.
   2. Check all cable connectors for tightness (with a torque wrench) and clearances. Torque test conductor terminations to manufacturer's recommendations.
   3. Perform a 1000 Vdc megger test on all secondary cables from the substation transformers to the secondary switchboards and on all switchboard feeders.

C. MECHANICAL AND ELECTRICAL INTERLOCK SYSTEM:
   1. Physically test each system to insure proper function, operation and sequencing.
   2. Closure attempt shall be made on locked open devices.
   3. Opening attempt shall be made on locked closed devices.
   4. Key exchange shall be made with devices operated in off normal positions.

D. METAL ENCLOSED BUS DUCT:
   1. Bus shall be inspected for physical damage, cleanliness and proper connection in accordance with the single line diagram.
   2. Inspect for proper bracing, suspension, alignment and enclosure ground.
   3. Check tightness of bolted joints by calibrated torque wrench method.
   4. Make close inspection for any indication of environmental influence on the bus enclosure (i.e. foreign material) which could affect insulation resistance by reducing clearance phase-to-phase or phase-to-ground.

E. GROUND FAULT SYSTEMS:
   1. Inspect the neutral main bonding connection to assure:
   2. Zero sequence system is grounded upstream of sensor.
   3. Ground strap systems are grounded downstream from the sensing device.
   4. Ground connection is made ahead of the neutral disconnect link.

**END OF SECTION**

# SECTION 26 09 00
# INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Instrumentation and control.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
   1. NEMA - National Electrical Manufacturers Association
      a. NEMA ICS 1 General Standards for Industrial Control Systems.
      b. NEMA ICS 2 Standards for Industrial Control Devices, Controllers and Assemblies.
      c. NEMA ICS 6 Enclosures for Industrial Controls and Systems.
      d. NEMA ST 1 Standard for Specialty Transformers (Except General Purpose Type.)

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Submit to NEMA ICS 1 indicating control panel layouts, wiring connections and diagrams, dimensions, support points.
C. Provide dimensions, size, voltage ratings and current ratings.

## PART 2 - PRODUCTS

### 2.1. CONTROL SWITCHES AND STATIONS

A. MANUFACTURERS: Square D 30mm.
B. Contacts: NEMA ICS 2, Form C.
C. Contact Ratings: NEMA ICS 2, A150.
D. Selector Switches Operators: Two, Three position rotary selector switch.
E. Pushbutton Operator: Unguarded, Recessed, Shrouded, Shielded, Covered or lockable type per drawings.
F. Control Stations: Heavy duty oiltight type pushbutton station.

### 2.2. MAGNETIC CONTROL RELAYS

A. MANUFACTURERS: Square D 30mm.
B. Magnetic Control Relays: NEMA ICS 2, Class A300.
C. Contacts: NEMA ICS 2, Form C, per drawing.
D. Contact Ratings: NEMA ICS 2, Class A150, per drawing.
E. Coil Voltage: per drawing

### 2.3. GENERAL PURPOSE CONTACTORS

A. MANUFACTURERS: Square D.
B. NEMA ICS 2, AC general purpose magnetic contactor.
C. Coil Voltage: 120 volts, 60 Hertz or As indicated.
D. Poles: As indicated.
E. Size: NEMA or IEC as indicated on drawings.
F. Accessories as indicated on drawings.

### 2.4. LIGHTING CONTACTORS

A. MANUFACTURERS: Square D.
B. NEMA ICS 2, magnetic lighting contactor.
C. Configuration: Electrically held or mechanically held, 2, 3 wire control as indicated on drawings.
D. 120 volts, 60 Hertz or as indicated on drawings.
E. Poles: As indicated on drawings.

F. Contact Rating: As indicated on drawings.
G. Enclosure: ANSI/NEMA ICS 6, Type 1, 3R, 4, or 12 as required to meet conditions of installation.
H. Accessories: As shown.

**2.5. ACCESSORIES**

A. Pushbuttons and Selector Switches: NEMA ICS 2, general duty type.
B. Indicating Lights: NEMA ICS 2, transformer push to test type.
C. Auxiliary Contacts: NEMA ICS 2, as required.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Install in accordance with manufacturer's instructions and all code requirements.
B. Install individual relays and time delay relays in enclosures.

**END OF SECTION**

# SECTION 26 09 23
# LIGHTING CONTROL DEVICES



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to and applies to all sections in this Division.

### 1.2. SPARE PARTS

A. Provide the following devices as a spare parts. Provide one per specific model used in this project:
1. Sensor
2. Analog dimmer
3. Rewind timer

## PART 2 - PRODUCTS

### 2.1. INTERIOR MOTION AND PHOTO SENSORS

A. BASIS OF DESIGN MANUFACTURER: Sensorswitch
B. Operate with 120-277V and 0-10V dimming signal
1. Low voltage sensors will not be acceptable except:
a. Retrofit installations where line-voltage conduit installation would not be possible. This include installation behind existing drywall
b. Where plans indicate use of low-voltage control is acceptable
c. Where low-voltage control is allowed, use the low-voltage sensor and power pack version of the scheduled line-voltage sensors. Include same features. Schedules will show the line-voltage device regardless. No cost shall be added to contract due to use of low-voltage controls.
C. Occupancy Detection based on Combination of (IR) Technology and passive microphonic (PM) based on scheduled sensor.
D. Where daylight is present, photosensor shall control dim-level of associated fixtures. After sufficient daylight is detected, lights shall be completely turned off. Sensors shall be able to auto calibrate and to differentiate between artificial and natural light. Adaptive delay must prevent system from cycling on cloudy days.
E. Where fixtures operate on 2-poles (e.g. 208V) a 2-pole sensor shall be used and included in bid price.
F. Plans will show sensor locations. Sensors shall be located to enable early detection when person enters the zone but shall also avoid detection bypassing persons in adjacent zones. Locations on plans may have to be adjusted to enable proper function. Coordinate final sensor location with engineer prior installation.
G. Sensors shall receive permanent label indicating the model number. Label shall be placed under removable sensor cover.
H. Flexible conduit behind suspended ceiling (i.e. acoustic, drywall) shall enable relocation of sensor by 5 feet in any direction.
I. Sensors mounted to fixtures may be the scheduled sensor or an equal fixture-mounted type with appropriate bracket.

### 2.2. ANALOG DIMMERS 0-10V

A. BASIS OF DESIGN: Wattstopper RH4BL3PW
B. Color: Match face plate color in same space
C. 3-way installation where indicated on plans
D. Manual Switch shall switch line voltage to downstream controls and fixtures
E. 0-10V sliding dimmer shall control dimming level. Flicker-free from 1-100%

### 2.3. DIMMERS LINE-VOLTAGE (TRACK LIGHTING)

A. BASIS OF DESIGN:
1. Use scheduled dimmer approved by track fixture manufacturer.
2. Use 400VA model or higher.
3. If the listed model is not available, an equal model (same functionality and same model, but re-branded) will be accepted. The originally listed manufacturer has to confirm the model is functionally and electrically the same.

B. Install in separate single-gang box to avoid de-rating.

**2.3. REWIND TIMER**

A. BASIS OF DESIGN: Intermatic FD/FF series
B. No hold function shall be implemented
C. Electromechanical spring wound timer
F. Color: Match face plate color to surrounding in finished spaces. Brushed metal in unfinished spaces.
D. Select Model based on length of time indicated on plans
E. Switch shall be rated for 120/277V, 800W load.

**2.4. PROGRAMMABLE TIMERS**

A. BASIS OF DESIGN: Intermatic ET 2800 Series
B. Minimum Features:
   1. 120-277V wide range input
   2. Astronomic time and dusk-dawn scheduling
   3. Holiday programming
   4. 100-hour superconductor
   5. Non-volatile EEPROM
   6. LED compatible
   7. Relays with zero-crossing technology
C. Models:
   1. 1-circuit: ET2805C
   2. 2-circuit: ET2825C
   3. 4-Circuit: ET2845C
   4. For exterior or wet-rated installation use NEMA 3R-rated version

**2.5. SWITCHES**

A. 20 Amp commercial specification grade series unless noted otherwise
B. SINGLE POLE SWITCH: P&S CSB20AC1, Hubbell: CBS120 or Leviton: CSB1-20
C. 3- AND 4-WAY SWITCHES: Same series and quality as single-pole
D. When water is near switch, use code-approved type of switch for the location.
E. Color: typically white or per architect and owner.
F. Install switches with OFF position down.
G. Install multi-switches close together. Scaled plans may show switches further apart for better readability.

**2.6. LOCKABLE COVERS**

A. BASIS OF DESIGN: Honeywell CG512A, CG511A, CG510A
   1. Use similar types if required to fit all controls.
   2. Owner approval required for differing type.
B. Where indicated on plans, provide lockable cover for all switches, timers and dimmers in the vicinity.
   1. Tags might indicate “COVER” or similar.
   2. If multiple switches in publicly accessible areas are labelled to be have a cover, it is to be assumed that all switches and dimmers in those public areas are to receive a cover even if not every single instance is labelled.
C. All locks shall be keyed the same unless owner provides keying scheme.

**2.7. LOW VOLTAGE CONTROL**

A. Use equipment equivalent to and compatible with the scheduled line-voltage devices. Where available, use same manufacturer and adjust model number to reflect low-voltage version.
B. Use Powerpack with integrated power supply and relay to switch the line voltage and provide low-voltage
C. Low voltage control is only allowed in these applications:
   1. REMOTE MANUAL SWITCH:
      a. Where plans show manual lighting control (i.e. switches) located far outside the controlled zone. Typical applications include:
         i. Switches located in a staff area to control lights in public areas
   2. TIMER OVERRIDE:
      a. Where plans show timer override the local zone is forced on by programmable timer.
      b. Local line voltage sensor can be overridden ON (parallel to sensor) with a power pack relay. Wiring from programmable timer to local powerpack can be low-voltage
   3. INACCESSIBLE LOCATIONS:
      a. Where plans show inaccessible locations. This typically includes existing drywall ceiling.
      b. Areas outside the inaccessible location shall be controlled by line voltage as scheduled. This typically includes a lay-in ceiling adjacent to an inaccessible drywall ceiling.
D. For multiple zones controlled by a single contact in “remote manual switch” and “timer override mode” use Wattstopper BZ-50 powerpacks in parallel (maximum 10 parallel devices). For normally-closed applications, use Wattstopper From-C powerpack.

## PART 3 – EXECUTION

### 3.1. INSTALLATION

A. Install in accordance with manufacturer's instructions and all code requirements.

**END OF SECTION**

# SECTION 26 27 00
# LOW-VOLTAGE DISTRIBUTION EQUIPMENT



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to connections to equipment, switches, receptacles and other distribution equipment

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. NEMA - National Electrical Manufacturers Association
   1. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. NEMA ICS 4 Terminal Blocks for Industrial Control Equipment and Systems.

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Provide product data showing model numbers, configurations, finishes, dimensions, and manufacturer's instructions.

## PART 2 - PRODUCTS

### 2.1. ELECTRICAL CABINETS AND ENCLOSURES

A. HINGED COVER ENCLOSURES
   1. MANUFACTURERS: Hoffman, Saginaw.
   2. CONSTRUCTIOn: NEMA 250, Type 1, 3R, 4, 4x steel enclosure as required for application.
   3. COVERS: Continuous hinge, held closed by flush latch operable by screwdriver. Outdoor enclosures to have hasp and staple for padlock.
   4. Provide interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
   5. Enclosure Finish: Manufacturer's standard enamel.
B. TERMINAL BLOCKS
   1. MANUFACTURERS: Allen-Bradley, General Electric, Square D.
   2. TERMINAL BLOCKS: ANSI/NEMA ICS 4.
   3. POWER TERMINALS: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
   4. SIGNAL AND CONTROL TERMINALS: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
   5. Provide ground bus terminal block, with each connector bonded to enclosure. Ground enclosure door.
C. ACCESSORIES
   1. Plastic Raceway: Hoffman, Panduit, Tyton
   2. Description: Slotted, light gray with cover.

### 2.2. WIRING DEVICES

A. Device colors shall be selected by architect’s interior designer and Agency representative during shop drawing review.
B. WALL SWITCHES:
   1. 20 Amp commercial specification grade series unless noted otherwise
   2. SINGLE POLE SWITCH:
      a. P&S CSB20AC1
      b. Hubbell: CBS120
      c. Leviton: CSB1-20
   3. DOUBLE POLE SWITCH:
      a. P&S CSB20AC2
      b. Hubbell CSB220
      c. Leviton CSB2-20
   4. 3- AND 4-WAY SWITCHES: Same series and quality as single-pole

5. INDICATOR SWITCH:
    a. P&S PS20AC1-XSL, PS20AC3-XSL
    b. Hubbell SNAP1221PL
    c. Leviton 1221-PL, 1223-PL
6. LOCATOR SWITCH:
    a. P&S: PS20AC1-XPL, PS20AC3-XPL
    b. Hubbell SNAP1221IL
    c. Leviton: 1221-LH, 1223-LH
7. When water is near switch, use code-approved type of switch for the location.
8. Color: typically white or per architect and owner.
9. Install switches with OFF position down.
10. Install multi-switches close together. Scaled plans may show switches further apart for better readability.

**2.3. ENCLOSED SWITCHES**

A. MANUFACTURERS: Square D

B. FUSIBLE SWITCH ASSEMBLIES: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.

C. NONFUSIBLE SWITCH ASSEMBLIES: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. ENCLOSURES: NEMA KS 1.
    1. Interior Dry Locations: Type 1.
    2. Exterior Locations: Type 3R.
    3. Wash down Locations: Type 4,4X.

**2.4. RECEPTACLES**

A. GENERAL:
    1. General Requirements: NEMA Type 5 20R, Nylon or high impact resistant face. Receptacles shall be UL498 Listed and meet Federal Specification WC-596. All duplex receptacles shall be heavy duty Specification Grade, 20 amp rated.
    2. Generally, all receptacles shall be duplex convenience type unless otherwise noted.
    3. All receptacles on emergency circuits shall have a red face with matching red cover plate.
    4. All receptacles designated as isolated ground shall have an isolated ground triangle imprint on the face of the receptacle.
    5. All receptacles installed in bathrooms, kitchens, and within 6 feet of the outside edge of sinks shall be GFCI type.
    6. All receptacles installed in outdoor locations, garages, rooftops, and in other damp or wet locations shall be GFCI type with a weather-resistant (WR) rating.

B. CONVENIENCE AND STRAIGHT BLADE RECEPTACLES: All receptacles shall be back- and side-wired, screw clamp type, suitable for solid or stranded wire up to #10 AWG, with a separate green ground screw. Receptacles shall be as follows:
    1. Hubbell 5362
    2. Leviton 5362-S
    3. Pass & Seymour 5362

C. GFCI RECEPTACLES: Duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class A, including self-test functionality and reverse line-load misfire function repeatability. GFCI receptacles shall be as follows:
    1. Hubbell GFR5362SG
    2. Leviton GFNT2-
    3. Pass & Seymour 2097

D. GFCI RECEPTACLES WITH A WEATHER-RESISTANT (WR) RATING: Weather-Resistant duplex convenience receptacle with integral ground fault current interrupter meeting the requirements of UL standard 943 Class-A, including self-test functionality and reverse line-load misfire function repeatability. WR GFCI receptacles shall be as follows:
    1. Hubbell GFR5362SG
    2. Leviton GFWR2-
    3. Pass & Seymour 2097TRWR

E. WALL PLATES:
    1. DECORATIVE COVER PLATE: Smooth Thermoplastic (nylon): P&S TP series, Hubbell NP series, Leviton 80700 series
    2. METAL PLATE: Surface mount. Appleton: 8300 series or equal.
    3. WEATHERPROOF COVER PLATE: Gasketed aluminum with hinged gasketed in-use aluminum device cover.

**2.5. CORDS AND CAPS**

A. Straight blade Attachment Plug: NEMA WD 1.

B. Locking blade Attachment Plug: NEMA WD 5.

C. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

D. Cord Construction: Oil resistant thermoset insulated multi-conductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

E. Cord Size: Suitable for connected load of equipment and rating of branch circuit overcurrent protection.

**PART 3 – EXECUTION**

**3.1. INSTALLATION**

A. Install in accordance with manufacturer's instructions and all code requirements.
B. Test all wiring and verify openings are at correct locations, neatly cut and will be completely covered by wall plates.
C. Connect wiring device grounding terminal to outlet box with bonding jumper or branch circuit equipment grounding conductor.
D. Install top of wall switch box 48 inches above finished floor.
E. Install bottom of receptacle box 18 inches above finished floor or 6 inches above counter.
F. A #12 green insulated ground conductor shall be installed with circuit conductors to all receptacles.

**3.2. EQUIPMENT CONNECTION**

A. PREPARATION:
   1. Verify that equipment is ready for electrical connection, wiring, and energizing.
   2. Working space for equipment shall be provided that is likely to require examination, adjustment, servicing or maintenance per NEC 110.26(A)(1) table.
   3. 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.
B. INSTALLATION
   1. Use wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
   2. Provide a green equipment ground conductor for all installed equipment wiring.
   3. Make conduit connections to equipment using flexible PVC-coated metal conduit.
   4. Requirements of NEC Article 300.22 shall apply for boxes, conduit, conduit connections to equipment, devices and luminaire located in Mechanical Plenum spaces.
   5. Install pre finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain relief clamps.
   6. Provide suitable strain relief clamps for cord connections to outlet boxes and equipment connection boxes.
   7. Make wiring connections in control panel or in wiring compartment of pre wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
   8. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
   9. All 120V single phase motor operated equipment such as fan coil units, unit heaters, door operators, shall be provided with a SSY, 2 gang combination plug fuse holder/ switch mounted adjacent to equipment.
C. Hand Dryers: Provide handle lock on source circuit breaker to serve as required lock open disconnect.
D. Drinking Fountains and Bottle Fill Fountains: Provide GFCI source circuit breaker to serve receptacle at fountain.
E. Knox Box: Provide 3/4” conduit stubbed between Knox Box and nearest interior location above accessible ceiling.
F. HVAC AND PLUMBING CONNECTIONS
   1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters, variable frequency drives (VFDs), controller overcurrent protection and disconnects to motors or to packaged control motor protection panels.
   2. Packaged control motor protection panels may include disconnects and starters and overcurrent protection. Provide all wiring between source and packaged control motor protection panel and motors. Install panel on exterior wall or adjacent to AHU’s.
   3. Contractor shall verify with mechanical contractor the electrical requirements including voltages, horsepower, disconnecting means, starters and variable frequency drives for motors and equipment prior to ordering circuit breakers, disconnects, controller overcurrent protection devices and starters.
   4. VFD Installations: Input power wiring shall be installed in a separate conduit, output power wiring shall be installed in a separate conduit and control wiring shall be installed in a separate conduit. Do not mix input power, output power, or control wiring in a common conduit. Separate conduits for input and output power wiring shall be provided for each motor.
   5. VFD Installations: Output power wiring for more than one motor shall not share a common conduit.
   6. VFD installations: Provide aux contact in local disconnect to de energize VFD when opening local disconnect.
   7. Provide 120 volts or 277V to each temperature control panel. Coordinate voltage, quantity and exact locations with HVAC/DDC contractors.
   8. Provide 120V, single phase 20 ampere combination lighting and convenience outlet circuit and switching means to serve field installed receptacles and interior lighting within each HVAC unit. Each access section shall contain a minimum of one marine grade light fixture/ luminaire. Sections wider than 6 feet shall have multiple marine grade light fixtures/luminaire with maximum spacing of 6 feet. Provide separate junction box at exterior of air handling unit.
   9. All conduit penetrations to AHU’s shall be sealed by electrical contractor.
   10. Each motor terminal box shall be connected with a minimum 12", maximum 36" piece of flexible PVC-coated metal conduit to a fixed junction box. When connections are located in Mechanical Plenum spaces located within Mechanical equipment, flexible metal conduit shall be utilized. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
   11. Provide separate junction box for each engineered supply, return/relief/exhaust system at exterior of air handling unit.
   12. All wiring shall be routed in conduit and a minimum of 12 AWG wire shall be used for all luminaires, switches and convenience outlets. All lighting, switches and convenience outlet circuits shall be a minimum of 20 amperes.
   13. Check for proper rotation of each motor.

14. All heating, air conditioning and refrigeration equipment installed on the exterior of the building or rooftop shall have a 120V, single phase, 20 ampere rated outlet at an accessible location within 25 feet of the equipment.

**END OF SECTION**

# 26 28 00
# LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Protection Devices.
B. Provide fused disconnects to all motor-driven appliances, motors and controllers regardless of distance and location of electrical panel and breakers.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. NEMA - National Electrical Manufacturers Association - www.nema.org
   1. NEMA AB 1 Molded Case Circuit Breakers
   2. NEMA KS 1 Enclosed Switches

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Switch ratings including:
   1. Short-circuit rating
   2. Voltage
   3. Continuous current
C. Fuse ratings and type
D. Cable terminal sizes

### 1.4. PERFORMANCE REQUIREMENTS

A. Safety switches used as motor disconnects shall be horsepower rated for the motor served.

### 1.5. EXTRA MATERIAL

A. Provide 3 spare fuses of each type.

## PART 2 - PRODUCTS

### 2.1. FUSES

A. MANUFACTURERS: Bussmann, Gould Shawmut, Littelfuse.
B. Interrupting Rating: 200,000 rms amperes.
C. FUSES 600A OR LESS:
   1. NEMA FU 1, Class as specified or indicated.
   2. Dual element
   3. Main Service Switches: Class RK1 time delay.
   4. Motor Load Feeder Switches: Class RK1 time delay.
   5. Lighting Load Feeder Switches: Class RK1 time delay.
   6. Motor Branch Circuits: Class RK1 time delay.
D. FUSES 601 A AND ABOVE:
   1. Low Peak
   2. UL Class L
E. Fuses shall not be installed until equipment is ready to be energized.

### 2.2. CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: Inverse time with integral thermal and instantaneous magnetic trip elements in each pole.
B. Electronic Trip Circuit Breaker: As scheduled on the drawings, electronic circuit breakers shall have, at a minimum, adjustments for long time trip, short time trip and instantaneous trip.
C. Provide integral ground fault sensing with adjustable ground fault trip where indicated on the drawings.
D. Provided for Arc Energy Reduction where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1200A or higher.

**2.3. DISCONNECTS**

A. MANUFACTURER: Square D

B. Construction
   1. Switches shall have a black handle through 100 A (except on plug-fuse type) that is easily pad-lockable with two 3/8-inch shank locks in the OFF position. Higher rating shall have a red handle that is easily pad-lockable with three 3/8-inch shank locks in the OFF position
   2. All switches shall have hinged doors. Door padlocking capability shall be provided.
   3. Switches shall be suitable for systems capable of 100 kA with Class R.

C. Switch Mechanism:
   1. Safety switches shall be quick-make quick-break type with permanently attached arc suppressors and constructed such that switch blades are visible in the "OFF" position with the door open.
   2. Double-make, double-break switch blade feature shall be provided.
   3. The operating handle shall be an integral part of the box, not of the cover. Switch shall have provision to padlock in the "OFF" position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the "ON" position or closing of the switch mechanism when the switch door is open.
   4. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel.
   5. All current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts.
   6. Lugs shall be copper-plated and front removable. Switch blades shall be copper.

D. Fusing: Provide fusible safety switches where indicated. Fuse clips shall be positive pressure rejection type fuse clips suitable for use with UL Class R fuses.

E. Neutral: Provide safety switches with number of switched poles as indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch.

F. Enclosures
   1. All enclosures shall be NEMA 1 general purpose unless otherwise noted.
   2. Paint color shall be ANSI 61 gray
   3. NEMA 1 enclosures shall have tangential knockouts on the top, bottom and sides of the enclosure. NEMA 3R enclosures shall have tangential knockouts on the bottom and sides. (Not applicable to NEMA 1 plug-fuse type).

G. Install within sight of device controlled to ensure visibility of on/off position from all typical maintenance locations.

**END OF SECTION**

**SECTION 26 33 23.13**
**CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING**



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Battery inverters for emergency lighting.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract. Examples of related sections include, but are not limited to:
B. UL – Underwriters Laboratory - www.ul.com
   1. UL 924 - Standard for Emergency Lighting and Power Equipment

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Factory circuit breaker number and sizing schedule

### 1.4. QUALITY ASSURANCE

A. Provide factory-startup and perform all required tests and adjustments.
B. Test lighting on battery operation for 90 minutes

## PART 2 - PRODUCTS

### 2.1. BATTERY INVERTER

C. BASIS OF DESIGN MANUFACTURERS: Myers
D. Ambient operating temperature minimum 32°F and maximum 100°F. Forced fan cooling during emergency mode.
E. Performance:
   1. Rated power output for 90 minutes
   2. Rated for fluorescent and LED lighting
   3. Under normal operation, bypass inverter. Transfer time 2ms or less
   4. Harmonic distortion < 10%
   5. Operating efficiency at full load >97%
   6. Output frequency 60Hz +/- 0.5Hz
   7. Overload Rating: 115% momentarily
   8. Audible noise less than 50 dB(A) at 3ft
F. Protection:
   1. Input circuit breaker and output circuit breaker sized based on unit output rating
      a. No single circuit shall be larger than 16A. Add number of circuits as required for design load.
   2. Unless plans show a specific layout, contractor can choose wiring path from inverter to the emergency fixtures. Balance loads evenly over the circuits.
G. Battery and charger:
   1. Maintenance-free sealed lead-calcium
   2. micro-processor controlled charger with 24 hour re-charge time
H. Diagnosis:
   1. Displaying input voltage, output voltage, battery voltage, battery current, output current, output VA, temperature, date, time and inverter wattage with controls and logging data
   2. Audible alarm will indicate high/low battery charger fault, near low battery, low battery, load reduction fault, output overload, high/low AC input volts, high ambient temperature, inverter fault, output fault.
   3. Program unit to meet all operation and self-testing requirements of IFC and NFPA 101. At minimum automatically test monthly for 5 minutes and annually for 90 minutes and provide log.
I. INCLUDED FEATURES:
   1. Inverter on Dry Form Contact
   2. Internal Maintenance bypass
   3. Output Trip for supervised Alarm
J. HEATER: In spaces heated to less than 50F heating setpoint, provide a cabinet-unit heater. Refer to HVAC or other plans.

## PART 3 – INSTALLATION

### 3.1. TESTING

A. Perform Factory Startup
B. Inspect for physical damage and evidence of corrosion. Clean units.
C. Measure system charging voltage and each individual cell voltage.
D. Measure the electrolyte specific gravity and level.

**END OF SECTION**

# SECTION 26 50 00
# LIGHTING



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to lighting fixtures.
B. All light fixtures marked as emergency light fixtures (black dot on plans) and EXIT signs shall be powered by the emergency lighting source. Refer to plans whether that source is a central battery inverter or a generator.
C. Egress light fixtures shall be equipped with fire alarm relay. Upon activation of fire alarm and/or power outage the following shall happen:
    1. Turn light on regardless of local lighting control (sensor or switch)
    2. Turn light to 100% light output regardless of local dimming signal (dimmer or sensor)

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. LM-79-08 (or latest) – IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
C. LM-80-08 (or latest) – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
D. TM-21-11 (or latest) – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
E. NEMA - National Electrical Manufacturers Association - www.nema.org
    1. NEMA SSL 1-2010 (or latest) – Electronic Drivers for LED Devices, Arrays, or Systems.
F. UL – Underwriters Laboratory - www.ul.com
    1. UL 924 - Standard for Emergency Lighting and Power Equipment

### 1.3. SUBMITTALS

A. Luminaire:
    1. Manufacturer and catalog number,
    2. Type (identification) as indicated on the plans and schedule,
    3. Delivered lumens,
    4. Input watts,
    5. Efficacy,
    6. Color rendering index.
B. Driver:
    1. Manufacturer and catalog number,
    2. Type (Non-Dimming, Step-dimming, Continuous dimming, etc.),
    3. Power Factor, Crest Factor, THD, etc.

### 1.4. PERFORMANCE REQUIREMENTS

A. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
B. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
C. Driver shall operate normally for input voltage fluctuations of plus or minus 10 percent and be rated for 120-277V.
D. Dimming shall employ 0-10V signal
E. Driver shall have a maximum Total Harmonic Distortion (THD) of <20% at full input power and across specified voltage range.
F. If the manufacturer offers a higher, or lower efficiency option, the higher efficiency option is to be used.
G. Include all accessories required for proper installation compatible with the wall, ceiling and other mounting surfaces. This includes, but is not limited to, suspension cables, mounting clips, and other items. Linear fixtures shown to be installed in a row shall include all required connector, and end pieces. Schedules don't necessarily show those accessories.

### 1.5. SPARE PARTS

A. Provide the following devices as a spare parts. Provide one per specific model used in this project:
   1. UL 924 relay
   2. Light fixtures: none unless schedule indicates a number of spare fixtures to be provided
   3. LED driver

### 1.6. WARRANTY

A. 5 year non-prorated warranty on fixture and driver

## PART 2 - PRODUCTS

### 2.1. TRACK LIGHTS

A. Provide complete track system from fixture manufacturer. Include all required adapters, connectors, end pieces, pendant kits etc. Track shall match fixture color.
B. Plans will show location and approximate length of track systems. Contractor shall derive required track material needs.
C. Install current-limiting feed for each dimmer. Select current based on down-rated dimmer (typically 75% of dimmer rating). Example: 400 VA dimmer requires <=2.5A current limiting device. Use mini end-feed. Unless noted otherwise, select largest possible (based on de-rating) current limiter to allow future addition of track heads.
D. Corner connectors shall be solid (not accordion style) where installation angles allow use of pre-fabricated corners.

### 2.2. AC-POWERED EXIT SIGNS

A. Approved Manufacturer: Lithonia or approved equal
   1. Approved Substitute: Chloride VERW
B. UL-damp location listed 50°F – 104°F.
C. MOUNTING:
   1. Wall, ceiling, back, or end mounting as required by location.
   2. Provide required number of face plates
D. FINISH: White face for both with clear baked enamel protective coating.
E. LAMPS: Light-emitting diode (LED), red color for EXIT signs.
F. MOUNTING HEIGHT: 90” above floor or 1” above door casing where mounted over doors. Where ceiling height is too low to maintain at least 6’8”clearance, locate sign next to path of egress. Consult designer for exact location.
G. Power from emergency lighting power source.
H. Enable directional arrows as shown or plans or to direct occupants towards exits. Confer with designer on egress paths.

### 2.3. FIRE ALARM RELAY

A. BASIS OF DESIGN: Functional Devices ESRN
B. Multiple relays wire in parallel. 0.016 mA for each relay.
C. UL 924 rated as “Emergency Lighting Equipment”
D. UL 2043 plenum rated
E. LED indicators for normal voltage, emergency voltage and load status
F. When fire alarm is triggered or if regular power is out, the relay shall force emergency lights on at 100% brightness level (override any dimming signals).
G. When fixture is outdoors, install relay in adjacent indoor space at accessible location.
H. For fixture-mounted sensors re-fit fixture to use appropriate relay inside or external to the fixture.
I. Install one relay per emergency lighting zone. Wire to emergency power source (inverter or generator).
J. Wire to local fire alarm panel. Contractor shall coordinate with fire alarm contractor and manufacturer the relay requirements. Provide additional relays as required to work with the different alarm panel types. Re-program or re-configure fire alarm panel as required to enable required functionality.

### 2.4. EXTERIOR LUMINAIRES AND ACCESSOIRES

A. Driver shall operate with 120-277V and 0-10V dimming signal.
B. Fixture must be water- and dust tight and corrosion resistant and UL listed for location.
C. Provide with built-in sensor and controls where schedule indicates fixture-control.

### 2.5. POLES

A. Furnish poles as specified in schedule on Drawings. Poles shall be galvanized. Handhole in pole shall have removable weatherproof cover. Anchor bolts as recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.
B. No precast bases for poles are permitted. Construct from reinforced concrete in sizes as shown on drawings and to meet the minimum structural requirements of AASHTO (American Association of State Highway and Transportation Officials) or as designed by a licensed structural engineer. The exposed surface area of the foundation shall have the forms removed and the concrete rubbed out to a smooth finish.
C. Provide 3/4" X 10'0" ground rods in the pole foundation so that the ground rod projects 3" up into center of pole base.

D. Install lighting poles at locations indicated. Install poles plumb. Provide shims or double nuts to adjust plumb. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.
E. Provide double nuts to adjust plumb. Grout around each base.
F. Minimum underground conduit size is 1 inch.
G. Underground and exterior wire shall be type XHHW-2 or USE.
H. Project anchor bolts 2 inches (50 mm) minimum above base. Install all anchor bolts and handhole fasteners with anti-seize compound.

**2.6. PILOT LIGHTS**

A. BASIS OF DESIGN: Line voltage indicator-LED in color specified
B. Visibility from a 180° angle
C. In finished areas only expose the tip of the pilot light. Conceal box.

**PART 3 – INSTALLATION**

**3.1. INSTALLATION**

A. GENERAL:
   1. Contractor shall install luminaire supports as required. Luminaire installations with luminaires supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all luminaires adequately, providing extra steel work for the support of luminaires if required. Any components necessary for mounting luminaires shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.
   2. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
   3. Bond luminaires and metal accessories to branch circuit equipment grounding conductor.
B. SUSPENDED FIXTURES:
   1. Use fixture manufacturer provided cables, connectors, end pieces and other accessories required for a stable and neat looking installation.
   2. Install suspended luminaires using aircraft cable, or pendants supported from swivel hangers. Heavy duty chain supports may be used where indicated on the luminaire schedule. Provide aircraft cable, pendants, or chain lengths required to suspend luminaire at indicated height. All aircraft cables or pendant supported luminaires shall have an independent support to structure at all cable or pendant support locations. When chain is used, tie-wrap the luminaire wiring method to the chain.
C. CEILING:
   1. Support luminaires larger than 2 x 4 foot (600 x 1200 mm) size independent of ceiling framing.
   2. Provide independent support for all luminaires over 50 lbs.
   3. Provide required surface- or drywall kit required for specific installation location.
   4. Verify that recessed fixtures are installed with hold down clips.
   5. Install recessed luminaires to permit removal from below.
   6. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

**END OF SECTION**

# SECTION 32 39 13
# MANUFACTURED METAL BOLLARDS



## PART 1 – GENERAL

### 1.1. SCOPE

A. This section includes information common to Metal bollards and crash barriers.
B.

### 1.2. REFERENCES

A. Work under this section depends on applicable provisions from other sections and the plan set in this contract.
B. ASTM - American Society for Testing and Materials - www.astm.org
   1. ASTM A 36 - Standard Specification for Carbon Structural Steel.
   2. ASTM A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, ZincCoated, Welded and Seamless.
   3. ASTM A 312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   4. ASTM A 536 - Standard Specification for Ductile Iron Castings.
   5. ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
C. SSPC - SSPC: The Society for Protective Coatings - www.sspc.org
   1. SSPC Q195 SSPC, Q235 SSPC and Q235 SSPC.

### 1.3. SUBMITTALS

A. All submittal requirements listed elsewhere in this contract.
B. Shop Drawings: Show mounted items and coordination required for work specified in other Sections; indicate construction and installation details.

### 1.4. QUALITY ASSURANCE

A. Damaged, cracked, chipped, deformed or marred products are not acceptable. Field touchup minor imperfections in accordance with manufacturer's instructions.

## PART 2 - PRODUCTS

### 2.1. METAL BOLLARDS

A. MANUFACTURER: Idealshield, Ontariobollards or approved equal
B. Color: Safety Yellow RAL 1023
C. Footing and fill: 3000 psi minimum concrete.
D. Pipe; Schedule 80
E. Contractor may choose between 2 options:
   1. Galvanized:
      a. Galvanized Schedule 80
      b. Upright Finish: ¼" Bollard Cover
   2. Carbon Steel:
      a. Steel: ASTM A36
      b. Upright Finish:
         i. Type: Polyester powder coat finish utilizing an epoxy prime coat and apolyester top coat.
         ii. Performance: 1000 hours salt-spray resistance as per ASTM D 1654
      c. Base Finish:
         i. Type: Environmental Friendly KTL Finish with UV Gloss
         ii. Performance: 1000 hours salt-spray resistance as per ASTM D 1654.
F. SIZE:
   1. Unless noted differently, Upright height shall be 5'
   2. Unless noted differently. Diameter shall be 8"
   3. Core Depth shall be 36"

## PART 3 – EXECUTION

### 3.1. INSTALLATION

A. Mark locations and verify with designer before proceeding.
B. Install in accordance with manufacturer's instructions and all code requirements.

C. Check for hazards underground, such as wiring and pipes.
D. Using a core drill, make a hole in the concrete with a diameter that allows 6 extra inches on each side of the pipe bollard base.
    1. In locations with suspected underground facilities, use a water/vacuum (vactor truck or similar) to create hole
E. Use a vacuum to remove all water and debris.
F. Dig the hole using an auger or a post hole digger.
G. Set 2” gravel drainage base and allow for 6” concrete under the bollard
H. Mix and pour the concrete around bollard.
I. Fill the hollow pipe bollard with concrete. Install plumb and reinforce bollard with bracing
J. Fill cores of bollards with concrete. Strike concrete level with top of steel bollard or dome approximately 2” above.
K. Allow 3 days for the concrete to cure before removing braces resuming work in that area.
L. After the curing period, inspect the site for any damage or scratches on the bollard

**END OF SECTION**