

الجمهورية اللبنانية

وزارة الثقافة

الملحق رقم 6

المواصفات الفنية

UNESCO Palace HVAC System 26101

شراء وتركيب اجهزة التكييف والتبريد وسائر الاعمال المرتبطة بها في قصر الاونيسكو -  
وزارة الثقافة

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## SECTION 011000 - SUMMARY

### PART 1- GENERAL

#### 1.01 PROJECT

- A. Project Name: UNESCO Palace HVAC System
- B. Employer's Name: Ministry of Culture (MOC).
- C. Engineer's Name: To be appointed by the Employer.
- D. The Project consists of the implementation of a new HVAC system.

#### 1.02 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is indicated on drawings.

#### 1.03 OWNER OCCUPANCY

- A. Employer intends to continue to occupy adjacent portions of the existing building during the entire project period.
- B. Schedule the Work to accommodate Employer occupancy.

#### 1.04 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
  - 1. Locate and conduct construction activities in ways that will limit disturbance to site.
- B. Provide access to and from site as required by law and by Employer:
  - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
  - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- C. Existing building spaces may not be used for storage.
  - 1. Use designated storage area for the purpose of storing removed/dismantled materials and equipment, as directed by the Employer.
- D. Time Restrictions:
  - 1. Refer to Section 015600 Safety and Environmental Requirements
- E. Utility Outages and Shutdown:
  - 1. Limit disruption of utility services to hours the building is unoccupied.
  - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Employer and authorities having jurisdiction.
  - 3. Prevent accidental disruption of utility services to other facilities.

### PART 2- PRODUCTS - NOT USED

### PART 3- EXECUTION - NOT USED

END OF SECTION 011000



## SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

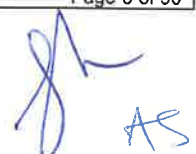
### PART 1- GENERAL

#### 1.01 SECTION INCLUDES

- A. Insurance
- B. General administrative requirements.
- C. Project Manager
- D. Resident Site Supervisor
- E. Preconstruction meeting.
- F. Progress meetings.
- G. Contractor's daily reports.
- H. Photographs of existing situation
- I. Progress photographs.
- J. Submittals for review, information, and project closeout.
- K. Requests for Interpretation (RFI) procedures.
- L. Submittal procedures.

#### 1.02 INSURANCE

- A. Workmen's Compensation Insurance Policy:
  - 1. To be issued by a reputable and accredited institution operating in the Lebanese market since more than 20 years.
  - 2. Policy shall be in accordance with Lebanese Labor Law decree no. 136 dated 16/09/1983.
  - 3. Insurance shall cover all employees, technicians, laborers, day hires of the Contractor, subcontractors, Employer, and Engineer,
  - 4. Insurance shall be against work accidents while engaged directly or indirectly in the construction works.
  - 5. Policy shall be issued to the order of Contractor, Employer, Engineer, and/or contractors and / or subcontractors.
  - 6. Particulars of the insurance policy shall be no less than the following:
    - a. Maximum liability shall be no less than \$25,000 per accident and \$100,000 in the aggregate.
    - b. The insured are to be treated at 2nd class hospitalization (if site workers) or 1st class hospitalization (if engineering or managerial staff) at reputable hospitals.
    - c. Cover shall be extended to include weekends, public holidays, night shifts, and overtime.
    - d. Cover shall be extended to include hernia, lumbago, and muscular strain up to \$5,000.
    - e. Waiver of subrogation against Contractor and/or subcontractors.
    - f. Insured shall be covered while commuting anywhere in Lebanon and from their residence to work places and vice versa.
- B. Contractor's All Risk Insurance Policy:
  - 1. To be issued by a reputable and accredited institution operating in the Lebanese market since more than 20 years.

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2. Policy shall be issued to the order of Contractor and Employer.
3. Particulars of the insurance policy shall be no less than the following:
  - a. Works, Materials, Plants, Removal of Debris, and the Contractor's Equipment: Full contract value plus \$500,000.
  - b. Third Party Liability: \$250,000
  - c. Existing property belonging to the insured: \$250,000
  - d. Unlimited number of occurrences.
  - e. Waiver of subrogation against Contractor and/or subcontractors.

**1.03 GENERAL ADMINISTRATIVE REQUIREMENTS**

- A. Make the following types of submittals to Engineer:
  1. Requests for Interpretation (RFI).
  2. Requests for substitution.
  3. Test and inspection reports.
  4. Design data.
  5. Manufacturer's instructions and field reports.
  6. Applications for payment and change order requests.
  7. Progress schedules.
  8. Coordination drawings.
  9. Correction Punch List and Final Correction Punch List for Substantial Completion.
  10. Closeout submittals.

**1.04 PROJECT MANAGER**

- A. Nominate for Engineer's approval a Project Manager to act as the single point of contact and to represent the Contractor in all project-related activities.
- B. Project Manager is to have 10 years' experience in similar projects.
- C. Project Manager is to remain assigned on full-time basis to the project for the duration of site activities.

**1.05 RESIDENT SITE SUPERVISOR**

- A. Appoint for Engineer's approval a resident site supervisor to act as the Contractor's site representative.
- B. Site Supervisor is to be present in the premises at all times whenever site works are in progress.
- C. Site Supervisor is to have 15 years' experience in similar project.

**PART 2- PRODUCTS - NOT USED**

**PART 3- EXECUTION**

**3.01 DAILY CONSTRUCTION REPORTS**

- A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.
- B. In addition to transmitting electronically a copy to Employer and Engineer, submit two printed copies at weekly intervals.
- C. Prepare a daily construction report recording the following information concerning events at Project site and project progress:



1. Date.
2. High and low temperatures, and general weather conditions.
3. List of subcontractors at Project site.
4. List of separate contractors at Project site.
5. Approximate count of personnel at Project site.
  - a. Include a breakdown for supervisors, laborers, journeymen, equipment operators, and helpers.
6. Major equipment at Project site.
7. Material deliveries.
8. Safety, environmental, or industrial relations incidents.
9. Meetings and significant decisions.
10. Unusual events (submit a separate special report).
11. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
12. Testing and/or inspections performed.
13. List of verbal instruction given by Employer and/or Engineer.
14. Signature of Contractor's authorized representative.

### **3.02 PHOTOGRAPHS OF EXISTING SITUATION**

- A. A Photographic Survey of the existing situation in all accessible areas of the premises is required.
- B. It is the Contractor's responsibility to ensure that no undue damage is incurred on areas within the premises that will not receive any alteration work. The Contractor will restore any damages at his own cost.
- C. It is the Contractor's responsibility to provide any additional photographic record for the existing premises.
- D. Prior to any site mobilization and any work being performed on site, provide photographs clearly documenting the existing conditions and highlighting the elements that deviate from the Employer's Photographic Survey.

### **3.03 REQUESTS FOR INTERPRETATION (RFI)**

- A. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- B. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
  1. Prepare a separate RFI for each specific item.
    - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
    - b. Do not forward requests which solely require internal coordination between subcontractors.
  2. Prepare in a format and with content acceptable to Employer.



- C. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
- D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
- E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- F. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
- G. Review Time: Engineer will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.

### 3.04 SUBMITTAL REVIEW

- A. Engineer's actions on items submitted for review:
  - 1. Authorizing purchasing, fabrication, delivery, and installation:
    - a. "Approved".
    - b. "Approved as Noted, Resubmission not required".
      - 1. At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
    - c. "Approved as Noted, Resubmit for Record".
      - 1. Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.
  - 2. Not Authorizing fabrication, delivery, and installation:

END OF SECTION 013000



## **SECTION 013553 SECURITY PROCEDURES**

### **PART 1- GENERAL**

#### **1.01 SECTION INCLUDES**

- A. Security measures including entry control, personnel identification, and miscellaneous restrictions.

#### **1.02 RELATED REQUIREMENTS**

- A. Section 015600 - Safety and Environmental Requirements

#### **1.03 ENTRY CONTROL**

- A. Restrict entrance of persons and vehicles into Project site and existing facilities.
- B. Submit to the Client a list of authorized representatives and personnel, including site workers and technical crews with ID copies.
- C. Allow entrance only to authorized persons with proper identification.
- D. Maintain log of workers and visitors, make available to Employer on request.
- E. Contractor shall control entrance of persons and vehicles related to Employer's operations.

#### **1.04 PERSONNEL IDENTIFICATION**

- A. Provide identification badge to each person authorized to enter premises.
- B. Maintain a list of accredited persons, submit copy to Employer on request.

#### **1.05 RESTRICTIONS**

- A. Do not allow cameras on site or photographs taken except by written approval of Employer.

### **PART 2- PRODUCTS - NOT USED**

### **PART 3- EXECUTION - NOT USED**

END OF SECTION 013553



## SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

### PART 1- GENERAL

#### 1.01 SECTION INCLUDES

- A. Temporary utilities.
- B. Vehicular access and parking.
- C. Waste removal facilities and services.

#### 1.02 RELATED REQUIREMENTS

- A. Section 013553 - Security Procedures

#### 1.03 TEMPORARY UTILITIES

- A. Provide and pay for all electrical power, lighting, and water required.

#### 1.04 VEHICULAR ACCESS AND PARKING

- A. Coordinate access and haul routes with governing authorities and Employer.
- B. Provide and maintain access to fire hydrants, free of obstructions.
- C. Existing parking areas may be used for construction parking.

#### 1.05 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site periodically.
- C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

#### 1.06 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition.

### PART 2- PRODUCTS - NOT USED

### PART 3- EXECUTION - NOT USED

END OF SECTION 015000



## SECTION 015600 - SAFETY AND ENVIRONMENTAL REQUIREMENTS

### PART 1- GENERAL

#### 1.01 SECTION INCLUDES

- A. This section covers the safety and environmental requirements governing in the project.

#### 1.02 GENERAL REQUIREMENTS

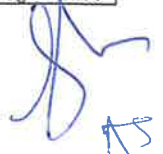
- A. Maintain full compliance with these requirements throughout the duration of the project.
- B. Maintain full compliance with governing laws and regulations in the locality of the project.
- C. Ensure that all Contractor's representatives are familiarized with these requirements and fully understand and abide by them.
- D. Take all measures necessary, whether mentioned explicitly, implied, or not mentioned in these requirements, to ensure the safety of all personnel, authorized visitors, and concerned individuals on the project.
- E. Take all measures necessary, whether mentioned explicitly, implied, or not mentioned in these requirements, to ensure upkeep of environmental conditions in and around the site.
- F. Avoid damage or nuisance to neighboring properties and individuals.

#### 1.03 MANDATORY COMPLIANCE WITH SAFETY & ENVIRONMENTAL REQUIREMENTS

- A. Ensure compliance with these requirements of subcontractors, personnel, and concerned individuals throughout the execution of the project.
- B. Comply with the Engineer's written and verbal instructions pertaining to these requirements as soon as practicable upon their issuance.
- C. Whenever Contractor is required to obtain public permit(s), Engineer's approval, or similar, such permit or approval shall not relieve the Contractor from his obligations under these and other Contract Documents.
- D. Instructions related to safety and environmental requirements and pertaining to these Specifications shall not entitle Contractor to additional time and cost remuneration.
- E. Implement a positive and constructive approach towards safety and environmental matters throughout Contractor's organization.

#### 1.04 NON-COMPLIANCE WITH SAFETY & ENVIRONMENTAL REQUIREMENTS

- A. The Engineer may request a local suspension of the works in case of non-compliance with these requirements until such conditions are met that warrant resumption.
- B. The Engineer may, at his discretion, notify Contractor of deductions applicable to the Contractor's payments as stipulated below. Such notice shall specify the location, nature, period, amount of deduction, and remedy of each occurrence. The notice shall also specify a reasonable deadline within which the Contractor is required to remedy the situation.
- C. Failure of the Contractor to comply with the Engineer's notice shall result in the deduction of the indicated amounts repeatedly until compliance of the Contractor is met.



- D. Deductions from payment shall be as follows:
  - 1. Type A - occurrences related to safety of personnel: USD 500/occurrence/day
  - 2. Type B - occurrences related to environmental control: USD 100/occurrence/day
- E. An occurrence is defined as the incidence of one element of non-compliance in one location. The definition of an "occurrence" shall be at the Engineer's discretion and in accordance with these requirements.
- F. The maximum cumulative amount to be deducted from the Contractor's payment is 1% of the Contract Price. The Client is entitled to terminate the Contract beyond such a limit.
- G. The Engineer and/or Employer may, upon written notice to the Contractor, arrange for third parties to provide the measures, equipment, items, or works necessary to achieve compliance with these requirements. Such actions shall not diminish the Contractor's obligations under the Contract Documents.

#### **1.05 SAFETY OFFICER**

- A. Appoint a full-time Safety Officer who shall be responsible for compliance with these requirements and coordinating with the delegated authority(ies) to take any action or measure necessary for their comprehensive implementation.
- B. Safety Officer shall be held accountable for compliance with these requirements.
- C. Safety Officer shall conduct daily site safety inspections to ensure that these requirements are met. His observations shall be recorded in a site diary which will be kept available for the Engineer's review.

#### **1.06 SAFETY REPORTING**

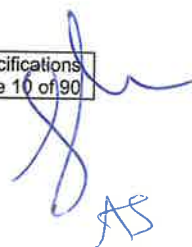
- A. Report any accident or dangerous occurrence to the Engineer.
- B. Reportable accidents or dangerous occurrences shall include accidents (or the potentiality of accidents) to persons which result in medical intervention or in an interruption in the work.
- C. Include witness statements and relevant information (diagrams, plans, photos, official reports, etc.).
- D. Comply with local legal and statutory requirements governing in the event of an accident to persons or property.
- E. Report to the Engineer any accidents or dangerous occurrences observed on the site and related to these requirements.

#### **1.07 SIGNAGE**

- A. Provide adequate signage in clear English and Arabic letters indicating a hazardous substances or dangerous situations.
- B. Provide instructions in English and Arabic about the handling of hazardous substances or dangerous situations.

#### **1.08 FIRST AID FACILITIES**

- A. Maintain adequate first aid facilities on site at all times throughout the duration of the project.



- B. Maintain personnel trained in first aid on site at all times throughout the duration of the project.
- C. Liaise with appointed medical facility and ensure immediate notification and dispatching of emergency medical staff when necessary.

#### **1.09 PERSONAL PROTECTION**

- A. Maintain an adequate stock of personal equipment for the use of all site personnel and visitors including hard helmets, safety goggles, safety gloves, anti-static safety shoes, mufflers, harnesses, etc.
- B. Ensure that all personal safety equipment is certified by and compliant with locally governing regulations. If no local regulations exist, the Engineer shall be considered the authority of reference.
- C. Ensure that hard helmets and anti-static safety shoes are worn throughout the site at all times during the project.
- D. Ensure that safety goggles are worn at least by personnel carrying out hammering, chipping, grinding, insulation handling, spray painting, welding, and other activities with the potential for eye injuries.
- E. Ensure that safety gloves are worn at least by personnel carrying out steel reinforcement handling, work with corrosive or toxic, materials, acids, and other activities with the potential for skin damage.
- F. Ensure that all safety shoes are reinforced (steel toe) and anti-static.
- G. Ensure that mufflers are worn at least by personnel carrying out activities with high noise levels (90 decibels and above).
- H. Ensure that all personnel carrying out work on scaffolding shall wear safety belts at all times throughout the duration of the project.

#### **1.10 LADDERS**

- A. Use only manufactured ladders meeting applicable local regulations and the Engineer's approval.
- B. Do not use ladders made on the site.
- C. Maintain ladders steps clean and free of dust and oil at all time throughout the duration of the project.

#### **1.11 EDGES AND OPENINGS**

- A. Equip all floor edges, riser openings, elevator shafts, etc. with secure railing to the Engineer's approval.
- B. In case no railing is possible, keep site personnel clear of the unsecure edge by preventive means (e.g. locked access doors to the floor, etc.). Provide warning signs.

#### **1.12 SITE ELECTRICAL FACILITIES**

- A. Comply with locally governing regulations related to temporary electrical installations. If no local regulations exist, the Engineer shall be considered the authority of reference.
- B. Erect temporary electrical facilities by qualified technicians supervised by an electrical engineer.
- C. Periodically inspect and maintain temporary electrical facilities.
- D. Use only properly earthed electrical power equipment.
- E. Use only sheathed wired and securely fastened power sockets.
- F. Keep all equipment clear of running water.



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### 1.13 WELDING TOOLS

- A. Use only equipment in sound working condition. No depleted equipment is allowed on the site.
- B. Ensure that only trained personnel carry out welding activities.
- C. Store flammable material in secure locations accessible only by designated personnel.
- D. Use spark arrestors on all gas welding equipment.

### 1.14 FIRE PROTECTION AND PREVENTION

- A. Generally, take all measures necessary to prevent the outbreak of fire on the project site.
- B. Train personnel in the use of the extinguishers.
- C. Provide vendor's verifications and certifications at the specified time interval; replace or recharge as appropriate after use.
- D. Turn off fuel-burning engines during re-fueling.
- E. Provide adequate ventilation where solvents or volatile agents are used to prevent the accumulation of flammable vapors.
- F. Store flammable substances away from electrical wires and emergency escapes routes.

### 1.15 DEMOLITIONS

- A. Submit a detailed method statement for each demolition activity to the Engineer.
- B. Use only manual means. The use of explosives is not allowed on the project.

### 1.16 POLLUTION

- A. Maintain the site clean from debris and rubbish at all times throughout the duration of the project.
- B. Take all measures necessary to limit pollution from dust and any air-borne materials throughout the duration of the project.
- C. Cover all vehicle-carried material with proper sheet to prevent discharge on the street.
- D. Comply with locally applicable regulations related to removal and disposal of waste and refuse material from the site.
- E. No waste shall be burned on site.
- F. Where excavation activities are ongoing, provide exit gate from the site with a pressurized water jet cleaning station. Remove accumulated excavated material from pneumatic tyres to avoid its discharge on the street.
- G. Maintain site methods that minimize, to the extent possible, noise and disruption to neighbors. Use only equipment in good condition and equipment with adequate silencers. Schedule work during working hours.

**PART 2- PRODUCTS - NOT USED**

**PART 3- EXECUTION – NOT USED**

END OF SECTION 015600



## SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

### PART 1- GENERAL -- NOT USED

### PART 2- PRODUCTS

#### 2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

### PART 3- EXECUTION

#### 3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

#### 3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

#### 3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

- E. Make neat transitions between different surfaces, maintaining texture and appearance.

### 3.04 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. Perform whatever cutting and patching is necessary to:
  - 1. Complete the work.
  - 2. Fit products together to integrate with other work.
  - 3. Provide openings for penetration of mechanical, electrical, and other services.
  - 4. Match work that has been cut to adjacent work.
  - 5. Repair areas adjacent to cuts to required condition.
  - 6. Repair new work damaged by subsequent work.
  - 7. Remove samples of installed work for testing when requested.
  - 8. Remove and replace defective and non-complying work.
- C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- F. Restore work with new products in accordance with requirements of Contract Documents.
- G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 078400, to full thickness of the penetrated element.
- I. Patching:
  - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
  - 2. Match color, texture, and appearance.
  - 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

### 3.05 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

### **3.06 PROTECTION OF INSTALLED WORK**

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

### **3.07 ADJUSTING**

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

### **3.08 FINAL CLEANING**

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Clean filters of operating equipment.
- F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

### **3.09 CLOSEOUT PROCEDURES**

- A. Make submittals that are required by governing or other authorities.
- B. Accompany Employer on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
- C. Notify Engineer when work is considered ready for Engineer's Substantial Completion inspection.
- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Engineer's Substantial Completion inspection.

- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Engineer's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Engineer.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Employer-occupied areas.
- G. Notify Engineer when work is considered finally complete and ready for Engineer's Substantial Completion final inspection.
- H. Complete items of work determined by Engineer listed in executed Certificate of Substantial Completion.

END OF SECTION 017000



## SECTION 075200 - MODIFIED BITUMINOUS MEMBRANE ROOFING

### PART 1- GENERAL

#### 1.01 SECTION INCLUDES

- A. Modified bituminous roofing membrane, conventional application.

#### 1.02 RELATED REQUIREMENTS

- A. Section 024100 - Demolitions

#### 1.03 REFERENCE STANDARDS

- A. EN 12311-1:1999 - Flexible sheets for waterproofing - Part 1.
- B. EN 1109:2013 - Flexible sheets for waterproofing.
- C. EN 12730:2015 - Flexible sheets for waterproofing.
- D. EN 965:1995 - Geotextiles and geotextile-related products.
- E. EN 964-1:1995 - Geotextiles and geotextile-related products.
- F. EN ISO 10319:2015 - Geosynthetics — Wide-width tensile test.
- G. EN ISO 12236:2006 - Static puncture test (CBR test).
- H. EN ISO 12958-1: Geotextiles and geotextile-related products — Determination of water flow capacity in their plane — Part 1.
- I. EN ISO 13438: Geosynthetics — Screening test method for determining the resistance of geotextiles and geotextile-related products to oxidation.
- J. EN 1928:2000 - Flexible sheets for waterproofing.
- K. EN 12310-1:1999: Flexible sheets for waterproofing - Part 1: Bitumen sheets for waterproofing - Determination of resistance to tearing.
- L. EN 13948 (2007): Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of resistance to root penetration.

#### 1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for membrane and bitumen materials, and any related accessories.
- C. Samples: Submit two samples 300 by 300 mm in size illustrating granule surfaced sheet.
- D. Submit sample of proposed flashing material.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Employer's name and registered with manufacturer.

#### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum fifteen years of documented experience.
- B. A recent project (<6 months) was completed in the same facility and consisted in applying new waterproofing membrane to the existing roof. Utilize services of the same applicator to ensure continuity of waterproofing warranty.

### 1.06 FIELD CONDITIONS

- A. Do not apply roofing membrane when environmental conditions are outside the ranges recommended by manufacturer.
- B. Do not apply roofing membrane during unsuitable weather.
- C. Do not apply roofing membrane when ambient temperature is below 5 degrees C.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- F. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

### 1.07 WARRANTY

- A. Provide 5 -year manufacturer's material and labor warranty to cover failure to prevent penetration of water.

## PART 2- PRODUCTS

### 2.01 MANUFACTURERS

- A. Modified Bituminous Membrane Roofing:
  - 1. Bituseal Elastomeric Polymer Bitumen membrane (SBS);
  - 2. Or approved equivalent.

### 2.02 MEMBRANE AND SHEET MATERIALS

- A. Membrane: Polymer modified asphalt, reinforced with nonwoven fabric; granule surfaced; with the following characteristics:
  - 1. Reinforcement: Non-woven reinforced polyester fabric.
  - 2. Compound: Elastomeric polymer bitumen (SBS).
  - 3. 4mm thick.
  - 4. Top finish: Slate.
  - 5. Lower finish: PE Film.
  - 6. Application method: Blowtorch.
  - 7. Tensile Strength EN 12311-1 (L/T): 500/400 N/50mm<sup>2</sup>.
  - 8. Flexibility at Low Temperature EN1109: -15 degrees C.
  - 9. Creep EN1296/1110: 100 degrees C.
  - 10. Load Resistance EN12730: 10Kg.

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.



### **3.02 INSTALLATION - MEMBRANE**

- A. Install modified bituminous membrane roofing system in accordance with manufacturer's recommendations.
- B. Install membrane; lap and seal edges and ends permanently waterproof.
- C. Install smooth, free from air pockets, wrinkles, fish-mouths, or tears. Ensure full bond of membrane to substrate.
- D. At end of day's operation, install waterproof cut-off. Remove cut-off before resuming roofing.
- E. At intersections with vertical surfaces:
  - 1. Extend membrane over cant strips and up a minimum of 203 mm onto vertical surfaces.
  - 2. Apply flexible flashing over membrane.
- F. Around roof penetrations, mop in and seal flanges and flashings with flexible flashing.
- G. Coordinate installation of roof drains and sumps and related flashings.

### **3.03 FIELD QUALITY CONTROL**

- A. Provide daily on-site attendance of roofing manufacturer's representative during installation of this work.
- B. Conduct flood testing of each roof portion by ponding of 50mm deep water.
  - 1. Provide water by own means (not from Employer's local source).
  - 2. Arrange to temporarily block roof drains for the duration of the test.
  - 3. Flood test the roof for 24 hours.

### **3.04 CLEANING**

- A. Remove bituminous markings from finished surfaces.
- B. In areas where finished surfaces are soiled by bitumen or other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

### **3.05 PROTECTION**

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 075200



## SECTION 078400 - FIRESTOPPING

### PART 1- GENERAL

#### 1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

#### 1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
- C. FM (AG) - FM Approval Guide; Current Edition.
- D. ITS (DIR) - Directory of Listed Products; Current Edition.
- E. UL (DIR) - Online Certifications Directory; Current Edition.
- F. UL (FRD) - Fire Resistance Directory; Current Edition.
- G. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

#### 1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

#### 1.04 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
  - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum fifteen years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
  - 1. Trained by manufacturer.



2. Recognized as a Qualified Contractor in compliance with requirements of UL (DIR) Solutions Qualified Firestop Contractor Program.
3. Verification of at least five satisfactorily completed projects of comparable size and type.

**1.05 FIELD CONDITIONS**

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

**PART 2- PRODUCTS**

**2.01 DETERMINATION OF FIRE RATING OF WALLS AND SLABS**

- A. The Engineer shall be the sole authority that can determine the fire-rating of a wall, slab, separation, or boundary or any kind. The Contractor shall refer to the Engineer and shall abide by the stipulated fire-rating required in each case.

**2.02 MANUFACTURERS**

- A. Firestopping Manufacturers:
1. 3M Fire Protection Products.
  2. Hilti, Inc.
  3. Or approved equivalent.

**2.03 MATERIALS**

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

**2.04 FIRESTOPPING ASSEMBLY REQUIREMENTS**

- A. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

**2.05 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION**

- A. Penetrations Through Floors or Walls By:
1. Multiple Penetrations in Large Openings:
    - a. 2 Hour Construction: UL System C-AJ-2863; HoldRite HydroFlame 100 Intumescent Firestop Sealant.
  2. Uninsulated Metallic Pipe, Conduit, and Tubing:
    - a. 3 Hour Construction: UL System C-AJ-1226; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
    - a. 2 Hour Construction: UL System C-AJ-2167; Hilti FS-ONE MAX Intumescent Firestop Sealant.
  4. Electrical Cables Not In Conduit:
    - a. 2 Hour Construction: UL System C-AJ-3283; Hilti CFS-SL SK Firestop Sleeve Kit.
  5. Cable Trays with Electrical Cables:



- a. 2 Hour Construction: UL System C-AJ-4094; Hilti CFS-BL Firestop Block.
6. Insulated Pipes:
  - a. 2 Hour Construction: UL System C-AJ-5091; Hilti FS-ONE IMAX Intumescent Firestop Sealant.
7. HVAC Ducts, Uninsulated:
  - a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE MAX Intumescent Firestop Sealant.

## 2.06 FIRESTOPPING SYSTEMS

### A. Firestopping:

1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

### 3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

### 3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

### 3.04 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

### 3.05 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 078400

AS

## SECTION 230500 - COMMON WORK RESULTS FOR HVAC

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
  2. Transition fittings.
  3. Mechanical sleeve seals.
  4. Sleeves.
  5. Grout.
  6. HVAC demolition.
  7. Equipment installation requirements common to equipment sections.
  8. Painting and finishing.
  9. Concrete bases.
  10. Supports and anchorages.

#### 1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
  2. PE: Polyethylene plastic.
  3. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  2. NBR: Acrylonitrile-butadiene rubber.



**1.04 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Mechanical sleeve seals.
- B. Welding/Brazing certificates.

**1.05 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

**1.07 COORDINATION**

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

**PART 2- PRODUCTS**

**2.01 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

**2.02 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

**2.03 JOINING MATERIALS**

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
  - C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
  - D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
  - E. Solvent Cements for Joining Plastic Piping:
    - 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- 2.04 TRANSITION FITTINGS**
- A. Plastic-to-Metal Transition Fittings: **PVC** one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - C. Plastic-to-Metal Transition Unions: MSS SP-107.
  - D. Manufacturers:
    - 1. NIBCO INC.
    - 2. NIBCO, Inc.; Chemtrol Div.
- 2.05 MECHANICAL SLEEVE SEALS**
- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
    - 1. Manufacturers:
      - a. Advance Products & Systems, Inc.
      - b. Calpico, Inc.
      - c. Metraflex Co.
      - d. Pipeline Seal and Insulator, Inc.
    - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - 3. Pressure Plates: Plastic Include two for each sealing element.
    - 4. Connecting Bolts and Nuts: steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- 2.06 SLEEVES**
- A. Galvanized-Steel Sheet: 0.6-mm minimum thickness; round tube closed with welded longitudinal joint.
  - B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
  - C. PVC Pipe: ASTM D 1785, Schedule 40.
- 2.07 GROUT**
- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 34.5-MPa, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

### **PART 3- EXECUTION**

#### **3.01 HVAC DEMOLITION**

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
  1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  2. Piping to Be removed to the vicinity of UNESCO where shown on the drawings: Drain piping and cap or plug piping with same or compatible piping material.
  3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
  4. Ducts to to the vicinity of UNESCO where shown on the drawings: Cap or plug ducts with same or compatible ductwork material.
  5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

#### **3.02 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.



- F. Install piping to permit servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Permanent sleeves are not required for holes formed by removable PE sleeves.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 50 mm above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide 6.4-mm annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. PVC
  - 4. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 25-mm annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - a. Install steel pipe in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials..
- P. Verify final equipment locations for roughing-in.
- Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

**3.03 PIPING JOINT CONSTRUCTION**

- A. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe

ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: 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.
- D. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- F. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- G. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- H. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

**3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

**3.05 PAINTING**

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

**3.06 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  1. Construct concrete bases of dimensions indicated, but not less than 100 mm larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 450-mm centers around the full perimeter of the base.
  3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Concrete Bases: Anchor equipment to concrete base supporting the air ducts on the roof and according to seismic codes at Project.
- 3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES**
- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
  - B. Field Welding: Comply with AWS D1.1.
- 3.08 GROUTING**
- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
  - B. Clean surfaces that will come into contact with grout.
  - C. Provide forms as required for placement of grout.
  - D. Avoid air entrapment during placement of grout.
  - E. Place grout, completely filling equipment bases.
  - F. Place grout on concrete bases and provide smooth bearing surface for equipment.
  - G. Place grout around anchors.
  - H. Cure placed grout.

END OF SECTION 230500



## SECTION 230700 - HVAC INSULATION

### PART 1- GENERAL

#### 1.01 SCOPE OF WORK

- A. Description: Furnish and install 25 mm thick, cross-linked closed-cell polyolefin foam insulation for all outdoor supply, return, fresh, and exhaust air ductwork.
- B. System Integrity: The system includes a factory-applied aluminum foil vapor barrier and a field-applied or integrated resin-based protective jacketing (cladding) to ensure UV resistance and mechanical protection.

#### 1.02 PERFORMANCE REQUIREMENTS

- A. Thermal Conductivity: Maximum 0.034 W/(m·K) at 23°C mean temperature.
- B. Water Vapor Permeability:  $< 1.0 \times 10^{-14}$  kg/(Pa·s·m).
- C. Operating Temperature: Suitable for a range of -40 °C to +80 °C.
- D. Fire Safety: Materials must be Class 0 rated (BS 476 Parts 6 & 7) or ASTM E84 compliant (Flame Spread  $< 25$ , Smoke Developed  $< 50$ ).

### PART 2- PRODUCTS

#### 2.01 INSULATION MATERIAL

- A. Type: Chemically cross-linked closed-cell polyolefin foam.
- B. Thickness: 25 mm.
- C. Facing: Factory-reinforced aluminum foil.
- D. Adhesion: High-tack, pressure-sensitive self-adhesive backing protected by a release liner.

#### 2.02 RESIN JACKETING (CLADDING)

- A. Material: Multi-layered laminate or liquid-applied polymer resin reinforced with glass fiber mesh.
- B. Properties: Non-corrosive, UV-stable, and resistant to chemical pollutants and salt spray.
- C. Color: Standard Grey or as specified by the architect for aesthetic uniformity.

#### 2.03 ACCESSORIES

- A. Sealing Tapes: 75 mm wide aluminum foil tape with high-performance acrylic adhesive.
- B. Mastic/Sealants: Weatherproof, UV-resistant joint sealant for all overlapping jacket seams.
- C. Fasteners: Impact-resistant plastic or non-corrosive metal pins (only if required for oversized duct spans).

### PART 3- EXECUTION

#### 3.01 PREPARATION

- A. Ducts must be pressure tested and cleaned of all oil, moisture, and debris.
- B. Ensure the duct surface temperature is within the manufacturer's recommended range for the self-adhesive backing (typically above 5 °C).

### 3.02 INSULATION INSTALLATION

- A. Application: Measure and cut foam to fit duct dimensions precisely. Remove release liner and apply firm, even pressure to ensure 100% contact.
- B. Joints: Butt joints must be tight. Apply 75 mm aluminum tape over all longitudinal and circumferential joints to maintain vapor seal integrity.
- C. Corners: Use "V-groove" cutting techniques for a clean, tight wrap around duct corners to prevent thinning of the foam.

### 3.03 RESIN APPLICATION

- A. Resin Cladding: Install the resin jacketing over the foil-faced foam. Overlap all seams by at least 50 mm in a "shingle fashion" to ensure water shed.
- B. Seaming: Chemically weld or seal all overlaps using the specified resin-compatible adhesive or heat-sealing method as per manufacturer instructions.
- C. Water Shedding: All longitudinal laps must be positioned on the side or bottom of the duct, never on the top flat surface where water can pool.

### 3.04 QUALITY CONTROL

#### A. INSPECTION CRITERIA

- 1. Visual: Check for any gaps, "fish-mouths" in the tape, or areas where the resin jacketing is not fully adhered.
- 2. Continuity: Ensure the vapor barrier (foil) and the weather barrier (resin) are continuous around all hangers and supports.
- 3. Puncture Check: Any punctures in the foil or resin must be patched immediately with a 100 mm margin beyond the damaged area.

#### B. "PULL-OFF" TEST

- 1. To verify the self-adhesive bond, the engineer may request a random pull-off test on a sample area. The adhesive should ideally stay bonded to the duct, with the foam tearing (cohesive failure) rather than the adhesive peeling off the metal.

### 3.05 PROTECTION AND MAINTENANCE

#### A. FINAL PROTECTION

- 1. Mechanical Damage: Install metal "kick plates" or guards in high-traffic areas or areas subject to maintenance foot traffic.
- 2. Storage: Store all polyolefin rolls and resin components in a dry, shaded area prior to installation to prevent premature activation of the adhesive or UV degradation of the resin.

#### B. CLEANING

- 1. Remove all scraps and adhesive residue from the site.
- 2. Clean the resin jacket surface using only mild soap and water; avoid abrasive chemicals that may degrade the UV-resistant topcoat.

END OF SECTION 230700



## SECTION 230923 - BUILDING MANAGEMENT SYSTEM

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. This Section includes furnishing, engineering, programming, installation, testing, commissioning, integration, training, and warranty of a complete BACnet-based Building Management System (BMS) for monitoring and control of the following HVAC systems serving the UNESCO facility:
  - 1. Rooftop Units (RTUs) serving:
    - a. Auditorium.
    - b. Multipurpose hall. Conference and meeting hall.
  - 2. Central split DX systems serving:
    - a. Main lobbies. Reception areas.
    - b. Public circulation areas and coulisse.
  - 3. Associated HVAC accessories and auxiliary systems.
  - 4. The Building Management System (BMS) is primarily intended for monitoring and control of the HVAC systems serving the UNESCO facility. However, the system architecture, hardware capacity, software licensing, and network infrastructure shall be designed to allow future expansion and integration of additional building systems and functions within the UNESCO facility, including but not limited to lighting control, energy monitoring, plumbing systems, fire alarm interfaces, ventilation systems, security systems, and other building services, without requiring replacement of the core BMS platform.
- B. The BMS shall provide centralized supervision, scheduling, alarming, trending, monitoring, energy management, and automatic control functions through BACnet native controllers and graphical user interface.
- C. The system shall be fully compatible with BACnet/IP open protocol architecture and shall allow future expansion without proprietary restrictions.
- D. The Contractor shall provide all labor, software, controllers, gateways, sensors, actuators, relays, wiring, panels, networking accessories, graphics, UPS and commissioning services required for a complete operational system.

#### 1.03 RELATED SECTIONS

- A. Common Work Results for HVAC.
- B. Common Motor Requirements for HVAC Equipment.
- C. Testing, Adjusting, and Balancing.
- D. HVAC Equipment.
- E. Electrical.
- F. Communications Network Infrastructure.




#### 1.04 REFERENCES.

- A. The latest editions of the following standards shall apply:
1. ASHRAE Standard 135 – BACnet Communication Protocol.
  2. ASHRAE Guideline 13 – Specifying DDC Systems.
  3. ASHRAE Guideline 36 – High Performance Sequences of Operation.
  4. ANSI/ASHRAE 62.1 – Ventilation for Acceptable Indoor Air Quality.
  5. NFPA 70 – National Electrical Code.
  6. UL 916 – Energy Management Equipment.
  7. ISO 16484 – Building Automation and Control Systems.
  8. IEEE 802.3 – Ethernet Standards.
  9. IEC 61000 – Electromagnetic Compatibility.

#### 1.05 SYSTEM DESCRIPTION

- A. Provide a fully distributed Direct Digital Control system based on BACnet/IP architecture
- B. System shall include:
1. BACnet Building Controller (BBC).
  2. BACnet Advanced Application Controllers (B-AAC).
  3. BACnet Application Specific Controllers (B-ASC).
  4. BACnet/IP network infrastructure.
  5. Web-based operator workstation.
  6. Color graphical user interface.
  7. Alarm management system.
  8. Historical trending and reporting.
  9. Time scheduling.
  10. Energy optimization functions.
  11. Integration interfaces
  12. UPS.
- C. All controllers shall be native BACnet devices.
- D. Gateways translating proprietary protocols into BACnet shall not be accepted unless specifically approved.
- E. The system shall remain fully operational in standalone mode during network communication failure.
- F. Loss of communication with central workstation shall not interrupt local control loops.

#### 1.06 SCOPE OF CONTROL

- A. The BMS shall monitor and control each of the six RTUs including but not limited to:
1. Unit enable/disable.
  2. Supply fan start/stop.
  3. Fan status.
  4. Cooling stages.
  5. Heating stages if applicable.
  6. Supply air temperature control.
- 

7. Space temperature monitoring.
  8. Return air temperature.
  9. Filter differential pressure status.
  10. Dirty filter alarm.
  11. Smoke detector status.
  12. Fire alarm shutdown interface.
  13. Free cooling/economizer control if equipped.
  14. Occupancy scheduling.
  15. CO monitoring
  16. Night setback operation.
  17. High and low temperature alarms.
  18. General fault alarm.
  19. Compressor status and alarms.
  20. Fan failure alarm.
  21. Runtime accumulation.
- B. The BMS shall monitor and control each central 5 central split unit including
1. Unit enable/disable.
  2. Indoor fan operation.
  3. Cooling operation.
  4. Space temperature monitoring.
  5. Return air temperature.
  6. Thermostat integration.
  7. Occupancy scheduling.
  8. Night setback.
  9. Common alarm status.
  10. Communication status.
  11. Condensate overflow alarm if available.
  12. Fault monitoring.
- 1.07 SEQUENCE OF OPERATION - GENERAL**
- A. The All HVAC systems shall operate automatically according to occupancy schedules unless manually overridden.
- B. Schedules shall be programmable by authorized operators.
- C. Operators shall be able to define:
1. Occupied periods.
  2. Unoccupied periods.
  3. Holiday schedules.
  4. Exceptional events.
  5. Summer/mid-season/winter schedules.
- 1.08 SEQUENCE OF OPERATION - RTU OCCUPIED MODE**
- A. Upon occupied command:
1. Supply fan shall start.
  2. Unit status shall be verified through current switch or proof contact.
  3. Space temperature shall be controlled to occupied cooling setpoint.

4. Control ventilation rate.
5. Cooling stages shall sequence automatically.
6. Economizer shall modulate if outside conditions permit.
7. Supply air temperature shall be maintained within adjustable limits.

B. Failure to prove operation within adjustable time delay shall generate alarm.

#### **1.09 SEQUENCE OF OPERATION - RTU UNOCCUPIED MODE**

A. During unoccupied command:

1. Unit shall remain off unless temperature exceeds setback limits.
2. Automatic restart shall occur upon high space temperature condition.
3. Unit shall stop after space temperature returns to acceptable range.
4. Program ventilation requirement.

B. Failure to prove fan operation within adjustable time delay shall generate alarm.

#### **1.10 SEQUENCE OF OPERATION - CENTRAL SPLIT UNIT MODE**

A. Central split systems serving lobbies shall maintain indoor temperature according to adjustable occupied and unoccupied setpoints.

B. Units shall start and stop automatically according to BMS schedules.

C. Temperature monitoring shall be continuously displayed at workstation.

D. Alarms shall be generated upon communication loss or unit fault.

#### **1.11 SEQUENCE OF OPERATION - FIRE ALARM INTERFACE**

A. Upon receipt of fire alarm signal:

1. Associated HVAC units shall stop immediately.
2. Shutdown status shall be indicated on BMS.
3. Manual reset shall be required where applicable.

B. Fire alarm interlocks shall comply with local code requirements.

#### **1.12 SEQUENCE OF OPERATION - ALARM MANAGEMENT**

A. The BMS shall generate alarms for the following minimum conditions:

1. High space temperature.
2. Low space temperature.
3. Fan failure.
4. Dirty filter.
5. Smoke detection.
6. Loss of communication.
7. Controller offline.
8. Sensor failure.
9. Power failure.
10. Unit general fault.

B. Alarm priorities shall be configurable.

C. Alarm notifications shall include:

1. Time stamp.
2. Equipment identification.
3. Alarm description.



4. Alarm priority.
5. Acknowledgement status.

**1.13 SUBMITTALS**

- A. Product data for all system components.
- B. BACnet compliance certificates.
- C. Shop drawings including:
  1. System architecture.
  2. Network topology.
  3. Controller layout.
  4. Wiring diagrams.
  5. Panel details.
  6. Point lists.
  7. Sequence of operations.
  8. IP addressing scheme.
  9. Riser diagrams.
- D. Software documentation.
- E. Graphic screen samples.
- F. Bill of quantities.
- G. Control schematics.
- H. Commissioning procedures.
- I. Test reports.
- J. Operation and maintenance manuals.
- K. Training agenda.

**1.14 QUALITY ASSURANCE**

- A. Manufacturer shall have minimum ten years documented experience in BACnet DDC systems.
- B. System integrator shall be factory certified.
- C. All controllers shall be BTL listed.
- D. System shall be installed by trained technicians.
- E. Electrical installation shall comply with NEC and local regulations.

**1.15 WARRANTY**

- A. Provide minimum twenty-four (24) months warranty from date of substantial completion.
- B. Warranty shall include:
  1. Parts.
  2. Labor.
  3. Software updates.
  4. On-site support.
  5. Corrective maintenance.



## **PART 2- PRODUCTS**

### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with requirements, acceptable manufacturers shall include:
1. Siemens
  2. Honeywell
  3. Johnson
  4. Delta
- B. Equivalent approved products may be accepted subject to consultant approval.

### **2.02 SYSTEM ARCHITECTURE**

- A. System shall consist of:
1. BACnet/IP Ethernet backbone.
  2. Distributed field controllers.
  3. Managed network switches.
  4. Operator workstation.
  5. Engineering workstation.
  6. Web server.
  7. Uninterruptible power supply.
- B. Communication speed shall not be less than 100 Mbps for backbone network.
- C. Controllers shall communicate using BACnet/IP or BACnet MS/TP.
- D. All controllers shall support peer-to-peer communication.

### **2.03 BUILDING MANAGEMENT SERVER**

- A. Server shall provide:
1. Web-based access.
  2. Multi-user capability.
  3. Alarm management.
  4. Historical trending.
  5. Data archiving.
  6. Scheduling.
  7. Graphic visualization.
  8. Report generation.
  9. Password protection.
  10. Audit trail.
- B. Server shall support minimum:
1. 10 simultaneous users.
  2. 10,000 trend records.
  3. 5 years historical archive.
  4. BACnet/IP communications.

### **2.04 OPERATOR WORKSTATION**

- A. Provide operator workstation including:



1. Color graphics.
  2. Real-time status.
  3. Alarm display.
  4. Trend charts.
  5. Scheduling interface.
  6. User management.
  7. System diagnostics.
- B. Workstation software shall be web-based and accessible through standard browser.

## 2.05 BACNET CONTROLLERS

- A. General
1. Controllers shall be fully programmable and support standalone operation.
  2. Controllers shall retain programming and database during power failure.
  3. Controllers shall include real-time clock.
  4. Controllers shall support automatic restart after power restoration.
- B. Application Controllers: Controllers shall support:
1. Analog inputs.
  2. Analog outputs.
  3. Binary inputs.
  4. Binary outputs.
  5. PID control loops.
  6. Trend logs.
  7. Alarm processing.
- C. Input and output capacity shall include minimum 20 percent spare points.

## 2.06 SENSORS

- A. Space Temperature Sensors: Provide electronic temperature sensors with:
1. Accuracy:  $\pm 0.5^{\circ}\text{C}$  maximum.
  2. LCD display where indicated.
  3. Override pushbutton where required.
  4. Occupancy indication.
- B. Duct Temperature Sensors
1. Averaging type sensors for supply air applications.
  2. Stainless steel probe construction.
  3. Accuracy  $\pm 0.5^{\circ}\text{C}$ .
- C. Differential Pressure Switches
1. Adjustable differential pressure switches for filter monitoring.
  2. Provide alarm indication for dirty filters.
- D. CO Sensors: requirements:
1. Measurement range: 0–300 ppm minimum.
  2. Accuracy:  $\pm 3$  ppm or  $\pm 5\%$  of reading.
  3. Resolution: 1 ppm.



4. Response time: less than 60 seconds.
5. Sensor life: minimum 5 years.
6. Repeatability:  $\pm 2\%$ .

## 2.07 CONTROL PANELS

- A. Panels shall be factory fabricated.
- B. Panels shall include:
  1. Lockable doors.
  2. Power supplies.
  3. Circuit breakers.
  4. Surge protection.
  5. Terminal blocks.
  6. Labeling.
  7. Control transformers.
  8. Network switches if required.
- C. Enclosures shall be minimum IP54 indoors.

## 2.08 NETWORKING COMPONENTS

- A. Managed Ethernet switches shall support:
  1. VLAN.
  2. SNMP.
  3. Redundancy.
  4. Industrial temperature range.
- B. CAT6 cabling shall be used for IP network.
- C. BACnet MS/TP cabling shall comply with manufacturer recommendations.

## 2.09 RAPHICS

- A. Provide fully animated color graphics for all systems.
- B. Graphics shall include:
  1. Floor plans.
  2. HVAC schematics.
  3. Real-time values.
  4. Alarm indications.
  5. Equipment status.
  6. Temperature display.
  7. Runtime indication.
- C. Graphics shall include minimum:
  1. Auditorium RTUs overview.
  2. Hall RTU overview.
  3. Lobby split unit overview.
  4. Alarm summary page.
  5. Trend pages.
  6. Schedule pages.



## 2.10 SOFTWARE FEATURES

- A. Software shall include:

1. Scheduling.
  2. Trending.
  3. Alarm routing.
  4. Energy reporting.
  5. User security.
  6. Backup and restore.
  7. Automatic database backup.
  8. Audit logging.
- B. System shall support minimum 5 user access levels.

### **PART 3- EXECUTION**

#### **3.01 INSTALLATION**

- A. Install system in accordance with manufacturer recommendations.
- B. Coordinate installation with mechanical and electrical trades.
- C. Install all sensors in accessible locations.
- D. Mount panels rigidly and level.
- E. Provide engraved identification labels.
- F. Install network cabling separate from power wiring.
- G. Provide surge protection for all network panels.

#### **3.02 CONTROL WIRING**

- A. All control wiring shall comply with Division 26 requirements.
- B. Provide shielded cable for analog signals.
- C. Wiring shall be concealed where possible.
- D. All wiring shall be identified at both ends.
- E. Provide separate conduits for low voltage controls.

#### **3.03 FIELD QUALITY CONTROL**

- A. Perform complete point-to-point testing.
- B. Verify all inputs and outputs.
- C. Demonstrate all sequences of operation.
- D. Verify BACnet communication.
- E. Verify alarm generation and acknowledgement.
- F. Verify trend logging.
- G. Verify graphics functionality.

#### **3.04 COMMISSIONING**

- A. Provide complete commissioning services.
- B. Functional performance testing shall include:
  1. RTU start/stop.
  2. Occupancy scheduling.
  3. Temperature control.
  4. Alarm functions.
  5. Fire alarm shutdown.
  6. Communication recovery.
  7. Sensor calibration.



- 8. Trend recording.
- C. Submit commissioning reports.

**3.05 TRAINING**

- A. Provide minimum three days on-site training.
- B. Training shall include:
  - 1. System overview.
  - 2. Operator interface.
  - 3. Scheduling.
  - 4. Alarm handling.
  - 5. Trend analysis.
  - 6. Graphics navigation.
  - 7. Backup procedures.
  - 8. Basic troubleshooting.

**3.06 DEMONSTRATION**

- A. Demonstrate complete operation of system to Consultant and Owner.
- B. Demonstration shall include:
  - 1. Graphics.
  - 2. Scheduling.
  - 3. Alarm management.
  - 4. Equipment control.
  - 5. Trend retrieval.
  - 6. Report generation.

**3.07 POINTS LIST**

- A. RTU: The RTUs are specified to be provided with BACnet interface capability for integration with the Building Management System (BMS). However, the Contractor shall be fully responsible for verifying, coordinating, and ensuring that all required BACnet communication points and functionalities listed in the following Points Schedule are fully available, operational, mapped, tested, and integrated into the BMS without additional cost to the Owner.

Point Description	Type
Unit Start/Stop Command	BO
Supply Fan Status	BI
Supply Fan Alarm	BI
Space Temperature	AI
Return Air Temperature	AI
Supply Air Temperature	AI
Cooling Stage Status	BI
Heating Status	BI
Dirty Filter Alarm	BI
Smoke Detector Status	BI
CO Detector Status	BI
Fire Alarm Shutdown	BI
Unit Common Fault	BI
Occupancy Command	BV
Runtime Accumulator	AV
Cooling Setpoint	AV
Occupied/Unoccupied Mode	BV
Refrigerant Leak Alarm	BI
General Alarm	BI

**B. CENTRAL SPLIT UNIT POINTS SCHEDULE**

Point Description	Type
Unit Start/Stop Command	BO
Unit Run Status	BI
Space Temperature	AI
Return Air Temperature	AI
Cooling Command	BO
General Alarm	BI
Communication Status	BI
Condensate Alarm	BI
Occupancy Command	BV
Temperature Setpoint	AV

### 3.08 OPERATION AND MAINTENANCE

A. OPERATION AND MAINTENANCE MANUALS: Provide complete O&M manuals including:

1. Product data.
2. Shop drawings.
3. As-built drawings.
4. Controller database.
5. Network architecture.
6. Sequence of operation.
7. Wiring diagrams.
8. Troubleshooting guides.
9. Software backup.
10. Maintenance procedures.
11. Spare parts lists.

B. Provide manuals in both printed and electronic format.

### 3.09 AS-BUILT DOCUMENTATION

A. Submit complete as-built documentation reflecting final installed conditions.

B. Include:

1. Final point lists.
2. IP addresses.
3. Controller locations.
4. Network diagrams.
5. Graphics screenshots.
6. Software backup.

### 3.10 PREVENTIVE MAINTENANCE

A. Provide preventive maintenance services during warranty period

B. Maintenance shall include:

1. Software verification.
2. Sensor calibration.
3. Controller diagnostics.
4. Network testing.
5. Alarm verification.
6. Backup verification.

### 3.11 SPARE PARTS

A. Furnish spare parts including:

1. Five percent spare sensors.

2. Spare controllers.
3. Spare relays.
4. Spare fuses.
5. Spare power supplies.

**3.12 FINAL ACCEPTANCE**

- A. Final acceptance shall occur upon:
1. Completion of installation.
  2. Successful commissioning.
  3. Completion of training.
  4. Submission of O&M manuals.
  5. Delivery of software backups.
  6. Resolution of all deficiencies.

END OF SECTION 230923



## SECTION 233113 - METAL DUCTS

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
1. Single-wall rectangular ducts and fittings.
  2. Double-wall rectangular ducts and fittings.
  3. Sheet metal materials.
  4. Duct liner.
  5. Sealants and gaskets.
  6. Hangers and supports.
  7. Seismic-restraint devices.
- B. Related Sections:
- C. Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

#### 1.03 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated.
1. Static-Pressure Classes:
    - a. Supply Ducts (Upstream from Air Terminal Units): 750 Pa.
    - b. Return Ducts (Negative Pressure): 750 Pa
    - c. Exhaust Ducts (Negative Pressure): 500 Pa
  2. Leakage Class:
    - a. Rectangular Supply-Air Duct: 0.29 L/s per sq. m at 250 Pa
  3. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SEI/ASCE 7

#### 1.04 SUBMITTALS

- A. Product Data: For each type of the following products:
1. Liners and adhesives.
  2. Sealants and gaskets.
  3. Seismic-restraint devices.
- B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  2. Factory- and shop-fabricated ducts and fittings.



3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  4. Elevation of top of ducts.
  5. Dimensions of main duct runs from building grid lines.
  6. Fittings.
  7. Reinforcement and spacing.
  8. Seam and joint construction.
  9. Penetrations through fire-rated and other partitions.
  10. Equipment installation based on equipment being used on Project.
  11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
  2. Joint and seam construction and sealing.
  3. Reinforcement details and spacing.
  4. Materials, fabrication, assembly, and spacing of hangers and supports.
  5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
  2. Structural members to which duct will be attached.
  3. Penetrations of smoke barriers and fire-rated construction.
- E. Field quality-control reports.
- 1.05 QUALITY ASSURANCE**
- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Mockups:
1. Before installing duct systems, build mockups representing static-pressure classes in excess of 750 Pa. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
    - a. Five transverse joints.
    - b. One access door.



- c. Two typical branch connections, each with at least one elbow.
  - d. Two typical flexible duct or flexible-connector connections for each duct and apparatus.
  - e. One 90-degree turn(s) with turning vanes.
  - f. One fire damper. (s).
  - g. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2- PRODUCTS

### 2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.02 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  1. Galvanized Coating Designation: G90 (Z275).
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

- D. Tie Rods: Galvanized steel, 6-mm minimum diameter for lengths 900 mm or less; 10-mm minimum diameter for lengths longer than 900 mm.

### 2.03 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
  - 1. Manufacturers:
    - a. Aeroflex USA Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC
  - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- B. Insulation Pins and Washers:
  - 1. Insulation-Retaining Washers: Self-locking washers formed from 0.41-mm-thick galvanized steel with beveled edge sized as required to hold insulation securely in place but not less than 38 mm in diameter.

### 2.04 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. VOC: Maximum 75 g/L (less water).
  - 7. Maximum Static-Pressure Class: 2500 Pa, positive and negative.
  - 8. Service: Indoor or outdoor.
  - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 0.14 L/s per sq. m at 250 Pa and shall be rated for 2500-Pa static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

#### 2.05 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1M, "Rectangular Duct Hangers Minimum Size,"
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

#### 2.06 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers:
  1. Ductmate Industries, Inc.
  2. Hilti Corp.
  3. Kinetics Noise Control.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service
  1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.



- E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

### **PART 3- EXECUTION**

#### **3.01 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round[ and flat-oval] ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 25 mm, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 38 mm.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials

#### **3.02 HANGER AND SUPPORT INSTALLATION**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 100 mm thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 100 mm thick.

5. Do not use powder-actuated concrete fasteners for seismic restraints.
  - C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1M, "Rectangular Duct Hangers Minimum Size.
  - D. Hangers Exposed to View: Threaded rod and angle or channel supports.
  - E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 3 m.
  - F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- 3.03 SEISMIC-RESTRAINT-DEVICE INSTALLATION**
- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." SEI/ASCE
    1. Space lateral supports a maximum of 19 m o.c., and longitudinal supports a maximum of (20 m) o.c.
    2. Brace a change of direction longer than 3. m.
  - B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
  - C. Install cables so they do not bend across edges of adjacent equipment or building structure.
  - D. Install cable restraints on ducts that are suspended with vibration isolators.
  - E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
  - F. Drilling for and Setting Anchors:
    1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
    2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
    3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
    4. Set anchors to manufacturer's recommended torque, using a torque wrench.
    5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.
  - G. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

- H. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

**3.04 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
  - 2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 3. Test for leaks before insulation application.
  - 4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**3.05 DUCT CLEANING**

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
  - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
  - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
  - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
  - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
  - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.



- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
  2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
  3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
  4. Coils and related components.
  5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
  6. Supply-air ducts, dampers, actuators, and turning vanes.
  7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  6. Provide drainage and cleanup for wash-down procedures.
  7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

END OF SECTION 233113



## SECTION 233300 - AIR DUCT ACCESSORIES

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. Section Includes:
1. Backdraft and pressure relief dampers.
  2. Manual volume dampers.
  3. Control dampers.
  4. Fire dampers.
  5. Smoke dampers.
  6. Combination fire and smoke dampers.
  7. Flange connectors.
  8. Duct silencers.
  9. Turning vanes.
  10. Duct-mounted access doors.
  11. Flexible connectors.
  12. Duct accessory hardware.

#### 1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Control damper installations.
    - d. Fire-damper, smoke-damper, combination fire- and smoke-damper.
    - e. Duct security bars.
    - f. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.



**1.04 QUALITY ASSURANCE**

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

**1.05 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fusible Links: Furnish quantity equal to 20 percent of amount installed.

**PART 2- PRODUCTS**

**2.01 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90 (Z275).

**2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. KBE
  - 3. Greenheck Fan Corporation
  - 4. Trox USA Inc

**2.03 MANUAL VOLUME DAMPERS**

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Trox USA Inc.
    - b. KBE
    - c. Trox USA Inc.
    - d. Air Balance Inc.; a division of Mestek, Inc
  - 2. Standard leakage rating Blades:
    - a. Multiple blade.
    - b. Opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized 1.62 mm thick.
  - 3. Blade Axles: Galvanized steel
  - 4. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Trox USA Inc.
  - b. KBE
  - c. Trox USA Inc.
  - d. Air Balance Inc.; a division of Mestek, Inc
2. Standard leakage rating
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 2.5-mm thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
  - a. Multiple blade.
  - b. Opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Roll-Formed Aluminum Blades: 2.5-mm thick aluminum sheet.
  - e. Extruded-Aluminum Blades: 1.2-mm thick extruded aluminum.
6. Blade Axles: Galvanized steel

**2.04 FIRE DAMPERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Air Balance Inc.; a division of Mestek, Inc.
  2. Arrow United Industries; a division of Mestek, Inc.
  3. Cesco Products; a division of Mestek, Inc.
  4. Greenheck Fan Corporation.
  5. Trox USA Inc.
  6. KBE
  7. Trox USA Inc.
  8. Air Balance Inc.; a division of Mestek, Inc
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 1-kPa static pressure class and minimum 20-m/s velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream]; fabricated with roll-formed, 0.85-mm thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  1. Minimum Thickness: 2 mm thick, as indicated, and of length to suit application.
  2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

- G. Mounting Orientation: Vertical or horizontal as indicated.
  - H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
  - I. Heat-Responsive Device: Replaceable, 74 deg C
- 2.05 COMBINATION FIRE AND SMOKE DAMPERS**
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Air Balance Inc.; a division of Mestek, Inc.
    - 2. Arrow United Industries; a division of Mestek, Inc.
    - 3. Cesco Products; a division of Mestek, Inc.
    - 4. Greenheck Fan Corporation.
    - 5. KBE
  - B. Type: Static and dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
  - C. Closing rating in ducts up to 1-kPa static pressure class and minimum 20-m/s velocity.
  - D. Fire Rating: 1-1/2 hours.
  - E. Frame: Curtain type with blades inside airstream fabricated with roll-formed, 0.85-mm- thick galvanized steel; with mitered and interlocking corners.
  - F. Heat-Responsive Device: Replaceable, 74 deg C rated, fusible links.
  - G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
  - H. Smoke Detector: Integral, factory wired for single-point connection.
- 2.06 DUCT SILENCERS**
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1. Industrial Noise Control, Inc.
    - 2. McGill AirFlow LLC.
    - 3. Ruskin Company.
    - 4. Vibro-Acoustics.
    - 5. KBE.
  - B. General Requirements: Factory fabricated.
    - 1. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
    - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
  - C. Shape:
    - 1. Rectangular straight with splitters or baffles.
  - D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275) 1.02 mm thick.
    - 1. Sheet Metal Thickness for Units up to 600 mm 0.85 mm thick.
    - 2. Sheet Metal Thickness for Units 660 through 1000 mm .02 mm thick.
    - 3. Sheet Metal Thickness for Units 1060 through 1300 mm 1.3 mm thick.

4. Sheet Metal Thickness for Units 1370 through 1500 mm 1.62 mm thick.
- E. Inner Casing and Baffles: ASTM A 653/A 653M, **G90 (Z275)** galvanized sheet metal, 0.85 mm thick, and with 3-mm diameter perforations.
- F. Special Construction:
  1. Suitable for outdoor use.
  2. High transmission loss to achieve STC 45.
- G. Connection Sizes: Match connecting ductwork.
- H. Principal Sound-Absorbing Mechanism:
  1. Dissipative / Film-lined type with fill material.
    - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression Moisture-proof nonfibrous material.

## 2.07 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Ventfabrics, Inc.
  4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 146 mm wide attached to 2 strips of 70-mm thick, galvanized sheet steel or 0.8-mm thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  1. Minimum Weight: 880 g/sq. m.
  2. Tensile Strength: 84 N/mm in the warp and 63 N/mm in the filling.
  3. Service Temperature: Minus 40 to plus 93 deg C.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  1. Minimum Weight: 810 g/sq. m.
  2. Tensile Strength: 93 N/mm in the warp and 77 N/mm)in the filling.
  3. Service Temperature: Minus 40 to plus 93 deg C.

## 2.08 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.



## PART 3- EXECUTION

### 3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft / control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Connect ducts to duct silencers with flexible duct connectors
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream and downstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 15 m spacing.
  - 8. Upstream and downstream from turning vanes.
  - 9. Upstream or downstream from duct silencers.
  - 10. Control devices requiring inspection.
  - 11. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 200 by 125 mm.
  - 2. Two-Hand Access: 300 by 150 mm.
  - 3. Head and Hand Access: 460 by 250 mm.

4. Head and Shoulders Access: 530 by 355 mm.
  5. Body Access: 635 by 355 mm.
  6. Body plus Ladder Access: 635 by 430 mm.
- L. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. Install duct test holes where required for testing and balancing purposes.
- O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 6-mm movement during start and stop of fans.

**3.02 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
  2. Inspect locations of access doors and verify that purpose of access door can be performed.
  3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  4. Inspect turning vanes for proper and secure installation.
  5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300



## SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS (RTU)

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units/ outdoor installation), heat-pump, for air handling, filtration and ventilation with the following components and accessories:
  1. Direct-expansion cooling.
  2. Heat-pump refrigeration components.
  3. Hot-gas reheat.
  4. Economizer outdoor- and return-air damper section capable of free cooling.
  5. Integral, space temperature controls.

#### 1.03 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- H. VVT: Variable-air volume and temperature.

#### 1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design RTU supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Wind-Restraint Performance:



1. Basic Wind Speed: 190Km/hr.
- C. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
  1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

#### 1.05 SUBMITTALS

- A. Product Data (Eurovent certified): Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Performance selection sheets (SCOP, SEER, airflow, ESP).
- C. Sound data.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- E. Wiring Diagrams: Power, signal, and control wiring.
- F. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  2. Detail mounting, securing, to roof structure. Indicate coordinating requirements with roof membrane system.
  3. Wind and Seismic Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
- G. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Structural members to which RTUs will be attached.
  2. Connection to Existing Ducts
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- J. Warranty: Special warranty specified in this Section.

#### 1.06 QUALITY ASSURANCE

- A. Unit shall have a EUR.1 Movement Certificate (EU-Lebanon Association Agreement) and Comply with:
  1. EU Regulation (EU) 2016/2281 – Ecodesign requirements
  2. Machinery directive 2006/42/EC.
  3. Electromagnetic compatibility directive 2014/30/EC.
  4. Pressure equipment directive 2014/68/EU.
  5. Low voltage directive 2014/35/EC.



6. RoHS directive 2011/65/EU (where applicable)
7. Gas appliances directive 2016/426/EU (where applicable)
8. Regulation (EU) 2016/2281 (implementation of directive 2009/125/EC).
9. Regulation (EU) 2016/2281 (implementation of directive 2009/125/EC) Second Tier (ErP 2021)
10. Eurovent certification ([www.eurovent-certification.com](http://www.eurovent-certification.com)) - rooftop unit program (RT).

B. B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.

**1.07 WARRANTY**

- A. RTU 12 months from commissioning
- B. Compressors: 5 years from commissioning.

**1.08 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: Two set (in addition to the replaced one after commissioning) of filters for each unit.

**PART 2- PRODUCTS**

**2.01 MANUFACTURERS**

- A. Approved brands:
1. Carrier Corporation.
  2. Lennox Industries Inc.
  3. Trane.
  4. YORK International Corporation.
  5. Mitsubishi Electric
  6. Climaveneta.
  7. CIAT.
  8. Daikin.
  9. Clivet.
  10. Systemair

**2.02 CASING**

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall Polyurethane insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
1. Exterior Casing Thickness: min. 1.6 mm.
- C. Inner Casing Fabrication Requirements:
1. Inside Casing: Galvanized steel, 0.7 mm.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

- E. Condensate Drain Pans: Formed sections of stainless steel sheet, a minimum of 50 mm deep with Drain Connections Threaded nipple from both sides of drain pan.

### 2.03 FANS

#### A. Direct Supply Fans

1. Type: Plug Fans, Direct driven, high efficiency. with brushless EC motor. Fans shall comply with IEC 60335-2-40, sections 22.116 and 22.117, suitable for operation in the presence of A2L refrigerant gas. The electric motor shall be equipped with built-in thermal protection. Motor ingress protection IP54, insulation class F, IE5.

#### B. Return air fan

1. Type: Plug Fans, Direct driven, high efficiency. with brushless EC motor. Fans shall comply with IEC 60335-2-40, sections 22.116 and 22.117, suitable for operation in the presence of A2L refrigerant gas. The electric motor shall be equipped with built-in thermal protection. Motor ingress protection IP54, insulation class F, IE5.

#### C. Condenser-Coil Fan:

1. Electronically commutated motors (EC)
2. Variable speed operation
3. Separate ventilation for each circuit, with the fans in the inactive circuit switched off.
4. Low noise design Propeller.

#### D. Relief-Air Fan: shaft mounted on permanently lubricated motor.

#### E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

### 2.04 COILS

#### A. Supply-Air Refrigerant Coil:

1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. The speed of the air through the coil no to exceed 2.7 m/s
3. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
4. Coil Split: Interlaced.
5. Blygold coating / HereShield. coating.
6. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.

#### B. Outdoor-Air Refrigerant Coil:

1. Condensing coil of the mechanically expanded copper tubes and corrugated aluminium fins with equalizing-type vertical distributor Each circuit must have its dedicated, independent condensing coil.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Blygold coating / HereShield. coating.

4. Each coil shall be equipped with a heater to prevent ice from forming after defrosting in winter operation.

C. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Cathodic epoxy coating.

**2.05 REFRIGERANT CIRCUIT COMPONENTS**

- A. Number of Refrigerant Circuits: minimum Two totally independent.
- B. Compressors: Type: Hermetic Scroll with at least one of the invert type, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief with. Compressor soundproofing insulation.
- C. Refrigeration Specialties:
1. Refrigerant type: R-32 or R-410A.
  2. Expansion valve with replaceable thermostatic element.
  3. Refrigerant bi-directional filter/dryer.
  4. Liquid and moisture indicator
  5. Manual-reset high-pressure safety switch.
  6. Automatic-reset low-pressure safety switch.
  7. Minimum off-time relay.
  8. Automatic-reset compressor motor thermal overload.
  9. Brass service valves installed in compressor suction and liquid lines.
  10. Low-ambient kit high-pressure sensor.
  11. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
  12. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
  13. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

**2.06 AIR FILTRATION**

- A. Minimum arrestance
1. Prefilter ISO Coarse 55% (G4)
  2. Plane filter ePM01-50% (F8)
  3. Filter Differential Pressure Switch (PDF).

**2.07 ENTHALPY FREE-COOLING AND HEAT RECOVERY**

- A. Units shall be equipped with a Enthalpy Free-Cooling configuration complete with:
1. Constant Air Flow Function.
  2. Rain hood and grille on fresh air intake
  3. Variable fan speed control DVV.
  4. Bird screen and hood
- B. Heat recovery by forcing the exhaust air through the exhaust damper to the outdoor coil so that residual thermal energy is recovered..



## 2.08 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

## 2.09 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. **DDC Controller** Multi-language keyboard 4.3" touch display with Remote keyboard installed directly in the air-conditioned area. The touch display is equipped with temperature and humidity probes.
1. Controller shall have volatile-memory backup.
  2. Temperature control shall be based on proportional + integral logic using the return air temperature probe reading. The set point can also be adjusted based on outside temperature, in both cooling and heating operation.
  3. Safety Control Operation:
    - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    - b. Firestats: Stop fan and close outdoor-air damper if air greater than 54 deg C. Provide additional contacts for alarm interface to fire alarm control panel.
    - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence for "Fire Detection and Alarm."
    - d. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
    - e. Refrigerant Leakage Detection System.
  4. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
  5. Unoccupied Period:
    - a. Heating Setback: 5.6 deg C.
    - b. Cooling Setback: System off.
    - c. Override Operation: Two hours.
  6. Supply Fan Operation:
    - a. Occupied Periods: Run fan continuously.
    - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
    - c. Partially occupied to control the required FA supply.
  7. Refrigerant Circuit Operation:
    - a. Occupied Periods: Cycle or stage compressors match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
    - b. Unoccupied Periods: Compressors off.
    - c. Switch reversing valve for heating or cooling.



8. Hot-Gas Reheat-Coil Operation:
    - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
    - b. Unoccupied Periods: Reheat not required.
  9. Fixed Minimum Outdoor-Air Damper Operation:
    - a. Occupied Periods / Partially Occupied Period (according the number of people).
    - b. Unoccupied Periods (CO sensors controls the F.A.).
  10. Economizer Outdoor / Free Cooling Air Damper Operation:
    - a. Operated by an enthalpy control requirement.
    - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper but keep monitoring for the Carbon Dioxide levels. (open FA damper if required).
    - c. Outdoor-Airflow Monitor
  11. Carbon Dioxide Sensor Operation:
    - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 800-ppm concentration.
    - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
  12. Interface Requirements for HVAC Instrumentation and Control System:
- C. Interface relay for scheduled operation: Provide BACnet compatible interface for central HVAC control workstation for the following:
1. Adjusting set points.
  2. Monitoring supply fan start, stop, and operation.
  3. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
  4. Monitoring occupied and unoccupied operations.
  5. Monitoring constant and variable motor loads.
  6. Monitoring variable-frequency drive operation.
  7. Monitoring cooling load.
  8. Monitoring economizer cycles.
  9. Monitoring air-distribution static pressure and ventilation air volume.

**2.10 SAFETY DEVICE FOR R32 GAS (A2L GAS)**

- A. Units with R32 refrigerant gas, A2L gas shall be equipped with suitable safety devices to prevent, in the event of leaks, the concentration of refrigerant gas towards the rooms served or inside the unit.
- B. A gas sensor shall be placed near the coils, as this is the source from which any leak of refrigerant may occur.
- C. Whenever leak is detected, units in steady-state operation maintains a minimum level of ventilation to prevent excessive accumulation of gas in the air-conditioned space, diluting it with the conditioned air flow and sends an alarm. If the leak occurs while the machine is off, the alarm stops the unit from starting up.

- D. The unit shall be equipped with a 'sensor malfunction' alarm, which triggers the same actions as described above if a sensor malfunction is detected.
- E. Units shall be equipped with "safety dampers", that lends itself especially to spaces with naked flames or in the event of a site blackout. Dampers shall be class 4 (in accordance with EN 751) on the air supply and return, with the aim of isolating the rooms served in the event of a leak of refrigerant gas. In this case, the two dampers close, ventilation is stopped and natural ventilation is ensured through the opening of the fresh air intake damper, which allows the evacuation of residual refrigerant.
- F. Dampers operation, in case of blackout, shall guarantee a maximum level of safety even when the machine is not powered.

### 2.11 ACCESSORIES

- A. Duplex, ground-fault-interrupter
- B. Low-ambient kit using variable-speed condenser fans.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Coil guards.
- E. Hail guards of galvanized steel, painted to match casing.
- F. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of the existing duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic.
- B. Equipment Mounting: Install the 4 RTUs supplying the main Auditorium on existing concrete bases using elastomeric mounts or restrained spring isolators. Comply with requirements of the manufacturer. For the 2 RTUs supplying the right and left halls the contractor shall Cast-in-Place Concrete bases before proceeding as previously described.
- C. Install wind and seismic and wind restraints according to manufacturer's written instructions.

### 3.03 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:



1. Install ducts and connect to the existing ducts.
2. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section " Air Duct Accessories."
3. Install return-air duct continuously through roof structure.

### 3.04 FIELD QUALITY CONTROL

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

### 3.05 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  1. Inspect for visible damage to unit casing.
  2. Inspect for visible damage to furnace combustion chamber.
  3. Inspect for visible damage to compressor, coils, and fans.
  4. Inspect internal insulation.
  5. Verify that labels are clearly visible.
  6. Verify that clearances have been provided for servicing.
  7. Verify that controls are connected and operable.
  8. Verify that filters are installed.
  9. Clean condenser coil and inspect for construction debris.
  10. Clean furnace flue and inspect for construction debris.
  11. Connect and purge gas line.
  12. Remove packing from vibration isolators.
  13. Inspect operation of barometric relief dampers.
  14. Verify lubrication on fan and motor bearings.
  15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  16. Adjust fan belts to proper alignment and tension.
  17. Start unit according to manufacturer's written instructions.



18. Start refrigeration system.
19. Complete startup sheets and attach copy with Contractor's startup report.
20. Inspect and record performance of interlocks and protective devices; verify sequences.
21. Operate unit for an initial period as recommended or required by manufacturer.
22. Calibrate thermostats.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
25. Start refrigeration system and measure and record the following when ambient is a minimum of 8 deg C above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
28. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
29. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Free cooling operation
  - f. Relief-air fan operation.
  - g. Smoke and firestat alarms.
30. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### 3.06 LEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to four visits to site during other-than-normal occupancy hours for this purpose.



- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

**3.07 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 237413



AS

## SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. This Section includes central split AC units, outdoor condensing unit, heat-pump, for air handling, filtration and ventilation with the following components and accessories:
1. Direct-expansion cooling.
  2. Heat-pump refrigeration piping and components.
  3. Integral, space temperature controls.

#### 1.03 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in condensing units. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. VVT: Variable-air volume and temperature.

#### 1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design Central Split AC System supports to comply with wind and seismic performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Wind-Restraint Performance:
1. Basic Wind Speed: 190Km/hr.
- C. Seismic Performance: Split Unit (Condensing unit and Indoor Unit) shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

## 1.05 SUBMITTALS

- A. Product Data (Eurovent certified): Include manufacturer's technical data for each unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Performance selection sheets (SCOP, SEER, airflow, ESP).
- C. Sound data.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- E. Wiring Diagrams: Power, signal, and control wiring.
- F. Delegated-Design Submittal: For Indoor and Outdoor supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 2. Detail mounting.
  - 3. Wind and Seismic Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
- G. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which the Condensing units will be attached.
  - 2. Connection of the Indoor unit to Existing Ducts
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For AC units to include in emergency, operation, and maintenance manuals.
- J. Warranty: Special warranty specified in this Section.

## 1.06 QUALITY ASSURANCE

- A. Unit shall have a EUR.1 Movement Certificate (EU-Lebanon Association Agreement) and Comply with:
  - 1. EU Regulation (EU) 2016/2281 – Ecodesign requirements
  - 2. Eurovent Certification – Performance certification
  - 3. EN 378 – Refrigeration safety and environmental requirements
  - 4. Pressure equipment directive 2014/68/EU.
  - 5. Low voltage directive 2014/35/EC.
  - 6. IEC / CENELEC standards for electrical components
- B. ASHRAE Compliance:
  - 1. Comply with ASHRAE 15 for refrigeration system safety.

## 1.07 WARRANTY

- A. AC units 12 months from commissioning
- B. Compressors: 5 years from commissioning.



## 1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: Two set (in addition to the replaced one after commissioning) of filters for each unit.

## PART 2- PRODUCTS

### 2.01 MANUFACTURERS

- A. Approved brands:
1. Carrier Corporation.
  2. Lennox Industries Inc.
  3. Trane.
  4. YORK International Corporation.
  5. Mitsubishi Electric
  6. Mitsubishi Heavy Industries
  7. CIAT.
  8. Daikin.
  9. Clivet.
  10. Systemair,

### 2.02 INDOOR UNIT

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall Polyurethane insulated panels made of galvanized steel factory-painted, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. General Fabrication Requirements for Casings: Formed and reinforced double-wall Polyurethane insulated panels made of galvanized steel factory-painted, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- C. FAN Type: Plug Fans, Direct driven, high efficiency. with brushless EC variable speed motor. Fans shall comply with IEC 60335-2-40. The electric motor shall be equipped with built-in thermal protection. Motor ingress protection IP54, insulation class F, IE5.
- D. Supply-Air Refrigerant Coil:
1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
  2. The speed of the air through the coil no to exceed 2.7 m/s
  3. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
  4. Coil Split: Interlaced.
  5. Baked phenolic
  6. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.:
- E. Condensate Drain Pan: Formed sections of stainless steel sheet, a minimum of 50 mm deep with Drain Connections Threaded nipple from both sides of drain pan.



- F. Air Filters.
  - 1. Prefilter ISO Coarse 55% (G4)
  - 2. Plane filter ePM01-50% (F8)
  - 3. Filter Differential Pressure Switch (PDF).
- G. Electric termination box for the power and control systems Enclosure rating IP rating: IP55 with Gasket-sealed door, disconnect switch, and Cable glands.

## 2.03 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, finished with baked enamel in color, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing
- B. Outdoor-Air Refrigerant Coil:
  - 1. Condensing coil of the mechanically expanded copper tubes and corrugated aluminium fins with equalizing-type vertical distributor Each circuit must have its dedicated, independent condensing coil.
  - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
  - 3. Blygold coating / HereShield. coating.
  - 4. Each coil shall be equipped with a heater to prevent ice from forming after defrosting in winter operation.
- C. Compressors:
  - 1. Type: Hermetic Scroll with at least one of the invert type, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief with. Compressor soundproofing insulation.
- D. Refrigeration Specialties:
  - 1. Refrigerant type: R-410A.
  - 2. Expansion valve with replaceable thermostatic element.
  - 3. Refrigerant bi-directional filter/dryer.
  - 4. Liquid and moisture indicator
  - 5. Manual-reset high-pressure safety switch.
  - 6. Automatic-reset low-pressure safety switch.
  - 7. Minimum off-time relay.
  - 8. Automatic-reset compressor motor thermal overload.
  - 9. Brass service valves installed in compressor suction and liquid lines.
  - 10. Low-ambient kit high-pressure sensor.
  - 11. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
  - 12. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
  - 13. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.
- E. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and

Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.

- F. Condenser-Coil Fan: Electronically commutated motors (EC) ,Variable speed operation and Low noise design Propeller.
- G. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

## 2.04 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. DDC Controller Multi-language keyboard 4.3" touch display with Remote keyboard installed directly in the air-conditioned area. The touch display is equipped with temperature and humidity probes.
  - 1. Controller shall have volatile-memory backup.
  - 2. Temperature control shall be based on proportional + integral logic using the return air temperature probe reading. The set point can also be adjusted based on outside temperature, in both cooling and heating operation.
  - 3. Safety Control Operation:
    - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    - b. Firestats: Stop fan and close outdoor-air damper if air greater than 54 deg C. Provide additional contacts for alarm interface to fire alarm control panel.
    - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence for "Fire Detection and Alarm."
    - d. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
  - 4. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
  - 5. Unoccupied Period:
    - a. Heating Setback: 5.6 deg C.
    - b. Cooling Setback: System off.
    - c. Override Operation: Two hours.
  - 6. Supply Fan Operation:
    - a. Occupied Periods: Run fan continuously.
    - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
    - c. Partially occupied to control the required FA supply.
  - 7. Refrigerant Circuit Operation:
    - a. Occupied Periods: Cycle or stage compressors match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.

- b. Unoccupied Periods: Compressors off.
    - c. Switch reversing valve for heating or cooling.
  - 8. Interface Requirements for HVAC Instrumentation and Control System:
    - C. Interface relay for scheduled operation: Provide BACnet compatible interface for central HVAC control workstation for the following:
      - 1. Adjusting set points.
      - 2. Monitoring supply fan start, stop, and operation.
      - 3. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
      - 4. Monitoring occupied and unoccupied operations.
      - 5. Monitoring constant and variable motor loads.
      - 6. Monitoring variable-frequency drive operation.
      - 7. Monitoring cooling load.

#### **2.05 ACCESSORIES**

- A. Duplex, ground-fault-interrupter
- B. Low-ambient kit using variable-speed condenser fans.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Coil guards.
- E. Hail guards of galvanized steel, painted to match casing.

### **PART 3- EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of Unit.
- B. Examine roofs for suitable conditions where CUs will be installed.
- C. Examine roughing-in for CU to verify actual locations of pads.
- D. Check for the existing duct connections before Indoor unit installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION**

- A. Dismantle and remove the existing chilled water air handling unit (ahu), along with all associated chilled water piping within the technical room. The area shall be thoroughly cleared of all redundant materials, debris, and unnecessary items prior to commencement of new installation works.
- B. The contractor shall be fully responsible for delivering and positioning the new unit in its designated location within the technical room. This responsibility shall include all necessary measures to ensure proper access and installation. If required, the contractor shall carry out temporary dismantling or modification of walls, door frames, or other obstructions (including cases where the door width is insufficient), and shall reinstate all affected elements to their original condition upon completion of the installation.

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- C. Following completion of cleaning and site preparation, the contractor shall supply and install a new direct expansion (dx) ahu. The unit shall be properly positioned, secured, and connected to the existing ductwork system after ensuring that all ducts are internally clean and free from dust and contaminants.
- D. Copper refrigerant piping of ACR grade shall be installed in accordance with recognized standards, including ashrae guidelines. The piping shall be properly sized, routed, supported, insulated, and connected to the outdoor condensing unit, which shall be installed at roof level. All connections shall be executed using approved brazing procedures and tested to ensure leak-tight and reliable operation.
- E. The contractor shall also supply and install all required electrical works, including power and control cabling, in accordance with applicable standards and manufacturer requirements. Proper cable routing, containment, termination, and identification shall be ensured. Additionally, the condensate drain piping shall be installed, properly trapped, sloped, and connected to the designated drainage point to ensure safe and efficient removal of condensate.
- F. Concrete Bases: Anchor CU to concrete base according to equipment manufacturer's written instructions and according to seismic requirements.
- G. Install wind and seismic and wind restraints according to manufacturer's written instructions.

### 3.03 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest drain or area drain.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts and connect to the existing ducts.
  - 2. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section " Air Duct Accessories."
  - 3. Install return-air duct continuously through roof structure.
- C. Install and connect the refrigerant pipes :
  - 1. Use ACR-grade copper pipes (deoxidized, dehydrated) according to ASTM B280
  - 2. Provide seismic supports with Rubber-lined clamps
  - 3. Oil Return trapes and slopes as required by the manufacturer.
  - 4. Use silver brazing alloy ( $\geq 15\%$  silver):
  - 5. During all brazing operations, a continuous flow of dry nitrogen shall be maintained within the piping system to displace oxygen and prevent internal oxidation (scale formation). The nitrogen flow rate shall be controlled to ensure a positive internal pressure without disturbing the brazing flame or alloy flow. Nitrogen used shall be clean, dry, and oil-free.
  - 6. Use dry nitrogen for pressure testing (600 psi) and hold for 24 Hrs.
  - 7. A high-quality, appropriately sized vacuum pump shall be utilized to evacuate the refrigeration system. The system shall be evacuated to a final vacuum level not exceeding 500 microns absolute pressure,

as measured by a calibrated micron gauge. In cases where moisture contamination is suspected, a triple evacuation procedure shall be performed, incorporating intermediate nitrogen breaking cycles to ensure complete removal of non-condensable gases and moisture.

8. Refrigerant charging shall be carried out in the liquid phase for systems utilizing R-410A. Charging shall be performed using a calibrated weighing scale to ensure accurate refrigerant quantity in accordance with manufacturer specifications. Upon completion, system performance shall be verified by measuring superheat, which shall be maintained within the typical range of 8–12°C, unless otherwise specified by the equipment manufacturer.
9. Use Closed-cell elastomeric insulation (e.g., nitrile rubber) Thickness:19 mm on all pipes.

### 3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections and prepare test reports.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.
- C. Tests and Inspections:
  1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. STARTUP SERVICE
- F. Engage a factory-authorized service representative to perform startup service.
- G. Complete installation and startup checks according to manufacturer's written instructions and do the following:
  1. Inspect for visible damage to indoor unit casing.
  2. Inspect for visible damage to compressor, coils, and fans.
  3. Inspect internal insulation.
  4. Verify that labels are clearly visible.
  5. Verify that clearances have been provided for servicing.
  6. Verify that controls are connected and operable.
  7. Verify that filters are installed.
  8. Clean condenser coil and inspect for construction debris.
  9. Remove packing from vibration isolators.
  10. Start unit according to manufacturer's written instructions.
    - a. Start refrigeration system.



- b. Complete startup sheets and attach copy with Contractor's startup report.
11. Inspect and record performance of interlocks and protective devices; verify sequences.
12. Operate unit for an initial period as recommended or required by manufacturer.
13. Adjust and inspect high-temperature limits.
14. Start refrigeration system and measure and record the following when ambient is a minimum of 8 deg C above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
15. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
16. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
17. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. Low-temperature safety operation.
  - b. Filter high-pressure differential alarm.
18. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### **3.05 CLEANING AND ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to four visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing and air-distribution systems, clean filter housings and install new filters.

### **3.06 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the split unit. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126



## SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

### PART 1- GENERAL

#### 1.01 RELATED DOCUMENTS

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

#### 1.02 SUMMARY

- A. This Section includes galvanized steel cable trays and accessories.

#### 1.03 SUBMITTALS

- A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
  - 1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
  - 2. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
    - a. Design Calculations: Calculate requirements for selecting seismic restraints.
    - b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
- C. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
  - 1. Vertical and horizontal offsets and transitions.
  - 2. Clearances for access above and to side of cable trays.
  - 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For cable trays to include in emergency, operation, and maintenance manuals.

#### 1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.



**1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Hot dip galvanized after fabrication may be stored outside without cover, but shall be loosely stacked, elevated off the ground, and ventilated to prevent staining during storage.
- B. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

**PART 2- PRODUCTS**

**2.01 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. OBO Bettermann.
  - 2. Tolmega.
  - 3. Vergokan.
  - 4. GS Metals Corp.; GLOBETRAY Products.
  - 5. MONO-SYSTEMS, Inc.
  - 6. MPHusky.
  - 7. PW Industries.

**2.02 MATERIALS AND FINISHES**

- A. Cable Trays, Fittings, and Accessories: Steel, complying with NEMA VE 1.
  - 1. Hot-dip galvanized after fabrication, complying with ASTM A 123/A 123M, Class B2; with chromium-zinc, ASTM F 1136

**2.03 CABLE TRAY ACCESSORIES**

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Covers: Solid type of same materials and finishes as cable tray.
- C. Barrier Strips: Same materials and finishes as cable tray.
- D. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

**2.04 WARNING SIGNS**

- A. Lettering: 40-mm- high, black letters on yellow background with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

**2.05 SOURCE QUALITY CONTROL**

- A. Perform design and production tests according to NEMA VE 1

**PART 3- EXECUTION**

**3.01 CABLE TRAY INSTALLATION**

- A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

- B. Remove burrs and sharp edges from cable trays.
- C. Fasten cable tray supports to building structure and install seismic restraints.
  - 1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details
  - 2. Place supports so that spans do not exceed maximum spans on schedules.
  - 3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
  - 4. Support bus assembly to prevent twisting from eccentric loading.
  - 5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
  - 6. Locate and install supports according on concrete bases to NEMA VE 1.
- D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
- E. Make changes in direction and elevation using standard fittings.
- F. Make cable tray connections using standard fittings.
- G. Seal penetrations through fire and smoke barriers.
- H. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- I. Workspace: Install cable trays with enough space to permit access for installing cables.
- J. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

**3.02 CABLE INSTALLATION**

- A. Install cables only when cable tray installation has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties as recommended by NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. On vertical runs, fasten cables to tray every 457 mm. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- D. In existing construction, remove inactive or dead cables from cable tray.
- E. Install covers after installation of cable is completed.

**3.03 CONNECTIONS**

- A. Ground cable trays according to manufacturer's written instructions.
- B. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.

**3.04 FIELD QUALITY CONTROL**

- A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:
1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
  2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by NFPA 70. Verify that communication or data-processing circuits are separated from power circuits by barriers.
  3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
  4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
  5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorquing in suspect areas.
  6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
  7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.
- B. Report results in writing.

**3.05 PROTECTION**

- A. Protect installed cable trays.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
  2. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over

END OF SECTION 260536



## SECTION 262416 - HVAC EQUIPMENT ELECTRICAL PANELBOARDS

### PART 1- GENERAL

#### 1.01 SUMMARY

- A. This Section includes furnishing, fabrication, assembly, factory testing, delivery, installation, testing, commissioning, and placing into operation of electrical panelboards serving rooftop units (RTUs), central split DX systems, and associated HVAC equipment.
- B. Work includes power distribution panelboards, motor protection devices, feeders, breakers, control interfaces, surge protection, metering, and all accessories required for a complete operational system.
- C. Panelboards shall serve the following HVAC systems:
  - 1. Auditorium rooftop units.
  - 2. Multipurpose hall rooftop units.
  - 3. Conference hall rooftop units.
  - 4. Central split systems serving lobbies.
  - 5. Associated ventilation equipment.
  - 6. Associated control panels and BMS interfaces.
- D. Panelboards shall be coordinated with HVAC equipment manufacturer requirements and Building Management System (BMS) integration.

#### 1.02 RELATED SECTIONS

- A. Section 23 09 23 – Direct Digital Control System for HVAC.
- B. Section 23 81 00 – Decentralized Unitary HVAC Equipment.
- C. Section 26 05 00 – Common Work Results for Electrical.
- D. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables.
- E. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- F. Section 26 05 29 – Hangers and Supports for Electrical Systems.
- G. Section 26 28 13 – Fuses.
- H. Section 26 43 13 – Surge Protective Devices.

#### 1.03 REFERENCES

- A. Latest editions of the following standards shall apply:
  - 1. IEC 61439 – Low Voltage Switchgear and Control gear Assemblies.
  - 2. IEC 60947 – Low Voltage Switchgear and Control gear.
  - 3. IEC 60204 – Safety of Machinery – Electrical Equipment.
  - 4. IEC 60529 – Degrees of Protection (IP Code).
  - 5. NFPA 70 – National Electrical Code.
  - 6. IEEE C62.41 – Surge Protection.
  - 7. NEMA PB1 – Panelboards.
  - 8. UL 67 – Panelboards.
  - 9. UL 489 – Molded Case Circuit Breakers.
  - 10. IEC 60364 – Electrical Installations for Buildings.

#### 1.04 SYSTEM DESCRIPTION

- A. Provide complete low voltage electrical panelboards dedicated for HVAC systems.

- B. Each panelboard shall include:
  - 1. Main incoming circuit breaker.
  - 2. Branch circuit breakers.
  - 3. Motor protection devices.
  - 4. Surge protection device (SPD).
  - 5. Digital multifunction power meter.
  - 6. Control transformer where required.
  - 7. Auxiliary contacts.
  - 8. Phase indication lamps.
  - 9. Terminal blocks.
  - 10. Grounding bar.
  - 11. Neutral bar.
  - 12. Engraved labeling.
  - 13. Space for future expansion.
- C. Panelboards shall distribute power to:
  - 1. Rooftop units.
  - 2. Central split outdoor units.
  - 3. Indoor split blower sections.
  - 4. Control panels.
  - 5. BMS panels.
  - 6. Ventilation accessories.
- D. Panelboards shall be suitable for continuous operation under ambient conditions of the project site.

#### 1.05 DESIGN REQUIREMENTS

- A. Panelboards shall be rated for:
  - 1. Voltage: 400/230V, 3 Phase, 4 Wire, 50 Hz unless otherwise indicated.
  - 2. Short circuit withstand capacity: minimum 25 kA unless otherwise indicated.
  - 3. Ambient temperature: 50°C.
  - 4. Relative humidity: 95% non-condensing.
- B. All components shall be fully coordinated and type tested.
- C. Selective coordination shall be maintained between upstream and downstream protective devices.
- D. Voltage drop shall not exceed:
  - 1. 3% for branch circuits.
  - 2. 5% total feeder and branch combined.

#### 1.06 SUBMITTALS

- A. Product data sheets.
- B. Shop drawings including:
  - 1. Single line diagrams.
  - 2. Panelboard layouts.
  - 3. Internal wiring diagrams.



4. Component schedules.
  5. Breaker coordination curves.
  6. Short circuit calculations.
  7. Heat dissipation calculations.
  8. Cable schedules.
  9. Panel dimensions.
  10. Busbar sizing calculations.
- C. Manufacturer certifications.
  - D. Factory test reports.
  - E. Operation and maintenance manuals.
  - F. Panel Builder Certification
  - G. As-built drawings.
- 1.07 QUALITY ASSURANCE**
- A. Manufacturer shall have minimum ten years experience in low voltage switchgear manufacturing.
  - B. Panelboards shall be factory assembled and tested.
  - C. Manufacturer shall be ISO 9001 certified.
  - D. Components shall be from same manufacturer where possible.
  - E. Assemblies shall be routine tested in accordance with IEC 61439.

**1.08 WARRANTY**

- A. Provide minimum twenty-four (24) months warranty from substantial completion.
- B. Warranty shall include:
  1. Parts.
  2. Labor.
  3. Technical support.
  4. Replacement of defective components.

**PART 2- PRODUCTS**

**2.01 ACCEPTABLE MANUFACTURERS**

- A. Subject to compliance with requirements, acceptable manufacturers shall include:
  1. Schneider Electric
  2. Siemens
  3. ABB
  4. Eaton
- B. Equivalent approved products may be accepted subject to consultant approval.

**2.02 PANELBOARD CONSTRUCTION**

- A. Panelboards shall be dead-front, front-accessible, modular construction.
- B. Enclosures shall be fabricated from minimum 2 mm thick sheet steel.
- C. Enclosures shall be:
  1. Indoor panels: minimum IP42.


- 2. Outdoor panels: minimum IP55.
- D. Outdoor panels shall include:
  - 1. Rain hood.
  - 2. UV resistant coating.
  - 3. Anti-condensation heater.
  - 4. Thermostat.
  - 5. Ventilation louvers with filters.
- E. Finish shall be electrostatic powder coating.
- F. Color shall be RAL 7035 unless otherwise indicated.

### 2.03 BUSBARS

- A. Busbars shall be high conductivity electrolytic copper.
- B. Busbars shall be fully insulated.
- C. Minimum busbar rating shall be 125% of calculated load.
- D. Neutral busbar shall be rated at 100% of phase bus.
- E. Ground busbar shall extend entire panel width.
- F. Busbars shall withstand specified short circuit current.

### 2.04 MAIN CIRCUIT BREAKERS

- A. Main breakers shall be molded case circuit breakers (MCCB).
- B. MCCBs shall comply with IEC 60947-2.
- C. Features shall include:
  - 1. Thermal magnetic protection.
  - 2. Adjustable trip settings.
  - 3. Short circuit protection.
  - 4. Overload protection.
  - 5. Phase failure protection.
  - 6. Auxiliary contacts.
  - 7. Shunt trip where indicated.
- D. Minimum interrupting capacity shall match panel short circuit rating.

### 2.05 BRANCH CIRCUIT BREAKERS

- A. Branch breakers shall be miniature circuit breakers (MCB) or MCCBs as required.
- B. Breakers shall comply with IEC 60898 or IEC 60947.
- C. Provide dedicated breakers for:
  - 1. Indoor fan sections.
  - 2. BMS power supplies and UPS.
  - 3. Convenience outlets where required.

### 2.06 SURGE PROTECTIVE DEVICE (SPD)

- A. Each panelboard shall include Type 2 surge protective device.
- B. SPD characteristics:
  - 1. Nominal voltage: 400V.
  - 2. Minimum surge capacity: 40 kA per phase.
  - 3. Visual status indication.



4. Thermal disconnect.
  5. Remote alarm contact.
- C. SPD shall comply with IEC 61643.

### **PART 3- EXECUTION**

#### **3.01 INSTALLATION**

- A. Install panelboards in accordance with manufacturer recommendations and approved shop drawings.
- B. Mount panels rigidly and level.
- C. Maintain minimum access clearances as required by code.
- D. Install panels away from water sources and excessive heat.
- E. Outdoor panels shall be installed on concrete housekeeping pads.
- F. Coordinate panel locations with architectural and mechanical requirements.

#### **3.02 ELECTRICAL CONNECTIONS**

- A. All wiring shall comply with Division 26 requirements.
- B. Terminate conductors using approved lugs.
- C. Tighten all electrical connections to manufacturer torque recommendations.
- D. Segregate power and control wiring.
- E. Provide grounding and bonding in accordance with specifications.

#### **3.03 IDENTIFICATION**

- A. Provide engraved nameplates indicating:
  1. Panel designation.
  2. Voltage.
  3. Short circuit rating.
  4. Source supply.
- B. Provide typed circuit directories.
- C. Label all breakers and devices.

#### **3.04 FIELD QUALITY CONTROL**

- A. Perform field testing including:
  1. Insulation resistance testing.
  2. Continuity testing.
  3. Phase rotation verification.
  4. Breaker operation testing.
  5. Functional testing.
  6. Meter calibration verification.
  7. BMS communication testing.
- B. Verify proper torque of all electrical connections.
- C. Submit testing reports.

#### **3.05 COMMISSIONING**

- A. Provide complete commissioning services.
- B. Verify:
  1. Proper panel operation.
  2. Protective device settings.



3. Alarm operation.
  4. BMS integration.
  5. Meter functionality.
  6. SPD operation.
- C. Demonstrate complete system operation.

**3.06 CLEANING**

- A. Clean panel interiors prior to energization.
- B. Remove dust, debris, and construction materials.

**3.07 TRAINING**

- A. Provide minimum one day training for Owner personnel.
- B. Training shall include:
  1. Panel operation.
  2. Breaker resetting.
  3. Meter operation.
  4. BMS monitoring.
  5. Maintenance procedures.

**3.08 PANELBOARD SCHEDULES**

A. PANELBOARD SCHEDULE

Description	Requirement
Panel Type	HVAC Power Panelboards
Panel	Form 2B Design Ferified
Voltage	400/230V, 3Ph, 4W
Frequency	50 Hz
Main Breaker	MCCB
Short Circuit Rating	25 kA minimum
Enclosure	IP55 Outdoor
Metering	Multifunction Meter
Surge Protection	Type 2 SPD
Spare Capacity	25% minimum

**3.09 OPERATION AND MAINTENANCE**

A. OPERATION AND MAINTENANCE MANUALS:

1. Provide complete manuals including:
  - a. Product data.
  - b. Shop drawings.
  - c. Wiring diagrams.
  - d. Protection settings.
  - e. Spare parts lists.
  - f. Troubleshooting procedures.
  - g. Maintenance procedures.
  - h. Test reports.
  - i. As-built drawings.
2. Manuals shall be submitted in printed and electronic formats.

B. AS-BUILT DOCUMENTATION: Submit complete as-built documentation indicating:

1. Final panel locations.
2. Circuit numbering.
3. Cable sizes.

4. Breaker ratings.
5. Communication points.
- C. PREVENTIVE MAINTENANCE:
  1. Preventive maintenance shall include:
    - a. Thermal scanning.
    - b. Connection tightening.
    - c. Breaker testing.
    - d. Meter verification.
    - e. SPD inspection.
    - f. Cleaning.
  2. Maintenance schedule shall comply with manufacturer recommendations.
- D. SPARE PARTS: Furnish spare parts including:
  1. Spare breakers.
  2. Spare indication lamps.
  3. Spare fuses.
  4. Spare relays.
  5. Spare auxiliary contacts.
- E. FINAL ACCEPTANCE: Final acceptance shall occur upon:
  1. Successful testing.
  2. Successful commissioning.
  3. Completion of training.
  4. Submission of O&M manuals.
  5. Resolution of deficiencies.

END OF SECTION 262416

