

SECTION 23 08 00 – TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The Test and Balance (TAB) Contractor shall furnish the testing, adjusting and balancing of the Heating, Ventilation and Air Conditioning (HVAC) system as a part of the HVAC rooftop units purchase from the rooftop equipment manufacturer. The rooftop equipment manufacturer shall incorporate the services of a certified national TAB firm for all of the stores in their assigned territories.
- B. TAB firm shall be certified by Associated Air Balance Council (AABC), National Environmental Balancing Bureau (NEBB), or Testing Adjusting and Balancing Bureau (TABB).
- C. All work shall be performed under the direction of a Certified Test and Balance Engineer. The Contractor's technicians shall meet the qualifications of the Contractor's certification agency (AABC, NEBB or TABB).
- D. All TAB Work shall be performed in accordance with the latest edition of ASHRAE Standard 111, "Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air Conditioning and Refrigeration Systems"; and either AABC "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing." In case of conflict, ASHRAE Standard 111 shall govern.
- E. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - b. Certify that TAB team complied with the procedures specified and referenced in this Specification.
- F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - a. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- H. Data Required for Recordkeeping: Every quarter, the TAB firm shall provide an export file containing store number and a summary containing rooftop unit number, area served, model number and serial number of HVAC equipment serving that store for import into Walgreens database.
- I. Additional Services: TAB firm will provide an HVAC system inspection and punch list as outlined in Section 1.03 and 1.06 below.

1.02 SCHEDULING

- A. This work shall be scheduled to be performed after the HVAC system has been started by the mechanical contractor and prior to fixture date. The TAB firm shall be responsible for scheduling the testing, adjusting, and balancing directly with the Walgreens Field Project Manager at least two weeks in advance. Walgreens Construction will provide an updated project list and Field Project Manager contact list with e-mail addresses and cell phone numbers to the HVAC manufacturer and TAB firm on a regular basis via e-mail.
- B. The TAB firm will e-mail a checklist to the Walgreens Field Project Manager with a copy to the Senior Regional Construction Manager to obtain project completion status and to schedule the site visit. Checklist to be filled out by the General Contractor (GC) to assure that the HVAC system shall be fully ready before TAB firm arrives at site. Completed checklist must be sent via e-mail with items addressed in a "YES or NO" format with explanation provided as necessary. The following must be complete prior to the TAB firm's visit:
 - 1. All rooftop units along with all field mounted accessories must be installed and economizer/outside air dampers installed and wired.
 - 2. All exhaust fans must be installed, wired and operational.
 - 3. Units must be properly tagged per design drawings, including exhaust fans.
 - 4. Gas piping completed and gas turned on.
 - 5. All power wiring completed, disconnects mounted and permanent power turned on.
 - 6. All fans checked for proper rotation.
 - 7. All control wiring completed including thermostats, sensors and smoke detectors.
 - 8. All duct work with balancing dampers and diffusers fully installed.
 - 9. Clean filters installed.
 - 10. All doors and windows installed and ceiling tiles in place.
 - 11. Additional items as deemed necessary.
- C. The TAB firm will request project design mechanical drawings (M-111, M-510, M-610 and M-620 as CAD files via e-mail) and specifications from the GC two weeks prior to site visit.
- D. The Walgreens Field Project Manager shall notify the GC of the scheduled balancing date. The GC shall coordinate with the Mechanical and Electrical Contractors in order to have the appropriate tradesmen on site to correct any deficiencies in wiring, ductwork, or equipment start-up.
- E. If, for any reason, the HVAC system is not operational in time for the TAB firm to schedule the work prior to fixture date, the GC shall be responsible for any and all additional costs incurred by rescheduling the TAB firm.
- F. Each Friday the TAB firm shall be responsible for sending out a list of all stores that are on their schedule for the upcoming week via email to Walgreens. The intent is to communicate with Construction and field maintenance staff so that they can perform an audit of TAB activities while TAB technician is on site.

1.03 HVAC SYSTEM INSPECTION AND PUNCH LIST

- A. The TAB technician shall inspect the HVAC system and notify the GC and Walgreens Field Project Manager of any deficiencies needing immediate attention. Verify and record the following as part of the HVAC system inspection:

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- 1. Inquire about any design, equipment, and installation problems.

2. Compare installed system to design mechanical plans for the specific store.

ROOFTOP INSPECTION

1. Inspect rooftop units and document any deficiencies.
2. Verify units are properly tagged for ease of identification.
3. Check disconnect switches and covers.
4. Check for obstructions to unit access panels such as conduit, gas piping or condensate drains.
5. Check for correct fan rotation (including condenser fans).
6. Check belt tension and pulley alignment.
7. Check any fan noise and vibration.
8. Check position of outside and return air dampers.
9. Check distance between outside air intakes in relation to exhaust fans, flues, water heater vent, and plumbing vents.
10. Check conditions of filters.
11. Check conditions of coils.
12. Check condensate drain seal (CostGard) and condensate line installation.
13. Check gas lines for proper installation. Verify that gas piping is painted.
14. Check heating/cooling, and economizer modes of RTU's.
15. Check smoke detectors for proper installation. (if applicable)
16. Cycle power exhaust. (if applicable)
17. Check hurricane tie-downs. (if applicable)
18. Check for evaporator coil coating. (if applicable)
19. Check exhaust fans for correct fan rotation, belt tension, pulley alignment and any fan noise or vibration.
20. Check exhaust fans for installation and proper operation of backdraft dampers.
21. Check that fan blower wheels are clean and free of damage.
22. Check entrance heater for proper installation.
23. Check ductwork above roof for insulation. (if applicable)

ABOVE CEILING INSPECTION

1. Check proper installation and accessibility of all volume dampers.
2. Check for proper installation of flexible ducts for bends, lengths and clamps.
3. Check that ductwork is insulated and ensure that insulation is properly secured, where applicable.
4. Verify that internally lined ductwork has not been used except as allowed in sales area return drops.
5. Check that exposed ductwork in the sales area is painted or insulated.
6. Check that supply grilles on exposed ductwork in the sales area have 6" minimum 90 degree straight tap fittings.
7. Check that supply grilles on exposed ductwork in the sales area are installed 22.5 degrees down from horizontal.
8. Check for insulation on the tops of diffusers.

BELOW CEILING INSPECTION

1. Check air curtain(s) for proper installation.
2. Record air curtain nameplate data.
3. Check thermostats and sensors (temperature, humidity, CO2) for proper wiring and settings.
4. Check thermostats and sensors for proper location.
5. Verify thermostats and sensors are properly tagged for the unit they control.
6. Verify controls for exhaust fans are installed and function properly.
7. Verify diffuser material, aluminum or steel, as specified on design mechanical plans.
8. Verify return/exhaust grilles and registers have inside pans painted black.
9. Check supply diffuser locations at entrance.

10. Check return registers above the communication cabinets in office and pharmacy for proper location.
 11. Check electric wall heaters for quantity, capacity, locations and proper operation.
- B. Provide HVAC punch list to Walgreens Field Project Manager and/or GC and Mechanical Contractor before leaving the site. Include punch list in the final Test and Balance Report. E-mail a rough draft HVAC punch-list of the following items to Walgreens Field Project Manager and Walgreens Senior Regional Construction Manager:
1. Any HVAC items not completed as of air balance date. (RTU's, exhaust fans, ductwork, dampers, diffusers, insulation, heaters, etc.)
 2. Any incorrect installations that need to be addressed.
 3. Any items omitted or revised from the design drawings.
 4. If TAB firm needs to be re-scheduled due to incompleteness of the systems.
 5. Include copy of the checklist of system completion received by TAB firm.

1.04 TESTING, ADJUSTING AND BALANCING

- A. The purpose of testing, adjusting, and balancing the HVAC system is to ensure optimal performance, comfort, and energy efficiency for the Owner's benefit. This service covers all heating, air-conditioning and exhaust ventilation systems.
- B. Air quantities shall be balanced to within +/-10% of design as a general rule. However, in some cases, the air quantities may need to be adjusted differently in order to ensure acceptable comfort levels, positive building pressure, noise consideration etc. Any excessive variation at certain diffusers (over 10%) must be reported with explanations if they cannot be balanced as required. However the total RTU supply CFM must be within +/- 10% of design.
- C. The TAB technician shall notify the GC and the Walgreens Field Project Manager of any deficiencies needing immediate attention. The GC shall have the Mechanical and Electrical Contractors available to promptly correct any such problems (i.e. replace burned out motors, failed thermostats, incorrect wiring, bad circuit breakers and starters, dirty filters, missing dampers, undersized RTU outside air intakes).
- D. The TAB work shall be completed in accordance with the following checklist:

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1. Compare installed system to design mechanical plans for the specific store.
2. Document design specifications for report.
3. Record unit nameplate data.

TEST, ADJUST AND BALANCE THE HVAC SYSTEM

1. Measure and adjust diffuser supply, return and exhaust airflows using balancing dampers, and locking them in that position (when applicable). Mark damper balance positions.
 - a. Adjust damper airflows at branch take-offs first and at diffusers second.
2. Adjust RPM as necessary to achieve design.
 - a. Check actual amps versus motor FLA for evaporator fan, compressors and condenser fans.
 - b. Note adjustments made on pulleys.
 - c. Measure final RPMs.
3. Measure space temperature, supply air temperature and return air temperature for the following areas: front checkout, pharmacy, office, general stock, sales area (three spot temperatures minimum). Temperature readings shall be recorded after the system has been running for at least eight hours and thermostats have been properly set.

4. Measure outside air temperature and relative humidity.
5. Check for drafts and hot/cold spots.
6. Adjust to provide design outside air flow with and without Demand Control Ventilation.
7. Ensure slightly positive building pressure.
 - a. Fine tune position of outside air dampers.
 - b. Measure final building pressure.

FINAL WRAP-UP AT SITE

1. Review data for completeness.
2. Discuss findings and results with Walgreens Field Project Manager and/or GC and Mechanical Contractor.

- F. In the event that the TAB firm is unable to perform a complete TAB of the entire system due to deficiencies in the completion of items outlined above, the Walgreens Field Project Manager may request that the TAB firm schedule a follow up visit to test and balance portions of the system that could not be completed on the initial visit. The GC shall be responsible to issue a purchase order and reimburse the HVAC manufacturer for the additional cost incurred, including travel and applicable expenses.

1.05 TEST AND BALANCE REPORT

- A. A certified report shall be submitted to the Walgreens Field Project Manager (2 copies), the GC, and the Mechanical Contractor within two weeks of completion. The TAB firm shall also post the report on its website to be accessible by Walgreens.
- B. Final test report shall include the following sections listed below:
- C. FIELD SUMMARY & HVAC PUNCH LIST
Provide a field summary report outlining all appropriate observations and punch list items.
- D. INSTRUMENT CALIBRATION RECORD
Provide record of instrument calibration including make, model, serial number, date of calibration and the name of party performing calibration for all instrumentation used in the TAB site survey.
- E. PHOTOGRAPHS
Provide digital photographs of rooftop equipment and any other items that would help in understanding the items reported as deficient.
- F. HVAC SYSTEM INSPECTION REPORT
Provide a full report for all items listed in the HVAC System Inspection check list included in the output forms on Walgreen's web site.
- G. BUILDING AIR BALANCE
Provide a tabulated summary of outside air and exhaust air. Include building balance in CFM and final building pressure reading.
- H. RTU DATA
Provide a tabulated summary of the following for each RTU:
 1. Design RTU data listing make, model #, catalog # (when applicable), nominal tons, external static pressure, evaporator fan HP, unit voltage/phase, supply air in CFM, return air in CFM, outside air in CFM, outside air ratio, etc.
 2. Installed RTU data listing make, model #, serial #, catalog # (when applicable), nominal tons, filter sizes and MERV rating, etc.

- a. Provide evaporator fan motor data including make, model #, HP, RPM, voltage, FLA.
3. Startup data including initial evaporator fan RPM, unit voltage and amperage.
4. Final data including evaporator RPM, calculated BHP, pulley and belt sizes, unit voltage and amperage.
5. Final data for external static pressure, total static pressure, supply air in CFM, return air in CFM, outside air in CFM, outside air ratio.

I. EXHAUST FAN DATA

Provide a tabulated summary of the following for each exhaust fan:

1. Design exhaust fan data including make, model #, motor HP, airflow in CFM, external static pressure and voltage/phase.
2. Installed exhaust fan data including make, model #, serial #.
 - a. Provide motor data included make, model #, HP, RPM, voltage, FLA, overload protection.
3. Startup data for each exhaust fan including initial RPM, voltage and amperage.
4. Final data for each exhaust fan including airflow in CFM, RPM, calculated BHP, voltage, amperage, pulley and belt sizes.

J. AIR BALANCE REPORT

1. Provide air balance report for each diffuser, RTU and exhaust fan to include design and actual airflow in CFM.
2. Provide summary of space temperatures, supply air temperatures, return air temperatures and outside air temperature measured during TAB site visit.

L. ADDITIONAL EQUIPMENT

Provide a tabulated summary of the following for any additional HVAC equipment:

WALL HEATERS

1. Location and design heating capacity in kW.
2. Installed make, model, serial number and heating capacity in kW.

AIR CURTAINS

1. Design airflow in CFM and heater capacity in kW.
2. Installed make, model, serial number, heater capacity in kW.
3. Airflow measurement in CFM.

M. THERMOSTAT SETTINGS

- A. Provide a tabulated summary of design and actual thermostat settings for both occupied and unoccupied modes.
- B. Include time settings for occupied and unoccupied modes.
- C. Include installed make and model of all thermostats.

N. HVAC PLAN SHOWING DIFFUSER & EQUIPMENT LAYOUT

Provide a store plan with diffuser, RTU and exhaust fan locations and tags matching the Air Balance Report.

O. ADDITIONAL INFORMATION (if any)

Include any additional information not listed above that might be useful for the specific store in understanding above report.

1.06 CLOSEOUT

- A. Provide photo verification of punch list items as a part of the TAB service. For each discrepancy that is not severe enough to warrant a return visit, TAB firm shall require the Contractor to submit photos to the TAB firm showing the item corrected to Walgreens U.D.S./industry standards.

- B. Upon acceptance of all corrected discrepancies the TAB firm shall issue a closeout letter which shall be a part of the project closeout documents. Without the letter from TAB firm, Contractor retainage is withheld making the TAB a critical part of the closeout.

END OF SECTION

SECTION 23 30 00 – HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section 01 11 00 Summary of Work, Section 20 05 00 Common Work Results for Mechanical Section 20 07 00 Mechanical Insulation, shall be considered a part of these specifications.
- B. Scope of Work: The HVAC air distribution work includes, but is not limited to, the following:
 - 1. Air conditioning outside air ducts, supply air ducts, return air ducts, insulation, diffusers grilles, supply fans, motors, manual dampers and fire dampers.
 - 2. Exhaust/ventilation system fans, blowers, ducts, grilles, diffusers, dampers, etc.
 - 3. Furnishing of roof curbs required for supply and exhaust fans.

1.02 DELIVERY, STORAGE AND HANDLING

- A. All self-adhesive labels for part identification are to be applied to external surfaces only.
- B. All ductwork and fittings shall be sealed either by blanking or capping duct ends, bagging small fittings, surface wrapping or shrink wrapped in plastic to prevent dust and dirt from touching the internal surfaces during delivery and storage.
- C. The material deliveries shall be inspected for cleanliness by the General Contractor before accepting delivery on site. The materials shall remain wrapped until installation occurs. The open end of installed ductwork and fittings shall remain sealed until receiving the next connection piece. Unsealed openings during construction will require the entire ductwork system to be cleaned and resealed.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Ducts, fittings and joints shall be constructed of galvanized steel and installed in accordance with the latest edition of the SMACNA HVAC Duct Construction Standards Metal and Flexible for a static pressure class of not less than +/- 2.0 inches of water column.
- B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

- E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation, liner, or duct wall thickness.

2.02 SHEET METAL DUCTWORK

- A. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," 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."
- B. Round Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," 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. Round or Oval Elbows, 90 degrees, shall be long radius and die formed construction to 12 inch diameter and 5 segment for larger than 12 inch. Elbows, 45 degrees, shall be die formed construction to 12 inch diameter and 3 segment for larger than 12 inch. Pleated and adjustable elbows are not acceptable. Seams in fittings which are not spiral locked shall be welded.
- D. Rectangular Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "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."
- E. Loose taps are not acceptable.
- F. Exposed un-insulated ductwork in General Sales will be painted A60 dull gray coating (galvannealed).
- G. Acceptable manufacturers of spiral products: Accuduct Manufacturing, Eastern Sheet Metal, Lindab, Omni Duct Systems, Semco and United McGill, providing they have been manufacturing these spiral products for at least 10 years. All round and oval ducts and fittings shall be manufactured by the same company. Factory fabricated fittings shall be used.
- H. Fiber ductwork is not acceptable.
- I. Internal lining is not acceptable in the supply ductwork. Internal lining is acceptable only in the exposed return ductwork in the General Sales for sound attenuation

1.02 FLEXIBLE ROUND DUCTWORK

- A. Flexible round ductwork shall be a factory made with a liner duct permanently bonded to a corrosion resistant spring steel wire helix supporting a fiberglass insulating blanket with an R-value not less than 4.2 and an ADC thermal certification seal. Ducts shall be UL listed 181 Class 1, complying with NFPA 90A, NFPA 90B, and all other codes having jurisdiction.
- B. Flexible round ductwork shall be by ATCO, Thermaflex, or equal.

1.03 DUCT SEALANT:

- A. Sealant shall be United Duct Sealer as manufactured by United-McGill Corporation or #6 mastic with red glasscoat as manufactured by RCD Corporation. Install per manufacturers and UL 181A & B recommendations.
- B. Shrink bands, manufactured by Raychem and applied in accordance with manufacturer's instructions are acceptable on round ducts.
- C. Foil mastic tape, Polyken 360-17, applied in accordance with manufacturer's instructions, is acceptable on round ducts. Sealant is not required for spiral gasketed ductwork.

2.03 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
2. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

- B. 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 inch thick.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 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.

- C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the Intervals of lined duct preceding unlined duct.
 8. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used; secure buildouts to duct walls with bolts, screws, rivets, or welds.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
 - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

B. HANGER AND SUPPORT INSTALLATION

- a. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "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 **4 inches (100 mm)** thick.
 - 4) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than **4 inches (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 5-1 (Table 5-1M)**, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within **24 inches (610 mm)** of each elbow and within **48 inches (1220 mm)** of each branch intersection.
- 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 **16 feet (5 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.

C. 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."] [SMACNA's "Seismic Restrain Manual: Guidelines for Mechanical Systems - OSHPD Edition."] [ASCE/SEI 7.]
 - 1) Space lateral supports a maximum of [**40 (12)**] **<Insert dimension> feet (m)** o.c., and longitudinal supports a maximum of [**80 (24)**] **<Insert dimension> feet (m)** o.c.
 - 2) Brace a change of direction longer than **12 feet (3.7 m)**.

D. CONNECTIONS

- a. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

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

- E. The open end of installed ductwork and fittings shall remain sealed until receiving the next connection piece. Unsealed openings during construction will require the entire ductwork system to be cleaned and resealed.
- F. Ductwork shall be installed in sizes and in location as indicated on plans. Where square corners are used, they shall be provided with turning vanes. Spiral ductwork joints shall have sheet metal screws in connections.
- G. The drawings do not attempt to show all offsets that are necessary for the required installation. Those offsets and similar items shall be provided at no additional cost to Walgreens.
- H. The ductwork system throughout the building shall be rigidly supported and so constructed as to eliminate vibration or any objectionable noise while the ventilation machinery is in operation.
- I. Where ducts pass through walls or floor openings, they shall be kept free of direct contact of building construction by supporting each side of opening. The space between duct and opening shall be sealed and caulked in place, to comply with local fire codes, ordinances, etc.
- J. Volume Controls for Balancing: Provide manual volume dampers for balancing the ventilation systems. On each manual volume damper, provide a regulator to lock the damper in a fixed position, where accessible through access panel. Where not accessible through panel, provide a key-operated Young regulator with indicator and ceiling plate.
- K. Flexible Connections: Furnish and install on the suction and discharge side of all fans and units, at least 4 inches of 10 oz. canvas or equivalent vinyl with heavy clamping bands. Canvas connection to all HVAC roof-top units shall be as close to unit as possible, just below roof curb.
- L. Fire Dampers: Provide fire dampers in duct locations where required by local authority having jurisdiction. Ducts shall be enlarged where fire dampers are installed to maintain the same airflow through damper frame as unobstructed run of duct. Provide access doors to service fire dampers.
- M. Access Doors: Provide tight sheet metal access doors (with gasket, hinges, and locks), or where access to plenum spaces or ducts is necessary. Access doors shall be of adequate size and installed per local codes.
- N. Louvers for exhaust and outside air shall be equipped with motorized dampers with a maximum leakage rate of 3 cfm/ft at 1.0 w.g. when tested in accordance with AMCA Standard 500. Such dampers shall be closed when fans are off.

3.02 DUCT SEALING

- a. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- b. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1) Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2) Outdoor, Supply-Air Ducts: Seal Class A.
 - 3) Outdoor, Exhaust Ducts: Seal Class C.
 - 4) Outdoor, Return-Air Ducts: Seal Class C.
 - 5) Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
 - 6) Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
 - 7) Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8) Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9) Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.
 - 10) Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
 - 11) Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12) Conditioned Space, Return-Air Ducts: Seal Class C.

3.03 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- D. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.04 DUCT CLEANING

- a. Apply the following section when duct cleaning is required after documented site inspection
- b. Use duct cleaning methodology as indicated in NADCA ACR.
- c. Use service openings for entry and inspection.

- 1) Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "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.
- d. 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.
- 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 in accordance with NADCA ACR. 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 in accordance with manufacturer's written instructions after removal of surface deposits and debris.

END OF SECTION

SECTION 23 80 00 – DECENTRALIZED HVAC EQUIPMENT

PART 1 - GENERAL

1.01. DESCRIPTION

- A. Section 01 11 00 Summary of Work and 20 05 00 Common Work Results for Mechanical, shall be considered a part of these specifications.
- B. Work under this section of the specifications includes the furnishing of all labor and material to provide a complete and operating, heating, ventilating, and air conditioning system.
- C. All components of equipment in this section and all devices installed on those units shall be accessible for service.
- D. Duct smoke detectors, unit mounted, shall be furnished by this Section. The duct smoke detector(s) shall be factory installed. Manufacturers that cannot install duct smoke detector in the factory, shall ship the specified duct smoke detectors, sensing tubes, remote test station and other accessories with the unit for field installation under this Section of the specifications.

1.02. SUBMITTALS

- A. This contractor shall submit product data of the packaged roof-top HVAC units and entrance heater before starting work.

1.03. WARRANTIES

- A. All warranties shall be at a minimum of the length indicated and commence from the date of acceptance by Walgreen Co.
- B. One (1) year on the packaged units and electric strip heaters.
- C. Five (5) years on the compressors.
- D. Five (5) years on the condenser coils with protective coating.
- E. Ten (10) years on natural gas heat exchangers in all HVAC equipment.

1.04. DELIVERY, STORAGE AND HANDLING

- A. The equipment shall be delivered to the job site suitably packaged and protected for overland trucking and for storing the equipment outside exposed to the weather. Duct connection openings shall be covered and sealed with either by blanking or capping duct ends with plywood or sheet metal caps, or surface wrapping or shrink wrapped in plastic to prevent dust and dirt from touching the internal surfaces during delivery and storage. Pipe connection openings shall be covered and sealed with caps.
- B. Filters shall be stored in sealed containers to avoid contamination.
- C. Equipment shall be inspected for cleanliness by the General Contractor before accepting delivery on site.

- D. The openings shall remain sealed and capped until being installed and connected.

PART 2 - PRODUCTS

2.01. PERFORMANCE REQUIREMENTS.

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.
- G. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
 - 1. Design RTU supports to comply with wind and seismic (as needed) performance requirements as dictated by local code.
- H. Heating and Cooling coils to comply with AHRI 410
- I. Gas fired equipment to comply with ANSI Z21.47/CSA 2.3 and NFPA 54.
- J. Steel to comply with:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- K. Stainless Steel to comply with:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- L. Galvanized Steel to comply with ASTM A653/A653M.
- M. Aluminum to comply with **ASTM B209** (**ASTM B209M**).
- N. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- O. Corrosion-Resistant Coating according to ASTM B117.
 - 1. Standards:

- a) ASTM B117 for salt spray.
 - b) ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
 - c) ASTM B3359 for cross-hatch adhesion of 5B.
- 2. Application: Immersion or Spray.
 - 3. Thickness: **1 mil (0.025 mm)**
 - 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

P. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1.

2.02. ROOFTOP HEATING, VENTILATION, AND AIR CONDITIONING UNITS

- A. Units shall be packaged combination heating and cooling type, consisting of compressor section, air-cooled condenser section, cooling section, heating section, fan section, and mixing box/filter section assembled on a common base. Provide units complete with control panel. Units shall be prepped and prewired.
- B. Approved Manufacturers: Trane and York alternates must be approved by Walgreens Engineering.
- C. All compressor motors shall have factory installed and wired thermal overload and phase monitoring protection with an automatic restart to protect motors and compressors against problems caused by phase loss, phase imbalance and phase reversal indication.
- D. **Furnish factory installed non-fused electrical disconnect switches.**
- E. Housings shall be painted and weatherproofed with gasketed hinged access doors and factory insulation.
- F. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- G. All units shall be installed level, secured to roof and elevated 14" high or code requirement whichever is higher. If roof curb is utilized curbs shall include a wood nailer, a galvanized sheet metal cap with space between for at least 3/8 inch thick roof flashing material. Refer to architectural drawing(s) for details.
- H. The supply air blower shall be adjustable belt drive. If belt drive is not available then adjustable direct drive motor is acceptable. The manufacturers of the HVAC equipment shall furnish the proper adjustable pulleys and belts necessary to achieve the specified design conditions be they factory installed, shipped loose, provided later, or any combination thereof.
- I. Gas fired units shall be AGA approved and be a complete automatic heater. Controls furnished with the unit shall be supplied for the specific gas type and specification and in accordance with local utility regulations.
- J. The heat exchanger shall be an integral, completely welded aluminized steel unit composed of venturi-shaped, baffle-free sections welded to top and bottom header plates. Flue gases shall be power vented. Separated combustion type shall be used when indicated with integral exhaust/combustion air inlet and concentric adapter. Minimum number of steps to be 2.

- K. Controls to include fan and limit controls, electronic ignition, pressure regulator, and shut-off cocks.
- L. Unit shall be capable of fully automatic operation with ambient temperatures down to (standard with manufacturer) 25 degree F for refrigeration cycle. Provide low ambient controls when needed based on manufacture recommendations.
- M. External High-Low pressure cut-outs factory installed are required on all rooftop units.
- N. Provide all necessary contactors, relays, motor starters, etc. for a complete operating unit.
- O. For all projects in Puerto Rico and those projects in the 50 United States, 5 miles (or less) from all salt water coastlines, bays, tributaries, etc. furnish condenser coil(s) corrosion resistant coil treatment.
- P. Unit sizes 7 1/2 ton and above shall be two-stage heating (medium and high) and two- or more stage cooling, complete with multiple refrigeration circuits and time delay.
- Q. Provide two (2) sets of throwaway type filters not less than MERV 8, with one set to be used during construction and the second set to be installed after substantial completion of construction.
- R. Rooftop units shall have factory-installed airside economizers meeting applicable Walgreens unified design standards (UDS) drawing and schedules.
- S. Furnish all required sensors specified on applicable UDS drawings.
 - 1. Thermostats shall be programmable electronic type compatible with the RTU equipment. They shall be capable of properly controlling 2-stage cooling and 2-stage heating. The heating and cooling set points shall be individually adjustable for both "Occupied" and "Unoccupied" periods, programmable 24 hours per day and 7 days a week.
 - 2. In the "Occupied" mode of operation, the outside air damper shall be open to achieve the design outside air CFM indicated on the RTU Equipment Schedule on drawing M-610. In the "Unoccupied" mode, the outside air damper shall be closed.
 - 3. The thermostat shall contain a manual selection for the evaporator fan as follows: In "ON" the evaporator fan shall run continuously. In "AUTO" the fan shall operate intermittently and run only when there is a call for cooling or heating with a short time delay. The fan operation shall be continuous during the "Occupied" periods except as noted otherwise.
 - 4. Remote dry bulb temperature sensors shall be furnished where specified on the drawings. The HVAC equipment shall be controlled from this remote sensor or the temperature sensor within the thermostat, as manually selected or programmed at the thermostat.
 - 5. The thermostat shall select the optimum time to begin building warm-up or cool down based on set points and the occupied program.
 - 6. Supplemental electric resistance heat shall be controlled at 2 degrees F. below the heating set point heat pump systems.

- T. Furnish a relative humidity sensor with each RTU that has the hot gas reheat option, to be mounted and wired in the field at location indicated on drawing M-111 and specified on drawings M-620. The compressor(s) shall run and lower the room relative humidity until the relative humidity set point is satisfied and then the hot gas reheat coil shall warm the supply air until the space dry bulb temperature is satisfied.
 - U. Furnish a CO2 sensor with each RTU that has the Demand Controlled Ventilation (DCV) option, to be mounted in occupied space and wired in the field, as specified on drawing M-620. The outside air intake damper shall remain at the minimum CFM position shown on the RTU Equipment Schedule unless the CO2 level reaches the set point, then the outside air intake damper shall open further to the design outside air CFM shown on the RTU Equipment Schedule, both shown on drawing M-610.
 - V. Furnish duct smoke detector (SD) where indicated on the equipment schedule, typically when the evaporator fan is greater than 2000 cfm and/or required by the governing building code and authorities having jurisdiction. Include an accessible wiring termination board for each unit with the smoke detectors. Duct smoke detectors and accessories shall comply with the requirements of Section 28 31 00.
 - W. Electric Resistance Heating Coils: Minimum Stages: 2
 - X. Internal Vibration Isolation: Internal components are to be internally isolated on independent mountings.
 - Y. Condensate Drain Pans: Single Wall, noncorrosive polymer or stainless steel meeting ASHRAE 62.1 slope and length recommendations.
- 2.03. Dampers: To be low leakage, double skin and airfoil-blade. CONDENSATE DRAIN
- A. This contractor shall furnish and install a condensate control device (Costgard) from each RTU. Costgard device system kit is manufactured by Trent Technologies, Inc., Tyler, Texas, Telephone # (903) 509-4843.
 - B. Condensate piping shall be Schedule 40 min. PVC or ABS unless code requires otherwise. Condensate piping and components located outside the building shall be weather, sunlight, and UV resistant and recognized by UL as suitable for outdoor use.
- 2.04. ROOF CURBS
- A. Materials: Insulated, Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 - B. Curb Height: Curb to be 14" or code minimum whichever is larger.
- 2.05. REFRIGERANT SYSTEM CHARGING
- A. Follow manufacturer's recommended charging procedure for both refrigerant and refrigerant oil.
 - B. Replace any refrigerant or oil lost from the system during the guarantee (one year) period at no expense to Walgreen Co.

PART 3 - EXECUTION

3.01. DUCTWORK CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 - 2. Install ducts to termination at top of roof curb.
 - 3. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 4. Connect supply ducts to RTUs with flexible duct connectors.
 - 5. Install return-air duct continuously through roof structure.

3.02. TESTING REFRIGERANT PIPING SYSTEM

- A. Manufacturer to factory pressure test units and provide documentation upon request. Expansion valves and compressor crankcases are not to be pressure tested.

3.03. CONDENSATE DRAIN SYSTEM INSTALLATION

- A. For units delivered without a drain connection provide drain connections in the field. Detailed installation instructions are provided with each shipment of Costgard drain seal.
- B. For locations west of 99° longitude or north of 33° latitude, run condensate piping 8" beyond the roof curb and discharge in the direction of the roof pitch. Locate discharge so that condensate runs away from RTU. Refer to architectural drawing for the required "splash block on walkway pad below water discharge".
- C. For locations both east of 99° longitude and south of 33° latitude, run condensate piping from RTU to an approved receptor. Condensate drain piping is to be run above the roof supported on 6"x6" black polycarbonate pipe supports, model No. 1.5 by Miro Industries, telephone (800) 768-6978. Provide stainless steel screws and strap to permit pipe movement. Position the support piping not more than 6'-0" apart. Secure the pipe support to roof membrane in a manner approved by the membrane manufacturer.
- D. Run condensate piping below the roof if code or local authorities prohibit piping above the roof or if discharging onto the roof is not allowed. Penetrate the roof through a pipe portal. Provide a higher than normal roof curb to raise the RTU high enough to make this scheme work.
- E. Condensate piping shall be supported as per manufacturers' recommendations.
- F. Condensate piping, drainage fittings and cleanouts shall be sized per manufacture recommendation and industry best practice..
- G. Locate condensate drain piping so it will not interfere with the required access to the RTU.

3.04. CLEANING

After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION

