

Mechanical General Information	B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.	D. Heating Coils:	PART 3 EXECUTION	2.04 MANUFACTURED DUCTWORK AND FITTINGS
A. General	1. Conform to all general and special conditions of contract as specified by architect, tenant and owner.	1. Identification/number.	3.01 EXAMINATION	A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
2. Specifications are applicable to all contractors and subcontractors for mechanical and electrical systems	2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.	2. Location.	A. Test ductwork for design pressure prior to applying insulation materials.	1. Manufacture in accordance with SMACNA (DCS).
3. Contractor shall comply with owner's standards, facility specifications, rules and regulations. All owner's criteria shall be complied with and included in this bid. Check other plans and specifications and fully coordinate with other trades and architect's requirements.	3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.	3. Service.	B. Verify that surfaces are clean, foreign material removed, and dry.	2. Insulation:
4. Visit site, check facilities and conditions, and verify all utility company requirements and connection points in field prior to starting work. Take all items into consideration in bid.	4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.	4. Air flow, design and actual.	C. Insulated Ducts in accordance with NAAMA National Insulation Standards.	a. Thickness: 1 inch (25 mm).
5. Systems are to be complete and workable in all respects, planned in operation and properly adjusted.	5. Units of Measure: Report data in I-P (inch-pound) units only.	5. Entering air temperature, design and actual.	A. Install in accordance with manufacturer's instructions.	b. Material: Fiberglass.
6. Each contractor shall provide for his own clean-up, removal and legal disposal of all rubbish daily.	6. Include the following on the title page of each report:	7. Leaving air temperature, design and actual.	B. Install in accordance with NAAMA National Insulation Standards.	B. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
7. The contractor shall be solely responsible for construction means, methods, and sequences of construction and the safety of workmen, comply with all OSHA regulations.	a. Name of Testing, Adjusting, and Balancing Agency.	8. Air pressure drop, design and actual.	C. Insulated Ducts Conveying Air Below Ambient Temperature:	1. Manufacture in accordance with SMACNA (DCS).
8. No piping, ductwork, controls, etc., shall be installed or routed above electrical panels and equipment or through elevator rooms or shafts.	b. Address of Testing, Adjusting, and Balancing Agency.	F. Air Moving Equipment:	1. Provide insulation with vapor barrier jackets.	C. Round Ducts: Round lockseam duct with galvanized steel outer wall.
9. The mechanical and electrical contractors shall coordinate the electrical characteristics of all mechanical equipment prior to ordering of equipment. No additional payment will be made for lack of contractor coordination of electrical characteristics.	c. Telephone number of Testing, Adjusting, and Balancing Agency.	1. Location.	2. Finish with tape and vapor barrier jacket.	1. Manufacture in accordance with SMACNA (DCS).
10. All mechanical and electrical system components shall be routed tight to underside of structure and through joists or trusses where possible. Coordinate installation to preserve headroom, equipment access, and architectural clearances for finishes, including ceiling heights. Coordinate with all other trades and do not conflict with the architectural requirements for the finished construction. Provide offsets where required to coordinate with other trades.	d. Project name.	2. Manufacturer.	3. Continue insulation through walls, ceilings, hangers, and other duct penetrations.	D. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
11. Refer to architectural reflected ceiling plans for locations of all grilles and diffusers.	e. Project location.	3. Model number.	4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.	1. UL labeled.
12. Operation and maintenance manuals: three (3) bound sets of the operation and maintenance manuals shall be provided to the construction representative at turnover, and are required for final acceptance.	f. Project Architect.	4. Serial number.	D. Insulated Ducts Conveying Air Above Ambient Temperature:	2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
13. As built drawings: the HVAC subcontractor shall progressively record all HVAC drawing changes which shall be available at all times for review by the construction representative. An AutoCAD copy of the final as-built drawings shall be provided to the construction representative at turnover. This AutoCAD as-built is required for final acceptance of the project.	g. Project Engineer.	4. Return air flow, specified and actual.	1. Provide with or without standard vapor barrier jacket.	3. Pressure Rating: 4 inches wg (1000 Pa) positive and 0.5 inches wg (175 Pa) negative.
B. Codes, standards and regulations	h. Project Contractor.	11. Outside air flow, specified and actual.	2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.	4. Maximum Velocity: 4000 fpm (203.3 mph).
1. Conform to all applicable codes, government regulations, utility company requirements, and national electrical code.	i. Project altitude.	12. Total static pressure (total external), specified and actual.	E. Ducts Expired in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.	5. Temperature Range: Minus 20 degrees F to 175 degrees F (Minus 28 degrees C to 79 degrees C).
2. Obtain permits and pay all fees. Arrange for all required inspections and approvals.	j. Report date.	13. Intef pressure.	F. Duct and Plenum Liner Application:	2.05 CASINGS AND PLENUMS
C. Related work specified elsewhere	C. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough settings.	14. Discharge pressure.	1. Adhere insulation with adhesive for 90 percent coverage.	A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
1. Openings and chases, when shown on architectural drawings.	3.2 PRODUCT - NOT USED	15. Sheave Make/Size/Bore.	2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.	B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
D. Drawings	3.01 GENERAL REQUIREMENTS	16. Number of Belts/Make/Size.	3. Seal and smooth joints. Seal and coat transverse joints.	C. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge, 0.0598 inch (1.52 mm) sheet steel back facing and 22 gauge, 0.0299 inch (0.76 mm) perforated sheet steel front facing with 3/32 inch (2.4 mm) diameter holes on 5/32 inch (4 mm) centers. Construct panels 3 inches (75 mm) thick packed with 4.5 lb/cu ft (72 kg/m <sup>3</sup> ) minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.0598 inch (1.52 mm) sheet steel.
1. The systems as shown on the contract drawings are diagrammatic.	A. Perform total system balance in accordance with one of the following:	17. Fan RPM.	4. Seal liner surface penetrations with adhesive.	3.02 SCHEDULES
2. The intent is for complete and workable systems. The drawings and these notes are to be used together as a basis of showing and/or describing the system requirements for the facility.	1. AABC (NISTS), AABC National Standards for Total System Balance.	G. Return Air/Outside Air:	5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.	3.01 EXECUTION
3. Verify all dimensions and clearances by field measurement and check for interferences prior to starting work.	2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.	1. Identification/location.	3.03 SCHEDULES	3.01 INSTALLATION
E. Base equipment and materials and substitutions	3. SMACNA (TAB).	2. Design air flow.	A. Exhaust Ducts Within 15 ft (3 m) of Exterior Openings: 1 inch	A. Install, support, and seal ducts in accordance with SMACNA (DCS).
1. All equipment and materials shall be new, free of defects and U.L. labeled.	B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.	3. Actual air flow.	B. Plenums: 1 1/2 inch	B. Install in accordance with manufacturer's instructions.
2. Submit shop drawings for all equipment, fixtures, etc., including all accessories to be furnished. Base bid manufacturers and models are included in specifications or listed in schedule on drawing. Any other manufacturer or model is a substitution.	C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.	4. Design return air flow.	C. Supply Ducts: 1-1/2 inch	C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
3. Substitutions are subject to the approval of the owner and shall be listed on the form of proposal for the owner's consideration prior to contract award. If substitution is submitted, it is the contractor's responsibility to evaluate it and certify that the substitution is equivalent in all respects to the base specifications.	D. TAB Agency Qualifications:	5. Actual return air flow.	END OF SECTION	D. Flexible Ducts: Connect to metal ducts with mechanical fastener.
4. If substitutions are approved, notify all other contractors, subcontractors or trades affected by substitution and fully coordinate. Any costs resulting from substitution, whether by contractor or others, shall be responsibility of and paid for by substituting contractor.	1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.	6. Design outside air flow.	SECTION 23 0913 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC	E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
5. All equipment shall be installed in full accordance with the manufacturer's installation instructions. It is this contractor's responsibility to check and conform to these requirements prior to starting work.	2. Having minimum of three years documented experience.	7. Actual outside air flow.	PART 1 GENERAL	F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
F. Check, test, start, adjust, balance and instructions	3. Certified by one of the following:	8. Return air temperature.	1.01 SECTION INCLUDES	G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
1. After installation, check all equipment, and perform start up in accordance with the manufacturer's instructions.	a. AABC, Associated Air Balance Council: www.aabc.com/#file; upon completion submit AABC National Performance Guaranty.	9. Outside air temperature.	A. Pressure independent valves and actuators.	H. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.
2. All piping shall be tested and free of leaks.	b. NEBB, National Environmental Balancing Bureau: www.nebb.org/why.	H. Exhaust Fans:	B. Dampers.	I. Use double nuts and lock washers on threaded rod supports.
3. Balance all systems, calibrate controls, check for proper operating sequence under all conditions, and make all necessary adjustments.	c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/file.	1. Location.	C. Damper Operators:	J. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
4. All wiring shall be fully tested and made free of grounds and short circuits.	E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.	2. Manufacturer.	1. Electric operators.	3.02 CLEANING
5. Instrut owner in operation of systems and submit operating and maintenance manual on all equipment and systems.	3.02 EXAMINATION	3. Model number.	2. Room humidistats.	A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.
6. Provide engraved labels and identification tags for all piping systems, valves and equipment.	A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:	4. Serial number.	3. Static pressure (air pressure) sensors.	END OF SECTION
7. Provide typed panel directories and engraved labels for all panels and equipment.	1. Systems are started and operating in a safe and normal condition.	5. Air flow, specified and actual.	4. Equipment operation (current) sensors.	SECTION 23 3300 AIR DUCT ACCESSORIES
G. Cutting, patching and drilling	2. Temperature control systems are installed complete and operable.	6. Total static pressure (total external), specified and actual.	5. Damper position indicators.	PART 1 GENERAL
1. All cutting and chasing of the building construction required for this work shall be by this contractor unless shown on architectural drawings and confirmed as to size and location prior to new construction.	3. Fans are rotating correctly.	7. Intef pressure.	6. Carbon dioxide sensors.	1.01 SECTION INCLUDES
2. Neatly saw cut all rectangular openings, set sleeve through opening, and finish patch or provide trim flange around opening.	4. Final filters are clean and in place. If required, install temporary media in addition to final filters.	8. Discharge pressure.	F. Thermostats:	A. Air turning devices/extractors.
3. Core drill and sleeve all round openings.	5. Fans are rotating correctly.	9. Sheave Make/Size/Bore.	1. Electric room thermostats.	B. Backdraft dampers - metal.
4. Cut and patch existing building walls as required for duct installation. Provide steel lintel above opening wider than 10". See structural drawings for sizes. Provide escutcheons or 2" wide sheet metal flanges around all exposed penetrations.	6. Access doors are closed and duct end caps are in place.	10. Number of Belts/Make/Size.	2. Low-limit temperature (air duct switch) (freezestat)	C. Duct access doors.
5. Do not cut any structural components without architect's approval.	7. Air outlets are installed and connected.	11. Fan RPM.	3. Line voltage thermostats.	D. Duct test holes.
6. Patch and finish to match adjacent areas that have been cut, damaged or modified to install equipment for this project.	11. Duct system leakage is minimized.	I. Duct Leak Tests:	4. Room thermostat accessories.	E. Flexible duct connectors.
7. Cutting of roof, installation of curbs, and patching of roof shall be by a certified roofing contractor, approved by building owner, and paid for by this contractor.	C. Beginning of work means acceptance of existing conditions.	1. Description of ductwork under test.	G. Time clocks.	F. Volume control dampers.
8. Fire stop all penetrations of fire rated construction in a code approved manner, using UL listed fire rated materials.	3.03 ADJUSTMENT TOLERANCES	2. Duct design operating pressure.	H. Energy Metering:	1.02 SUBMITTALS
9. Patch and finish to match adjacent areas that have been cut, damaged or modified to install equipment for this project.	A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.	3. Duct design test static pressure.	1. Hydronic BTU (U) meters.	A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
10. Exact location of roof top mechanical units shall be approved by owner's structural engineer. Mechanical contractor shall furnish and install all supplemental support steel for all panels and roof duct penetrations after approval of structural engineer.	B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.	4. Duct capacity, air flow.	J. Level Switches:	B. Maintenance Manuals: Furnish the following for Owner's use in maintenance of project.
H. Warranty	C. Ensure recorded data represents actual measured or observed conditions.	5. Maximum allowable leakage duct capacity times leak factor.	1. Float Sensors:	1. Gate Fusible Links: One of each type and size.
1. Fully warrant all materials, equipment and workmanship for one (1) year from date of acceptance.	D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.	6. Test apparatus:	2. Flow switches.	c. Free-floating level switch.
2. Extend all manufacturer's warranties to owner, including five (5) year compressor and ten (10) year heat exchanger extended warranty on HVAC equipment.	E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	a. Blower.	J. Level Switches:	1.02 SUBMITTALS
3. Repair or replace without charge to the owner all items found defective during the warranty period.	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	b. Orifice, lube size.	1. Float Sensors:	A. Product Data: Provide description and engineering data for each control system component. Include sizing as required. Provide data for each system component and software module.
SECTION 23 2053 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	3.03 ADJUSTMENT TOLERANCES	c. Orifice size.	2. Flow switches.	END OF SECTION
PART 1 GENERAL	A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.	d. Calibrated.	J. Level Switches:	SECTION 23 3100 HVAC DUCTS AND CASINGS
1.01 SECTION INCLUDES	B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.	7. Test static pressure.	1. Float Sensors:	PART 1 GENERAL
A. Nameplates.	C. Ensure recorded data represents actual measured or observed conditions.	8. Test orifice differential pressure.	2. Flow switches.	1.01 SECTION INCLUDES
B. Tags.	D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.	9. Leakage.	J. Level Switches:	A. Metal ductwork.
C. Stencils.	E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	K. Air Distribution Tests:	1. Float Sensors:	B. Nonmetal ductwork.
2.01 IDENTIFICATION APPLICATIONS	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	1. Air terminal number.	2. Flow switches.	C. Casings and plenums.
A. Rooftop units: Nameplates.	3.03 AIR SYSTEM PROCEDURE	2. Room number/location.	J. Level Switches:	D. Duct cleaning.
B. Automatic Controls: Tags. Key to control schematic.	A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.	3. Terminal type.	1. Float Sensors:	1.02 QUALITY ASSURANCE
C. Small-sized Equipment: Tags.	B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.	4. Terminal size.	2. Flow switches.	A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
D. Thermostats: Nameplates.	C. Measure air quantities at air inlets and outlets.	5. Area factor.	J. Level Switches:	1.03 FIELD CONDITIONS
2.02 NAMEPLATES	D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.	6. Design velocity.	1. Float Sensors:	A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
A. Letter Color: White.	E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and filters.	7. Design air flow.	2. Flow switches.	B. Maintain temperatures within acceptable range during and after installation of duct sealants.
B. Letter Height: 1/4 inch (6 mm).	F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	8. Test (final) velocity.	2.01 DUCT PRODUCTS	2.01 AIR TURNING DEVICES/EXTRACTORS
C. Background Color: Black.	G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	9. Test (final) air flow.	A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.	A. Multi-blade device with blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.
2.03 TAGS	H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	10. Air outlets are installed and connected.	B. Ducts: Galvanized steel, unless otherwise indicated.	2.02 BACKDRAFT DAMPERS - METAL
A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) diameter.	I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.	11. Duct system leakage is minimized.	C. Low Pressure Supply (Heating Systems): 1 inch wg (250 Pa) pressure class, galvanized steel.	A. Gravity Backdraft Dampers, Size 12x12 inches (300x300 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.	J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.	END OF SECTION	D. Low Pressure Supply (System with Cooling Coils): 1 inch wg (250 Pa) pressure class, galvanized steel.	B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers, Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
2.04 STENCILS	K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.	2.01 PRODUCTS	E. Return and Relief: 1 inch wg (250 Pa) pressure class, galvanized steel.	2.03 DELIVERY, STORAGE, AND HANDLING
A. Stencils: With clean cut symbols and letters of following size:	L. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.	F. General Exhaust: 1 inch wg (250 Pa) pressure class, galvanized steel.	A. Protect dampers from damage to operating linkages and blades.
1. Equipment: 2-1/2 inch (65 mm) high letters.	M. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.	2.02 REGULATORY REQUIREMENTS	2.01 MATERIALS	2.02 PRODUCTS
3.01 PREPARATION	N. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.	A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M F5 Type B, with G60/Z180 coating in accordance with ASTM E84 or UL 723.	2.01 AIR TURNING DEVICES/EXTRACTORS
A. Degrease and clean surfaces to receive adhesive for identification materials.	3.02 SUBMITTALS	3.06 SCOPE	B. Un-Galvanized Steel for Ducts: ASTM A1008/A1008M Designation CS (commercial steel), cold-rolled.	A. Fabricate in accordance with SMACNA (DCS) and as indicated.
3.02 INSTALLATION	A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and location.	A. Test, adjust, and balance the following:	C. Aluminum for Ducts: ASTM B209 (ASTM B209M), aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.	B. Access doors with sheet metal screw fasteners are not acceptable.
A. Install nameplates with corrosion-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.	1. Running log of events and issues.	1. Packaged Roof Top Heating/Cooling Units.	D. Stainless Steel for Ducts: ASTM A666, Type 304.	2.03 DUCT TEST HOLES
END OF SECTION	2. Discrepancies, deficient or uncompleted work by others.	2. Fans.	E. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.	A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
SECTION 23 0993 TESTING, ADJUSTING, AND BALANCING FOR HVAC	3. Contract interpretation requests.	3. Air inlets and Outlets.	1. Kraft paper with glass fiber yarn and bonded to aluminumized film.	B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to create dead isolation.
PART 1 GENERAL	4. Lack of completed tests.	E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ngPa s m), when tested in accordance with ASTM E910/E910M.	2.07 FLEXIBLE DUCT CONNECTORS
1.01 SECTION INCLUDES	5. Fans are rotating correctly.	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	3. Secure with pressure sensitive tape.	A. Fabricate in accordance with SMACNA (DCS) and as indicated.
A. Testing, adjustment, and balancing of air systems.	A. Electric Motors:	3.05 AIR SYSTEM PROCEDURE	C. Vapor Barrier Tape:	B. Flexible Duct Connections: Fabric crimped into metal edging strip.
B. Measurement of final operating condition of HVAC systems.	1. Manufacturer.	A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.	1. Kraft paper reinforced with glass fiber yarn and bonded to aluminumized film, with pressure sensitive rubber based adhesive.	1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).
1.02 SUBMITTALS	2. Model/Frame.	B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.	2. Indoor Vapor Barrier Mastic:	2. Metal: 3 inches (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel.
A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.	3. HP/BHP.	C. Measure air quantities at air inlets and outlets.	1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.	2.08 VOLUME CONTROL DAMPERS
1. Include at least the following in the plan:	4. Phase, voltage, amperage; nameplate, actual, no load.	D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.	2.03 GLASS FIBER, RIGID	A. Fabricate in accordance with SMACNA (DCS) and as indicated.
a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.	5. RPM.	E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and filters.	A. Insulation: ASTM C612; rigid, noncombustible blanket.	B. Splitter Dampers:
b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.	6. Service factor.	F. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	1. K (Ksi) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.	1. Material: Same gauge as duct to 24 inches (600 mm) size in either direction, and two gauges heavier for sizes over 24 inches (600 mm).
c. Final test report forms to be used.	7. Starter size, rating, heater elements.	G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	2. Maximum Service Temperature: 450 degrees F (232 degrees C).	2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
d. Procedures for formal deficiency reports, including scope, frequency and distribution.	8. Sheave Make/Size/Bore.	H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	3. Maximum Water Vapor Absorption: 5.0 percent.	3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.
END OF SECTION	A. Air Cooled Condensers:	I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.	4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).	C. Single Blade Dampers:
A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.	1. Identification/number.	J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.	5. Maximum Water Vapor Absorption: 5.0 percent by weight.	1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
1. Include at least the following in the plan:	2. Location.	K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.	6. Vapor Barrier Jacket:	2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.
a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.	3. Manufacturer.	L. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	1. Kraft paper with glass fiber yarn and bonded to aluminumized film.	D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 6 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.	4. Model number.	M. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.	2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ngPa s m), when tested in accordance with ASTM E910/E910M.	E. Quadrants:
c. Final test report forms to be used.	5. Serial number.	N. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	3. Secure with pressure sensitive tape.	1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
d. Procedures for formal deficiency reports, including scope, frequency and distribution.	6. Entering DB air temperature, design and actual.	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	C. Vapor Barrier Tape:	2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
END OF SECTION	7. Leaving DB air temperature, design and actual.	3.06 SCOPE	1. Kraft paper reinforced with glass fiber yarn and bonded to aluminumized film, with pressure sensitive rubber based adhesive.	3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.
A. Testing, adjustment, and balancing of air systems.	8. Number of compressors.	A. Test, adjust, and balance the following:	D. Indoor Vapor Barrier Finish:	2.09 VOLUME CONTROL DAMPERS
B. Measurement of final operating condition of HVAC systems.	C. Cooling Coils:	1. Packaged Roof Top Heating/Cooling Units.	1. Vinyl emulsion type acrylic, compatible with insulation, black color.	A. Fabricate in accordance with SMACNA (DCS) and as indicated.
1.02 SUBMITTALS	1. Identification/number.	2. Fans.	2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION	B. Splitter Dampers:
A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.	2. Location.	3. Air inlets and Outlets.	A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in-sheet form.	1. Material: Same gauge as duct to 24 inches (600 mm) size in either direction, and two gauges heavier for sizes over 24 inches (600 mm).
1. Include at least the following in the plan:	3. Service.	E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).	2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.	4. Manufacturer.	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	2. Maximum Service Temperature: 180 degrees F (82 degrees C).	3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.
b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.	5. Air flow, design and actual.	G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	3. Connection: Waterproof vapor barrier adhesive.	C. Single Blade Dampers:
c. Final test report forms to be used.	6. Entering air DB temperature, design and actual.	H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	B. Elasticomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.	1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
d. Procedures for formal deficiency reports, including scope, frequency and distribution.	7. Entering air WB temperature, design and actual.	I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.	2.05 DUCT LINER	2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.
END OF SECTION	8. Leaving air DB temperature, design and actual.	J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.	A. Elasticomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.	D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 6 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
A. Testing, adjustment, and balancing of air systems.	9. Leaving air WB temperature, design and actual.	K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.	B. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.	E. Quadrants:
B. Measurement of final operating condition of HVAC systems.	10. Air pressure drop, design and actual.	L. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	2.06 DUCT LINER	1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
1.02 SUBMITTALS	END OF SECTION	M. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.	A. Elasticomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.	2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.	END OF SECTION	N. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.	B. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.	3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.
1. Include at least the following in the plan:	END OF SECTION	F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.	2.07 FLEXIBLE DUCT CONNECTORS	2.09 VOLUME CONTROL DAMPERS
a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.	END OF SECTION	G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.	A. Fabricate in accordance with SMACNA (DCS) and as indicated.	A. Fabricate in accordance with SMACNA (DCS) and as indicated.
b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.	END OF SECTION	H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.	B. Flexible Duct Connections: Fabric crimped into metal edging strip.	B. Flexible Duct Connections: Fabric crimped into metal edging strip.
c. Final test report forms to be used.	END OF SECTION	I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.	1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).	1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).
d. Procedures for formal deficiency reports, including scope, frequency and distribution.	END OF SECTION	J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate		