

SECTION 23 05 93-TESTING, ADJUSTING, AND BALANCING

- 1.01 GENERAL
- BALANCING SHALL BE DONE BY AN INDEPENDENT FIRM SPECIALIZING SOLELY IN THE DISCIPLINE OF BALANCING AIR AND WATER SYSTEMS, AND A MEMBER OF NEBB. FIRMS DESIRING TO FURNISH SERVICES FOR THIS PROJECT SHALL SUBMIT FOR WRITTEN APPROVAL DURING BIDDING, ALL AIR AND HYDRONIC SYSTEMS SHALL BE BALANCED USING APPLICABLE PROPORTIONATE PROCEDURE.
 - CONTRACTOR SHALL FURNISH SERVICES FOR TWO COMPLETE ADJUSTMENTS OF THE HEATING, AIR CONDITIONING AND AIR DISTRIBUTION SYSTEMS WITH A REPORT FOR EACH VISIT. REPORTS MUST SUBMIT TO THE ARCHITECT FOR REVIEW AND APPROVAL. MOTOR OVERLOADS AS REQUIRED.
 - SYSTEM SHALL BE TESTED, ADJUSTED & BALANCED BY NEBB® CERTIFIED PERSONNEL.

2.01 TESTING CONDITIONS

- AIR BEFORE ANY ADJUSTMENTS ARE MADE, CHECK THE SYSTEM FOR SUCH ITEMS AS DIRTY FILTERS, DUCT AND DAMPER LEAKAGE, VIBRATIONS, ETC. ALL DIFFUSERS, DUCT SECTIONS, ETC SHALL BE ADJUSTED TO DELIVER DESIGN QUANTITIES WITHIN 5%. AIR QUANTITIES SHALL BE TESTED SIMULATING FILTERS BEING 50% LOADED. ADJUST/REPLACE SHEAVES AND BELTS AS REQUIRED TO ACHIEVE DESIGN AIR QUANTITIES. REPLACE THERMAL DAMPER MOTOR OVERLOADS AS REQUIRED.
- MERV 8 FILTERS SHALL BE INSTALLED PRIOR TO TEST AND BALANCE.

2.02 VERIFICATION OF TEMPERATURE CONTROL

- THE TEST AND BALANCE AGENCY SHALL BE ASSISSED BY THE CONTROL CONTRACTOR IN VERIFYING THE OPERATION AND CALIBRATION OF ALL TEMPERATURE CONTROL SYSTEMS. THE FOLLOWING TESTS SHALL BE CONDUCTED:
 - VERIFY THAT ALL CONTROL COMPONENTS ARE INSTALLED IN ACCORDANCE WITH PROJECT REQUIREMENTS AND ARE FUNCTIONAL, INCLUDING ALL ELECTRICAL INTERLOCKS, DAMPER SEQUENCES, AND FIRE AND SMOKE DETECTORS.
 - VERIFY THAT ALL CONTROLLING INSTRUMENTS ARE CALIBRATED AND SET FOR DESIGN OPERATING CONDITIONS.
 - W/OLDED, ANNEALED, SHEET, EXPOSED SURFACE FINISH SHALL BE NO. 4.

2.03 REPORT

- AFTER ALL ADJUSTMENTS ARE MADE, A DETAIL WRITTEN REPORT SHALL BE PREPARED AND SUBMITTED FOR APPROVAL. FINAL ACCEPTANCE OF THE PROJECT WILL NOT BE MADE UNTIL A SATISFACTORY REPORT IS RECEIVED AND FIELD VERIFIED. THE REPORT SHALL DETAIL THE TEST EQUIPMENT AND BALANCE PROCEDURES AT THE DESIGN, GENERAL, TEST AND BALANCE AGENCY. THE BEING TESTED INCLUDING EQUIPMENT DETAILS; PROVIDE DATA SHEETS INDICATING THE REQUIRED AND ACTUAL CFM OF ALL OUTLETS AND INLETS.
- SIX (6) COPIES OF THE TEST AND BALANCE REPORT ARE REQUIRED AND SHALL BE SUBMITTED TO THE ARCHITECT.
- TEST & BALANCE REPORT TO INCLUDE OUTSIDE AIRFLOW READINGS.
- THE REPORT SHALL CONTAIN THE FOLLOWING GENERAL DATA IN A FORMAT SELECTED BY THE TEST AND BALANCE AGENCY: PROJECT NUMBER, PROJECT TITLE, PROJECT LOCATION, PROJECT ARCHITECT, PROJECT MECHANICAL ENGINEER, TEST AND BALANCE AGENCY, TEST AND BALANCE ENGINEER, OWNER, MECHANICAL SUBCONTRACTORS, DATES TESTS WERE PERFORMED, CERTIFICATION.
- THE TEST AND BALANCE REPORT SHALL BE RECORDED ON REPORT FORMS CONFORMING TO THE RECOMMENDED STANDARD FORMS. THE FOLLOWING INFORMATION SHALL BE INCLUDED:
 - PREFACE - A GENERAL DISCUSSION OF THE SYSTEM, ANY ABNORMALITIES AND PROBLEMS ENCOUNTERED (DEFICIENCIES OUTSTANDING LISTED).
 - INSTRUMENTATION LIST - THE LIST OF INSTRUMENTS INCLUDE TYPE, MODEL, MANUFACTURER, SERIAL NUMBER AND DATE.
 - SYSTEM IDENTIFICATION - IN EACH REPORT, THE VAV BOXES, ZONES, SUPPLY, RETURN, DATA SHEETS, ALONG WITH A DRAWING SHOWING THE ABOVE.
 - AIR HANDLING EQUIPMENT TEST REPORT FORMS - RECORD THE FOLLOWING ON EACH AIR-HANDLING EQUIPMENT TEST FORM:
 - MANUFACTURER, MODEL NUMBER AND SERIAL NUMBER.
 - ALL DESIGN AND MANUFACTURER-RATED DATA.
 - TOTAL ACTUAL CFM BY TRAVERSE IF PRACTICAL, IF NOT PRACTICAL, THE SUM OF THE OUTLETS MAY BE USED, OR THE SUM OF THE INLETS MAY BE USED.
 - SUCTION AND DISCHARGE STATIC PRESSURE OF EACH FAN, AS APPLICABLE.

2.04 ACCEPTANCE OF TEST AND BALANCE REPORT

- AT THE TIME OF ACCEPTANCE OF THE TEST AND BALANCE REPORT, THE TEST AND BALANCE AGENCY SHALL, IF REQUESTED, RECHECK IN THE PRESENCE OF THE OWNER REPRESENTATIVE, SPECIFIC AND RANDOM SELECTIONS OF DATA RECORDED IN THE CERTIFIED TEST AND BALANCE REPORT.
- POINTS AND AREAS FOR RECHECK SHALL BE SELECTED BY THE ENGINEER OF RECORD.
- MEASUREMENTS AND TEST PROCEDURES SHALL BE THE SAME AS THE ORIGINAL TEST AND BALANCE.
- SELECTIONS FOR RECHECK, SPECIFIC PLUS RANDOM, SHALL NOT NORMALLY EXCEED 15% OF THE TOTAL NUMBER OF TEST POINTS. EXCEPT WHERE SPECIAL AIR SYSTEMS REQUIRE A COMPLETE RECHECK FOR SAFETY REASONS.
- IF RANDOM TESTS DEMONSTRATED A MEASURED FLOW DEVIATION OF 15% OR MORE FROM THAT RECORDED, A NEW CERTIFIED TEST AND BALANCE REPORT MUST BE SUBMITTED, AND A NEW INSPECTION TEST MADE, ALL AT NO ADDITIONAL COST TO OWNER.

3.01 AIR SYSTEM PROCEDURES

- THE TEST AND BALANCE AGENCY SHALL PERFORM THE FOLLOWING TESTING AND BALANCING FUNCTIONS:
 - DESIGN CONDITIONS INCLUDING SUPPLY/ EXHAUST AIRFLOW, MOTOR HP, FAN RPM, OUTLET VELOCITY, STATIC PRESSURE.
 - INSTALLED EQUIPMENT INFORMATION INCLUDING BELT, SHEAVE SIZE, MOTOR, MODEL NUMBERS.
 - FAN SPEEDS - TEST AND ADJUST FAN RPM TO ACHIEVE DESIGN CFM REQUIREMENTS.
 - CURRENT AND VOLTAGE - MEASURE AND RECORD MOTOR CURRENT AND VOLTAGE.
 - PITOT TUBE TRAVERSE - PERFORM A PITOT TUBE TRAVERSE OF MAIN SUPPLY AND RETURN DUCTS TO OBTAIN TOTAL CPFA. IF A PITOT TUBE TRAVERSE IS NOT PRACTICAL, THE SUMMATION OF THE OUTLETS OR INLETS MAY BE USED, AN EXPLANATION WHY A TRAVERSE WAS NOT MADE MUST APPEAR ON THE APPROPRIATE DATA SHEET.
 - OUTSIDE AIR - TEST AND ADJUST SYSTEM MINIMUM OUTSIDE AIR BY PITOT TUBE TRAVERSE. IF A PITOT TUBE TRAVERSE IS NOT PRACTICAL, THE PERCENTAGE OF OUTSIDE AIR MAY BE DETERMINED BY CALCULATIONS FROM THE RETURN AIR, OUTSIDE AIR, AND MIXED AIR TEMPERATURE. MAKE ALLOWANCES FOR HEAT OF COMPRESSION AND MOTOR HEAT WHERE APPLICABLE.
 - STATIC PRESSURE - TEST AND RECORD SYSTEM STATIC PRESSURES, INCLUDING SUCTION AND DISCHARGE STATIC PRESSURE PROFILE OF EACH FAN.
 - AIR TEMPERATURE - TAKE WET-BULB AND DRY-BULB AIR TEMPERATURES ON THE ENTERING AND LEAVING SIDE OF EACH HEATING COIL.
 - TOLERANCE - TEST AND BALANCE EACH DIFFUSER, GRILLE, AND REGISTER TO WITHIN 10 PERCENT OF DESIGN AND REQUIREMENT.
 - DESCRIPTION - RECORD THE SIZE AND TYPE OF EACH DIFFUSER, GRILLE, AND REGISTER ON AIR OUTLET DATA SHEETS.
 - TERMINAL BOXES - ALL ASSOCIATED TEMPERATURE CONTROLS SHALL BE CHECKED FOR PROPER OPERATION AND CALIBRATION.
 - MINIMIZING DRAFTS - ADJUST ALL DIFFUSERS, GRILLES, AND REGISTERS TO MINIMIZE DRAFTS IN ALL AREAS.
 - EQUIPMENT SHALL BE BALANCED TO AIRFLOWS WITHIN:
 - TERMINAL DEVICES & BRANCH LINES: ±10% OF DESIGNED LOADS
 - MAIN DUCTS & AHUS: ± 5% OF DESIGNED LOADS
 - EXHAUST FANS/HOODS
 - MEASURE EXHAUST FAN STATIC PRESSURE, TOTAL CFM, MAKEUP AIR AND FAN RPM.
 - MEASURE MOTOR OPERATING VOLTAGE AND AMPERAGE.
 - MEASURE HOOD AVERAGE FACE VELOCITIES AND ADJUST AS NECESSARY. WHERE POSSIBLE, BALANCE FLOW USING A PITOT TRAVERSE WITHIN HOOD WHERE DUCTS ARE CONNECTED.
 - RECORD THE SPECIFIED AGAINST THE ACTUAL SUPPLIED HORSEPOWER AND ELECTRICAL CHARACTERISTICS OF ALL MOTORS. RECORD, IF SPECIFIED, TO BE SELF OR PERMANENTLY LUBRICATED.

SECTION 23 11 23 - FUEL GAS PIPING

- 2.01 BLACK STEEL PIPE AND FITTINGS
- PROVIDE BLACK STEEL PIPE IN ACCORDANCE WITH ASTM A 53/A 53, TYPE E OR S, GRADE B, SCHEDULE 40.
 - PROVIDE MALLEABLE-IRON THREADED FITTINGS ASME B16.3, CLASS 150 OR STEEL THREADED FITTINGS ASME B16.1 FORGED STEEL THREADED FITTINGS.
 - STEEL WELDED FITTING SHALL COMPLY WITH ASME B16.9 AND SHALL BE WROUGHT STEEL OR ASME B16.11 FORGED STEEL.
 - UNIONS SHALL BE ASME B16.39, CLASS 150, MALLEABLE IRON AND HAVE THREADED ENDS.
 - CAST IRON FLANGES AND FLANGED FITTINGS SHALL BE ASME B16.1, CLASS 125 OR STEEL FLANGES AND FLANGED FITTINGS IN ACCORDANCE WITH ASME B16.5. GASKET MATERIAL SHALL BE SUITABLE FOR GAS.

2.04 PIPING SPECIALTIES

- FLEXIBLE CONNECTORS: ANSI Z21.24, COPPER ALLOY.
- QUICK-DISCONNECT DEVICES: ANSI Z21.41, CONVENIENCE OUTLETS AND MATCHING PLUG CONNECTOR.
- Y-PATTERN STRAINERS SHALL BE ASTM A 126, CLASS B, CAST IRON BODY WITH BOLTED COVER AND BOTTOM DRAIN CONNECTION. END CONNECTIONS SHALL BE THREADED ENDS FOR 2 INCH AND SMALLER, FLANGED ENDS FOR 2 1/2 INCH AND LARGER. PERFORATED STAINLESS-STEEL BASKET WITH 50 PERCENT FREE AREA. COLD WORKING PRESSURE OF 125 PSIG.
- WEATHERPROOF VENT CAP: CAST- OR MALLEABLE-IRON INCREASER FITTING WITH CORROSION-RESISTANT WIRE SCREEN, WITH FREE AREA AT LEAST EQUAL TO CROSS-SECTIONAL AREA OF CONNECTING PIPE AND THREADED-END CONNECTION.

2.05 VALVES

- NATURAL GAS VALVES 3 INCH AND SMALLER
 - BALL VALVES, BRONZE OR BRASS BODY WITH AGA OR CSA STAMP, UL LISTED OR FM APPROVED FOR SERVICE, WITH CHROME-PLATED BRASS BALL AND LEVER HANDLE, 125-PSIG MINIMUM PRESSURE RATING, VALVE SHALL HAVE LOCKING CAPABILITY.
 - APPROVED MANUFACTURERS: APOLLO VALVE; CONBRACO INDUSTRIES, INC.; NIBCO INC.; WATTS WATER TECHNOLOGIES, INC.; WATTS REGULATOR CO.

SECTION 23 31 13 - METAL DUCTS

1.01 DUCTWORK

A. GENERAL

- ALL DUCTWORK SHALL BE CONSTRUCTED STRICTLY ACCORDING TO THE LATEST ASHRAE 90A, SMACNA, AND IMC STANDARDS. DUCT SIZES SHOWN ARE INSIDE CLEAR DIMENSIONS; MAINTAIN SIZES INSIDE LINING FOR LINED DUCTS.
- REFER TO DUCT APPLICATION SCHEDULES FOR MATERIALS, PRESSURE CLASS, SEAL CLASS, AND LOCATIONS.
- DUCT PRESSURE DEFINITIONS:
 - LOW PRESSURE: UP TO 2 INCH WG AND VELOCITIES LESS THAN 1,500 FPM. CONSTRUCT FOR 2 INCH WG POSITIVE OR NEGATIVE STATIC PRESSURE.
 - MEDIUM PRESSURE: GREATER THAN 2 INCH WG TO 6 INCH WG AND VELOCITIES GREATER THAN 1,500 FPM AND LESS THAN 2,500 FPM. CONSTRUCT FOR 6 INCH WG POSITIVE OR NEGATIVE STATIC PRESSURE.
 - HIGH PRESSURE: GREATER THAN 6 INCH WG TO 12 INCH WG AND VELOCITIES GREATER THAN 2,500 FPM. CONSTRUCT FOR 12 INCH WG POSITIVE OR NEGATIVE STATIC PRESSURE.

2.01 SHEET METAL

A. MATERIALS

- GALVANIZED STEEL CONFORMING TO ASTM STANDARDS ASTM A-653/ A 653M. GALVANIZED COATING DESIGNATION SHALL BE G90 WITH FINISHES FOR EXPOSED SURFACES MILL PHOSPHATIZED. REINFORCEMENT SHALL BE CONSTRUCTED OF GALVANIZED STEEL.
- CARBON-STEEL SHEETS CONFORMING WITH ASTM A 366/A 366A, WITH OILED, MATTE FINISH FOR EXPOSED DUCTS.
- ALUMINUM SHEETS CONFORMING WITH ASTM B 209 (ASTM B 209M) ALLOY 3003, H14 TEMPER, WITH MILL FINISH FOR CONCEALED DUCTS, AND STANDARD, ONE-SIDE BRIGHT FINISH FOR DUCT SURFACES EXPOSED TO VIEW.
- STAINLESS-STEEL SHEETS CONFORMING WITH ASTM A 480/A 480M, TYPE 304 OR 316, COLD ROLLED, ANNEALED, SHEET, EXPOSED SURFACE FINISH SHALL BE NO. 4.
- PVC-COATED GALVANIZED STEEL CONFORMING WITH UL 181, CLASS 1 LISTING. LOCK-FORMING-GALVANIZED STEEL SHEET COMPLYING WITH ASTM A 653/A 653M AND HAVING 60 (2180) COATING DESIGNATION. FACTORY-APPLIED PVC COATINGS SHALL BE 4 MILS THICK ON INTERIOR SHEET METAL SURFACES. EXTERIOR SURFACES SHALL BE 6 MILS THICK. COATING CONDITIONS AND MINIMUM 1 MIL THICK ON INTERIOR AND/OR EXTERIOR SURFACES.
- DUCT THICKNESS SHALL CONFORM TO THE ABOVE STANDARDS. WHERE THERE IS A DISCREPANCY, THE GREATER THICKNESS SHALL APPLY. REINFORCEMENT, JOINT TYPE, SPACING AND THICKNESS MAY BE VARIED AT THE CONTRACTORS DISCRETION, IN CONFORMANCE WITH THE ABOVE STANDARDS, EXCEPT WHERE SPECIFICALLY NOTED. MINIMUM THICKNESS OF DUCTS SHALL BE 26-GAUGE SHEET METAL.
- RECTANGULAR DUCTWORK
 - PROVIDE RECTANGULAR DUCTWORK AND HOUSINGS TO SIZES AS SHOWN ON DRAWINGS.
 - PROVIDE ROUND AND FLAT-OVAL DUCTS AND OFFSETS WITH A MINIMUM CENTERLINE RADIUS OF 1 1/2 TIMES THE DUCT WIDTH, WHERE SPACE DOES NOT PERMIT FULL RADIUS ELBOWS PROVIDE SHORT RADIUS ELBOWS WITH A MINIMUM OF TWO CONTINUOUS SPLITTER VANES. VANES SHALL BE THE ENTIRE LENGTH OF THE BEND, PROVIDE MITERED ELBOWS WHERE SPACE DOES NOT PERMIT RADIUS ELBOWS WHERE SHOWN ON THE DRAWINGS OR AT THE OPTION OF THE CONTRACTOR WITH THE ENGINEER'S APPROVAL. MITERED ELBOWS LESS THAN 45 DEGREES SHALL NOT REQUIRE TURNING VANES. MITERED ELBOWS 45 DEGREES AND GREATER SHALL HAVE TURNING VANES. TURNING VANES SHALL BE THE SAME LENGTH AND HAVE THE SAME SPACING, FASTENED WITH GUIDE STRIPS IN DUCTWORK. VANES FOR MITERED ELBOWS SHALL BE PROVIDED IN ALL SUPPLY, RETURN, OUTSIDE AIR, AND EXHAUST DUCTWORK.

D. ROUND AND FLAT-OVAL DUCTWORK

- PROVIDE ROUND AND FLAT-OVAL DUCT TO SIZES AS SHOWN ON DRAWINGS.
- LOW PRESSURE FITTINGS 24" IN DIAMETER AND LESS SHALL BE PREFABRICATED, SPOTWELDED AND INTERNALLY SEALED. CONTINUOUSLY WELD FITTINGS LARGER THAN 24" IN DIAMETER. FITTING GASKET SHALL BE 22-GAUGE FOR 36" FITTINGS AND UNDER 26 GAUGE FOR LARGER SIZES. 90-DEGREE TEE'S SHALL BE CONICAL TYPE. SEAL LONGITUDINAL AND TRANSVERSE DUCTWORK JOINTS AIR-TIGHT WITH HEAVY WATER BASED LIQUID SEALANT APPLIED ACCORDING TO MANUFACTURER'S INSTRUCTIONS. PROVIDE GASKET THICKNESS IN MEDIUM PRESSURE DUCTWORK AS RECOMMENDED BY SMACNA.
- APPROVED MANUFACTURERS OF ROUND AND FLAT-OVAL SPIRAL LOCK-SEAM DUCTS ARE LINDAB INC, MCGILL AIRFLOW CORP, SEMCO INC, LAPINE METAL PRODUCTS, OR APPROVED EQUAL. ROUND AND FLAT-OVAL SPIRAL LOCK-SEAM SUPPLY AND RETURN DUCTS SHALL BE FABRICATED ACCORDING TO SMACNA STANDARDS BASED ON PRESSURE CLASS. MINIMUM THICKNESS OF DUCT SHALL BE 26 GAUGE SHEET METAL. ROUND AND FLAT-OVAL FITTINGS SHALL BE FACTORY FABRICATED WELDED DESIGN. DUCTS UP TO 20" INCHES IN DIAMETER SHALL HAVE CENTER-BEADED SPLIT COUPLING, SEALED BEFORE AND AFTER FASTENING, ATTACHED WITH SHEET METAL SCREWS. DUCTS 21" TO 72" INCHES SHALL HAVE A THREE-PIECE GASKETED FLANGED JOINT CONSISTING OF TWO INTERNAL FLANGES WITH SEALANT AND ONE EXTERNAL, CLASURE BAND WITH GASKET. PREFABRICATED CONNECTION SYSTEM CONSISTING OF FLANGES AND GASKETS ARE ACCEPTABLE. APPROVED MANUFACTURERS ARE DUCTMATE INDUSTRIES INC AND LINDAB. ELBOWS, TEES, AND BENDS SHALL HAVE A RADIUS NOT LESS THAN 1 1/2 TIMES THE WIDTH OF THE CENTERLINE. TRANSITIONS IN DUCT SIZE SHALL BE GRADUAL, NOT EXCEEDING 15 DEGREES WHERE POSSIBLE. ROUND ELBOWS UP TO 14 INCHES SHALL BE PLATEED AND GORED FOR 16" AND ABOVE. ALL FLAT OVAL ELBOWS SHALL BE GORED. 90 DEGREE TEES, LATERALS, AND CONICAL TEES SHALL BE FABRICATED TO SMACNA.
- ROUND DUCTWORK EXPOSED TO THE PUBLIC SHALL BE GALVANIZED STEEL, SPIRAL WOUND, MAINTAINING IN A CLEAN, SHINY APPEARANCE, AND NOT UTILIZING VISIBLE SEALING MATERIAL. CONCEALED ROUND DUCTWORK MAY SPIRAL WOUND, OR SNAP LOCK TYPE GALVANIZED STEEL DUCTWORK.

- EAL DUCTWORK WITH HEAVY LIQUID WATER BASED SEALANT. SEALANTS SHALL COMPLY WITH THE FOLLOWING REQUIREMENTS: MILL FINISH ALUMINUM SUBSTRATE WITH GRAY ADHESIVES, MINIMUM 30 MIL THICK, MINIMUM 17 LB/IN PEEL STRENGTH, MAX SMOKE DEVELOPED OF 50 WHEN TESTED IN ACCORDANCE WITH ASTM G-53, VOC CONTENT OF 250 g/L OR LESS, PRESSURE CLASS UP TO 10" W.C., HARDCAST FLEX/IMP-650, UNITED MCGILL DUCT SEALER, MON-ECO INDUSTRIES ECO DUCT SEAL 44-50 OR EQUIVALENT, OR APPROVED EQUAL APPLIED ACCORDING TO SEALANT MANUFACTURER'S INSTRUCTIONS.
- LOCATION: SHEET METAL MAY BE USED THROUGHOUT THE PROJECT.

- SUPPORTS
 - SUPPORT HORIZONTAL RUNS OF DUCT ON CENTERS NOT TO EXCEED 8'-0". DO NOT SUPPORT CEILING GRID, CONDUITS, PIPES, EQUIPMENT, ETC. FROM DUCTWORK. COORDINATE ROUTING OF DUCT WORK WITH OTHER CONTRACTORS SUCH THAT PIPING, ELECTRICAL CONDUIT, AND ASSOCIATED SUPPORTS ARE NOT ROUTED THROUGH THE DUCTWORK.

b.

SECTION 23 33 00 - DUCT ACCESSORIES

2.01 BALANCING DAMPERS

A. APPROVED MANUFACTURERS: GREENHECK, KRUEGER, NAILOR, RUSKIN, OR APPROVED EQUAL.

- WHERE SHOWN ON DRAWINGS AND WHEREVER NECESSARY FOR COMPLETE ACCESS & CONTROL OF AIR FLOW:
 - ROUND VOLUME DAMPERS SHALL BE BUTTERFLY OR SINGLE BLADE TYPE CONSISTING OF CIRCULAR BLADE MOUNTED TO A SHAFT, AMCA CERTIFIED. INSTALL WITH GASKETS ON OUTSIDE OF DUCT. BLADES SHALL NOT BE LESS THAN 16 GAUGE GALVANIZED, ROLL-FORMED STEEL WITH THE AIRSTREAM SHALL COMPLY WITH REQUIREMENTS IN ASHRAE 62.1. FAN SHALL BE CENTRIFUGAL MOTOR AND SLEEVE BEARINGS MOUNTED. DIRECT DRIVE. FAN MOTORS SHALL BE ELECTRONICALLY CONTROLLED MOTOR (ECM) CONTROLLED BY INTEGRATED FURNACE/BLOWER CONTROL. GAS TYPE SHALL BE NATURAL OR PROPANE. HEAT EXCHANGER SHALL BE STAINLESS STEEL. BURNER SHALL HAVE 100 PERCENT DUCT OUTSIDE OF FURNACE. BLADES AND FLANGE SHALL NOT BE LESS THAN 16 GAUGE GALVANIZED, ROLL-FORMED STEEL WITH GALVANIZED STEEL, KYLE, OIL-IMPREGNATED BRONZE WITH MOLDED SYNTHETIC STAINLESS STEEL BEARINGS. ZINC PLATED STEEL DAMPER HARDWARE AND 1 INCH GALVANIZED STEEL JACKSHAF.
 - DAMPERS FRAME SHALL BE FLANGED FOR INSTALLATION IN WALLS AND FLANGELESS FOR INSTALLATION IN DUCTWORK.

2.02 BACKDRAFT DAMPERS

- DAMPERS SHALL BE PARALLEL ACTION COUNTER BALANCED FACTORY MADE OF .065" EXTRUDED ALUMINUM BLADES WITH EDGE SEALS, 16 GAUGE ALUMINUM FRAME SUPPORTED BY BRONZE OR ALUMINUM RODS. BLADES SHALL NOT BE LARGER THAN 30INCHES LENGTH AND 6 INCHES WIDE. DAMPERS SHALL COMPLY WITH AMCA 500. BACKDRAFT DAMPERS SHALL BE MANUFACTURED BY GREENHECK, RUSKIN, OR APPROVED EQUAL.

2.03 FIRE DAMPERS

- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, NAILOR, OR APPROVED EQUAL.
- CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR NEOPRENE BLADE SEALS. JAMB SEALS SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.
- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, TAMCO, JOHNSON CONTROLS, HONEYWELL, OR APPROVED EQUAL.
- OUTDOOR CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.
- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, TAMCO, JOHNSON CONTROLS, HONEYWELL, OR APPROVED EQUAL.
- OUTDOOR CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.

C. RATING.

- 1 1/2 HOUR FOR 2 HOUR RATED WALL.
- 3 HOURS FOR 4 A HOUR RATED WALL.

2.04 MOTORIZED CONTROL DAMPERS

- CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.
- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, TAMCO, JOHNSON CONTROLS, HONEYWELL, OR APPROVED EQUAL.
- OUTDOOR CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.
- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, TAMCO, JOHNSON CONTROLS, HONEYWELL, OR APPROVED EQUAL.
- OUTDOOR CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.
- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, TAMCO, JOHNSON CONTROLS, HONEYWELL, OR APPROVED EQUAL.
- OUTDOOR CONTROL DAMPERS SHALL COMPLY WITH AMCA 500. FRAME SHALL BE MINIMUM 16 GAUGE GALVANIZED STEEL. BLADES SHALL BE MINIMUM 14 GAUGE GALVANIZED STEEL, MAXIMUM 8" WIDE AND 60" LONG ATTACHED TO MINIMUM 1 1/2" SHAFTS. DAMPERS RATED TO 4 INCH WG. SHALL HAVE 3/4" SHAFTS. PROVIDE SYNTHETIC ELASTOMERIC OR EXTRUDED EPDM BLADE SEALS. JAMB SEALS SHALL BE SILICONE OR SYNTHETIC ELASTOMER. RATED PRESSURE AND VELOCITY TO EXCEED DESIGN CONDITIONS.

2.06 PLENUMS AND SCREENS

- CONSTRUCT PLENUMS WITH GALVANIZED STEEL FRAMING MEMBERS AND GALVANIZED SHEET METAL BRACED WITH GALVANIZED ANGLES, GAUGES AND BRACING SHALL CONFORM TO SMACNA RECOMMENDATIONS FOR DUCTWORK SIZES. WHERE ACCESS DOORS ARE SHOWN, PROVIDE HINGED DOORS WITH #202 VENTLOK LATCH. MAKE WATERTIGHT CONNECTIONS TO LOUVERS, SLOPING BOTTOM OF PLENUM TO DRAIN WATER TO WEEPHOLES IN BOTTOM OF LOUVER.
- PROVIDE SCREENS ON LOUVERS, DUCTS, HOODS, FANS, AND OPENINGS TO THE OUTDOORS AS WELDED, PERFORATED, OR NOTED ON THE DRAWINGS. BIRD SCREENS SHALL BE 0.041-INCH, 1/2-INCH MESH GALVANIZED STEEL WIRE.

2.07 TURNING VANES

- DOUBLE WALL AIRFOIL FORMED TYPE TURNING VANES WITH VANE RUNNERS SHALL BE INSTALLED AT EACH CHANGE IN DIRECTION FOR ALL SQUARE/ RECTANGULAR DUCTWORK. OR SHALL BE MANUFACTURED BY AERO/DYNE COMPANY, DUCTMATE, DURO DYNE CORP, OR WARD INDUSTRIES.

2.08 FLEXIBLE DUCTWORK (POLYMER LINER)

- APPROVED MANUFACTURERS: FLEXMASTER TYPE 1M, HART & COOLEY, HART & COOLER OR EQUIVALENT.
- FLEXIBLE DUCTWORK SHALL BE CONSTRUCTED OF A SPRING STEEL HELIX SUPPORTING A PLASTIC CORE. IT SHALL BE INSULATED WITH 1" FIBERGLASS INSULATION AT A DENSITY OF 1 LB./CU.FT. (R-6.0). THE INSULATION SHALL BE SHEATHED IN A FIRE-RETARDANT POLYETHYLENE PROTECTIVE JACKET/VAPOR BARRIER, UL-181 CLASS 1.
- THE DUCT SHALL BE RATED AT 10" W.G. AND A MAXIMUM VELOCITY OF 4000 FPM. THE DUCT SHALL BE LISTED IN ACCORDANCE WITH UL STANDARD 191, CLASS 1.
- FLEXIBLE DUCT SHALL BE LIMITED TO A MAXIMUM LENGTH OF 5'-0" AS A MEANS OF CONNECTING BOXES, DIFFUSERS, ETC. TO THE DUCT SYSTEM.
- FLEXIBLE DUCT RUNS SHALL BE INSTALLED FULLY EXTENDED AND STRAIGHT AS POSSIBLE. AVOIDING TIGHT TURNS. INSTALL FLEXIBLE DUCT IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. NO MORE THAN ONE (1) 90-DEGREE BEND SHALL BE CREATED. BENDS SHALL NOT EXCEED A CENTERLINE RADIUS OF ONE DUCT DIAMETER. DUCT SAG SHALL NOT EXCEED 1/2-INCH. SUPPORTING MATERIAL IN DIRECT CONTACT WITH THE DUCT SHALL NOT BE LESS THAN 1 1/2-INCHES IN WIDTH.
- CONNECT FLEXIBLE DUCT TO RIGID METAL DUCT OR AIR DEVICES AS RECOMMENDED BY THE MANUFACTURER. AT A MINIMUM, INSTALL TWO WRAPS OF DUCT TAPE AROUND THE INNER CORE CONNECTION AND A METALLIC OR NON- METALLIC CLAMP OVER THE TAPE AND TWO WRAPS OF DUCT TAPE OR A CLAMP OVER THE OUTER JACKET. DUCT CLAMPS SHALL BE LABELED IN ACCORDANCE WITH UL 1818 AND MARKED 181B-C. DUCT TAPE SHALL BE LABELED IN ACCORDANCE WITH UL 1818 AND MARKED 181B-FX.
- PROVIDE FLEXIBLE ELBOW SUPPORT CONSTRUCTED OF DURABLE COMPOSITE THAT IS FULLY ADJUSTABLE MANUFACTURE BY AUTOMATION INDUSTRIES THERMAFLEX OR SMART AIR AND ENERGY SOLUTIONS.

2.09 DUCT ACCESS DOORS

- WHERE MOTORIZED DAMPERS, FIRE DAMPERS, CONTROL EQUIPMENT, ETC. ARE INSTALLED IN DUCTS, AND FOR CLEANING DUCTWORK, ACCESS DOORS SHALL BE PROVIDED IN THE DUCTS, MADE AIR-TIGHT WITH GASKETED EDGES. USE VENTLOK, OR EQUAL, SPONGE RUBBER OR FELT GASKETING MATERIAL. THE DOORS SHALL BE DOUBLE-WALL CONSTRUCTION WITH 1" OF RIGID INSULATION FILL AND SHALL BE ATTACHED TO THE DUCT WITH CAM LATCHES. PROVIDE HINGES AND MULTIPLE COMPRESSION CAM LOCKS FOR ACCESS DOORS GREATER THAN 12 INCHES. OMIT ACCESS DOOR INSULATION AND DOUBLE-WALL CONSTRUCTION IF DUCTS ARE NOT SPECIFIED TO BE INSULATED. ACCESS DOORS SHALL BE CONSTRUCTED OF THE SAME MATERIALS AS THE DUCTWORK. APPROVED MANUFACTURERS ARE DUCTMATE AND FLEXMASTER.
- PROVIDE ACCESS PANELS WHERE REQUIRED FOR ACCESS TO THE "DUCT ACCESS DOORS" IF THESE ACCESS PANELS ARE PLACED IN FIRE-RATED WALLS OR CEILING OR FLOOR, THEN THE ACCESS PANEL SHALL HAVE THE SAME RATING.

2.10 FLEXIBLE CONNECTIONS

- ALL SUPPLY AND EXHAUST FANS AND OTHER AIR HANDLING UNITS WITH INLET AND OUTLET DUCT OR CASING CONNECTIONS SHALL HAVE A FLEXIBLE CONNECTOR IN EACH CONNECTION. CONNECTOR SHALL BE MADE OF AT LEAST ONE LAYER OF VENTLOK FABRIC, TWO-SIDE, NEOPRENE-COATED, 3-1/2 INCHES WIDE FABRIC WITH 2-1/2 INCH STRIPS, UL APPROVED AND LABELED, FLAME SPREAD OF 25 OR LESS AND SMOKE DEVELOPED RATING NOT HIGHER THAN 50. MAKE AIRTIGHT JOINTS AND INSTALL WITH MINIMUM 1-1/2" SLACK. APPROVED MANUFACTURERS ARE DURO-DYNE, ADDCO MANUFACTURING, VENTFABRICS, OR EQUAL.

2.13 CEILING FIRE DAMPERS

- APPROVED MANUFACTURERS: RUSKIN, GREENHECK, NAILOR, METALEIRE, OR APPROVED EQUAL.
- GENERAL DESCRIPTION: LABELED ACCORDING TO UL 555C, COMPLY WITH CONSTRUCTION DETAILS FOR TESTED FLOOR- AND ROOF-CEILING ASSEMBLIES AS INDICATED IN UL'S "FIRE RESISTANCE DIRECTORY."
- FRAME: GALVANIZED SHEET STEEL, ROUND OR RECTANGULAR, STYLE TO SUIT CEILING CONSTRUCTION.
- BLADES: GALVANIZED SHEET STEEL WITH REFRACTORY INSULATION.
- FUSIBLE LINKS: REPLACEABLE, WITH TEMPERATURE RATING MATCHING THE TEMPERATURE RATING OF THE SPRINKLERS IN THE IMMEDIATE AREA.

SECTION 23 54 16 GAS FIRED FURNACES

2.02 HIGH EFFICIENCY GAS FIRED FURNACE

- APPROVED MANUFACTURERS: LENNOX, RHEEM, CARRIER, TRANE, AND YORK.
- BLOWER SHALL HAVE FACTORY-INSTALLED INSULATION. LIFT-OFF PANELS SHALL EXPOSE BURNERS AND ALL OTHER ITEMS REQUIRING ACCESS FOR MAINTENANCE. FACTORY PAINT EXTERNAL CABINETS IN MANUFACTURER'S STANDARD COLOR. AIRSTREAM SURFACES IN CONTACT WITH THE AIRSTREAM SHALL COMPLY WITH REQUIREMENTS IN ASHRAE 62.1. FAN SHALL BE CENTRIFUGAL MOTOR AND SLEEVE BEARINGS MOUNTED. DIRECT DRIVE. FAN MOTORS SHALL BE ELECTRONICALLY CONTROLLED MOTOR (ECM) CONTROLLED BY INTEGRATED FURNACE/BLOWER CONTROL. GAS TYPE SHALL BE NATURAL OR PROPANE. HEAT EXCHANGER SHALL BE STAINLESS STEEL. BURNER SHALL HAVE 100 PERCENT DUCT OUTSIDE OF FURNACE. BLADES AND FLANGE SHALL NOT BE LESS THAN 16 GAUGE GALVANIZED, ROLL-FORMED STEEL WITH GALVANIZED STEEL, KYLE, OIL-IMPREGNATED BRONZE WITH MOLDED SYNTHETIC STAINLESS STEEL BEARINGS. ZINC PLATED STEEL DAMPER HARDWARE AND 1 INCH GALVANIZED STEEL JACKSHAF.
- DAMPERS FRAME SHALL BE FLANGED FOR INSTALLATION IN WALLS AND FLANGELESS FOR INSTALLATION IN DUCTWORK.

SECTION 23 58 29 - ELECTRIC WALL AND CEILING HEATERS

2.01 ELECTRIC WALL HEATER

- APPROVED MANUFACTURERS: INDECO, MARKEL, QMARK, BERKO, AND STERLING.
- DESCRIPTION: AN ASSEMBLY INCLUDING CHASSIS, ELECTRIC HEATING COIL, FAN, MOTOR, AND CONTROLS. COMPLY WITH UL 2021.
- CABINET:
 - FRONT PANEL: EXTRUDED ALUMINUM BAR GRILLE, WITH REMOVABLE PANELS FASTENED WITH TENSER-PAFF FASTENERS.
 - FINISH: BAKED ENAMEL, OVER BAKED-ON PRIMER WITH MANUFACTURER'S CUSTOM COLOR SELECTED BY ARCHITECT, APPLIED TO FACTORY-ASSEMBLED AND -TESTED WALL AND CEILING HEATERS BEFORE SHIPMENT.
 - AIRSTREAM SURFACES: SURFACES IN CONTACT WITH THE AIRSTREAM SHALL COMPLY WITH REQUIREMENTS IN ASHRAE 62.1.
 - SURFACE MOUNTING CABINET ENCLOSURE: STEEL WITH FINISH TO MATCH CABINET.
 - ELECTRIC-RESISTANCE HEATING COIL: NICKEL-CHROMIUM HEATING WIRE, FREE FROM EXPANSION NOISE AND HUM, EMBEDDED IN MAGNESIUM OXIDE REFRACTORY AND SEALED IN CORROSION-RESISTANT METALLIC SHEATH. TERMINATE ELEMENTS IN STAINLESS-STEEL, MACHINE-STAKED TERMINALS SECURED WITH STAINLESS-STEEL HARDWARE, AND LIMIT EXPOSURE TO AIR. PROVIDE INTEGRAL TEMPERATURE PROTECTION. PROVIDE INTEGRAL CIRCUIT BREAKER FOR OVERCURRENT PROTECTION.
 - FAN: ALUMINUM PROPELLER DIRECTLY CONNECTED TO MOTOR.
 - MOTOR: PERMANENTLY LUBRICATED.
 - CONTROLS: LIMIT-MOUNTED THERMOSTAT.
 - ELECTRICAL CONNECTION: FACTORY WIRED MOTORS AND CONTROLS FOR A SINGLE FIELD CONNECTION INCLUDING FACTORY WIRED DISCONNECT SWITCH AND STARTER.
 - CAPACITIES AND CHARACTERISTICS: REFER TO SCHEDULE ON DRAWINGS.

SECTION 23 82 16 REFRIGERANT COOLING COILS

COOLING COIL

- APPROVED MANUFACTURERS: LENNOX, RHEEM, CARRIER, TRANE, AND YORK.
- PROVIDE A COOLING COIL TESTED AND RATED ACCORDING TO AHR 410 AND ASHRAE 33. MINIMUM WORKING-PRESSURE RATING: 300 PSIG AND FACTORY TESTED TO 450 PSIG. TUBES SHALL BE ASTM B 743 COPPER, MINIMUM 0.049 INCH THICK. FINN SHALL BE ALUMINUM, MINIMUM 0.010 INCH THICK. SUCTION AND DISTRIBUTOR PIPING SHALL COMPLY WITH ASTM B 88, TYPE 1 (ASTM B 88M, TYPE B) COPPER TUBE WITH BRASS JOINTS. FINN SHALL BE GALVANIZED STEEL. CHANNEL FRAME, MINIMUM 0.064 INCH THICK FOR SLIP-IN OR FLANGED MOUNTING. CABINETS INSULATED WITH THICK FIBERGLASS INSULATION.

SECTION 23 82 00 PACKAGED COMPRESSOR AND CONDENSING UNITS

2.01 PACKAGED CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

- APPROVED MANUFACTURERS: LENNOX, RHEEM, CARRIER, TRANE, AND YORK.
- CONDENSER SHALL BE AIR-COOLING TYPE, RATED ACCORDING TO AHR 410 AND ASHRAE 33. AIR CONDITIONERS AND COMPONENTS WITHIN BONDED FOR GROUNDING TO MEET SAFETY STANDARDS FOR SERVICING REQUIRED BY ETL, NEC, AND CEC. UNITS ARE TO MEET ETL CERTIFIED FOR THE U.S. COMPRESSOR SHALL BE SCROLL, HERMETICALLY SEALED, WITH RUBBER VIBRATION ISOLATORS. TWO-SPEED MOTOR, AND INCLUDING THERMOSTAT, OVERLOAD DEVICES, START CAPACITOR, RELAY, AND CONTACTOR. VARIABLE SPEED INVERTER DUTY COMPRESSOR SHALL INCLUDE MANUAL-RESET, HIGH-PRESSURE SWITCH AND AUTOMATIC-RESET, LOW-PRESSURE SWITCH. PROVIDE ACCUMULATOR SUCTION TUBE.
- REFRIGERANT: R-407C OR R-410A.
- CONDENSER COIL: SEAMLESS COPPER-TUBE, ALUMINUM-FIN COIL; CIRCUITED FOR