SECTION 23 3400 - FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. For fans in air handling units, refer to project air handling unit section(s) for additional requirements.

1.2 SUMMARY

A. Section Includes: For each product.

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Plenum fans.
4. High Blow Lab Exhaust Fans
5. Fan Arrays.

1.3 REFERENCES

A. ANSI/AMCA Standards 99-10, 204-05, 300-08, 500-D-12, 500-L-12, and 210-07.

B. ANSI/AMCA Publications 211-05 and 311-05.

C. AMCA Standard 260-07.

D. SMACNA - Medium Pressure Plenum Construction Standard.

E. OSHA Guidelines 1910.212, 1910.219, and 1926.300.

F. UL 705.

G. ASHRAE - Lab Design Guide.

H. ANSI/AIHA Z9.5-2012.

I. ABMA Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999).

1.4 QUALITY ASSURANCE

A. Performance ratings: Conform to applicable ANSI/AMCA Standards 210, 260 and 300. Fans must be tested in accordance with applicable AMCA Publications 211, 260 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fans shall be licensed to

bear the AMCA ratings seal for air performance (AMCA 210), sound performance (AMCA 300), and induced flow fan for high plume dilution blowers (AMCA 260). Manufacturers that are not licensed to bear the AMCA 210 and 260 ratings seal, must provide performance witness testing (at the manufacturer's expense), per paragraph 1.4.D.

B. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.

C. Each fan shall be vibration tested before shipping, as an assembly, in accordance with ANSI/AMCA Standard 204. Each assembled fan shall be test run at the factory at the specified fan RPM and vibration signatures shall be taken on each bearing in three planes - horizontal, vertical, and axial. The maximum allowable fan vibration shall be less than 0.08 in. /sec peak velocity; filter-in reading as measured at the fan RPM. This report shall be provided at no charge to the customer upon request.

D. Manufacturers that do not comply with paragraph 1.4.A must also provide, at the owner and engineer's option and manufacturer's expense, witness testing of fan discharge and entrainment airflow, performed in an AMCA accredited laboratory, in accordance with AMCA 210 and 260. This test shall verify the critical and safety related dilution performance of high plume dilution blowers, as stated by the manufacturer.

E. Comply with FM Global requirements for fans and blowers and for monitoring and diagnosis of vibration in rotating machinery.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

B. Northwestern University Maintenance Requirement Forms, see Division 01.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.

C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set for each belt-driven unit.

1.10 SPECIAL WARRANTIES

A. Five (5) years, see Division 01.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fan arrays are the standard for the University air handlers, and other fan types for air handling units are considered exceptions.

B. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

C. Unusual Service Conditions:

1. Ambient Temperature: <**Insert deg C**>.
2. Altitude: <**Insert** feet (m)> above sea level.
3. High humidity.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Capacities and Characteristics:

1. See Schedule(s) on Drawings.

2.2 AIRFOIL CENTRIFUGAL FANS

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

1. Barry Blower.
2. Howden/Buffalo.
3. Chicago Blower.
4. Greenheck Fan Corporation.
5. Industrial Air.
6. Twin City

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Airfoil Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. [Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" Subparagraph below.]
3. Ball-Bearing Rating Life: ABMA 9, Ll0 at [50,000] [120,000] hours.
4. Roller-Bearing Rating Life: ABMA 11, Ll0 at [50,000] [120,000] hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
2. [Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" Subparagraph below.]
3. Ball-Bearing Rating Life: ABMA 9, Ll0 at [**50,000**] [**120,000**] hours.
4. Roller-Bearing Rating Life: ABMA 11, Ll0 at [**50,000**] [**120,000**] hours.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Inlet Screens: Grid screen of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Spark-Resistant Construction: AMCA 99.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

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

1. Barry Blower.
2. Howden/Buffalo.
3. Chicago Blower.
4. Greenheck Fan Corporation.
5. Industrial Air.
6. Twin City

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Backward-Inclined Wheels:

1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. ***[Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" Subparagraph below.]***
3. ***Ball-Bearing Rating Life: ABMA 9, LI0 at [50,000] [120,000] hours.***
4. ***Roller-Bearing Rating Life: ABMA 11, LI0 at [50,000] [120,000] hours.***

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].

3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Inlet Screens: Grid screen of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Spark-Resistant Construction: AMCA 99.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.4 PLENUM FANS

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

1. Barry Blower.
2. Howden/Buffalo.
3. Chicago Blower.
4. Greenheck Fan Corporation.
5. Industrial Air.
6. Twin City

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, ***belt-driven or direct driven*** centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Airfoil Wheels:

1. Single-width-single-inlet construction with smooth-curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

D. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings ***(If belt drive)***:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
2. [Retain "Ball-Bearing Rating Life" or "Roller-Bearing Rating Life" Subparagraph below.]
3. Ball-Bearing Rating Life: ABMA 9, Ll0 at [50,000] [120,000] hours.
4. Roller-Bearing Rating Life: ABMA 11, Ll0 at [50,000] [120,000] hours.

F. Belt Drives ***(If belt driven)***:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
2. Spark-Resistant Construction: AMCA 99.
3. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.5 HIGH BLOW LAB EXHAUST FANS

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

1. Greenheck Fan Corporation.
2. Strobic Air.

B. General

1. Base fan performance at standard conditions (density 0.075 Lb. /ft^3).

2. Each fan shall be direct driven in AMCA arrangement 2 according to drawings.
3. Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.
4. Fasteners exposed to corrosive exhaust shall be stainless steel.
5. Curb cap shall be hot rolled steel ***[316 stainless steel]*** coated with corrosion resistant coating.
6. Fan assemblies that use flexible connectors that can fail and cause loss of laboratory containment shall not be acceptable.
7. Fan assembly shall be designed for project design wind loading, without the use of guy wires.
8. Fans to be constant plume design.

C. Corrosion Resistant Coating

1. All fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with a two part electrostatically applied and baked, sustainable, corrosion resistant coating system, or equal. Standard finish color to be chosen by University.
2. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
3. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.
4. The coating system, a total thickness of up to 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.
5. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.

D. Fan Housing and Outlet

1. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan housing shall be bifurcated, allowing all drive components, including the motor, to be serviced without contact of the contaminated airstream. Must be manufactured of welded steel and meet specification section 2.5-C for corrosion resistant coating. No uncoated metal fan parts will be acceptable.
3. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
4. A multi-stage air induction discharge nozzle shall be supplied by the fan manufacturer designed to efficiently handle an outlet velocity of up to 7000 FPM. The multi-stage nozzle shall induce ambient air up to 270% of fan capacity. Nozzle / Wind band assemblies that are manufactured by third party vendors or that are fabricated of plastic or resins, having mechanical properties less than steel shall not be acceptable.
5. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.
6. A bolted & gasketed access door shall be supplied for impeller inspection and service.
7. Fan assembly shall be AMCA type C spark resistant construction minimum or as noted on the schedule.

E. Fan Impeller

1. Fan impeller shall be mixed flow design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.
2. Fan impeller shall be manufactured of welded and coated steel. Reference specification section 2.5-C for corrosion resistant coating.
3. Fan impellers that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, and lower maximum tip speeds are not acceptable.
4. Vacuum Seal: Fan impeller shall include a secondary fan blade located on the impeller back plate. This secondary impeller shall create a negative pressure at the shaft opening; preventing hazardous or toxic exhaust fumes from escaping through the housing shaft opening. Mechanical shaft seals that wear out and need to be replaced or seal systems that use hoses or tubes that can leak, are not acceptable.

F. Bypass Air Plenum

1. For constant volume systems, the fan / nozzle assembly shall be connected directly to roof curb and exhaust duct without the need of the bypass air plenum. Fans mounted directly to roof curb shall be provided with a damper tray located in the roof curb for mounting of the gravity isolation damper.
2. For variable volume systems, a bypass air plenum shall be provided as shown on drawings. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weatherhood and bird screen.
3. The plenum shall be constructed of welded and coated steel and meet specification section 2.5-C for corrosion resistant coating. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
4. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings.
5. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be permitted.
6. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of galvanized steel ***[316 stainless steel]*** for structural rigidity as standard. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be equal to or exceed a heavy duty control damper, Greenheck HCD-130 or equal. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.
7. If stated in the schedule notes, an optional, integral bypass air packed acoustic attenuator fabricated of galvanized steel ***[galvanneal or stainless steel construction]*** shall be provided by the fan manufacturer (if shown on the drawings).
8. Fan isolation damper(s), shall be parallel-blade design, airfoil design, fabricated of steel ***[304 stainless steel construction]*** for structural rigidity as standard. Damper(s) shall be coated up to 4 mils of chemically resistant Hi-Pro Polyester resin (or equal), electrostatically applied and baked. Isolation damper(s) shall have plated steel damper rods (if specified as 304 stainless steel damper, stainless steel damper rods will be provided), stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be equal to or exceed a heavy duty control damper, Greenheck HCD-130 or equal. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.

9. Isolation damper actuator(s), if scheduled shall be factory mounted and shall be wired to a step-down transformer. Actuator and transformer are located in a weatherproof enclosure.
10. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

G. Bypass Air Plenum Curb

1. Exhaust system manufacturer shall supply a structural support curb for the plenum of specified height as shown on the drawings.
2. Curb shall be fabricated of a minimum of 12 gauge corrosion-resistant coated steel and structurally reinforced.
3. Curb shall be insulated.
4. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand project required wind loadswithout additional structural support.

H. Fan Motor and Drive

1. Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, TEFC with a 1.15 service factor. A factory-mounted NEMA 3R ***[NEMA 4X]*** disconnect switch shall be provided for each fan.
2. Motor maintenance shall be accomplished without fan or fan impeller removal, or requiring maintenance personnel to access the contaminated exhaust components.
3. Motor mounting shall be “C-face” and / or foot mount.
4. Drive arrangement shall be AMCA arrangement 2, utilizing a direct mount coupling connecting the motor shaft and fan impeller shaft. Belt drive arrangement 9 or 10, or direct drive arrangement 4 requiring access and handling of hazardous and contaminated fan components are not acceptable.
5. Fan shaft to be turned and polished of 1040 steel material ***[316 stainless steel]*** as standard, coated with corrosion resistant coating.
6. Fan shaft bearing shall be Air Handling Quality, ball or roller pillow block type, and sized for an L-10 life of no less than 200,000 hours.
7. All shaft bearings and non-permanently lubricated motors shall have nylon [stainless steel braided] extended lube lines with zerk fittings.
8. Motor, coupling, and bearing shall all be outside the contaminated exhaust, and be capable of replacement without disassembling fan and accessing hazardous and contaminated fan components.

2.6 FAN ARRAYS

1. Fan Array

a. Fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for duty specified. Fans shall be selected to deliver scheduled airflow quantity at scheduled operating total static pressure and scheduled fan/motor speed. Fan array shall be selected to operate at system total static pressure that does not exceed 90% of scheduled fan’s peak static pressure producing capability at scheduled fan/motor speed.
b. Fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. Motors shall be standard pedestal mounted type, T-frame motors selected at specified operating voltage, rpm, and efficiency as needed to meet performance requirements. Motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to

meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.

1) Fan array shall provide uniform air flow and velocity profile across entire air way tunnel cross section. Airflow and velocity shall not exceed scheduled cooling coil and/or filter bank face velocity when measured at a point 12 inches from intake side of fan wall array intake plenum wall, and distance of 48 inches from discharge side of fan wall intake plenum wall.
2) Provide partition between fans to minimize system effect.
3) Provide structural frame to support upper fans with solid floor panel partition between fans as shown on drawings to minimize system effect.
4) Each fan in array shall be provided with back flow prevention means that produces less than 0.10 inches wc of static pressure drop and/or system effect when that fan is enabled. Any such system effects and/or pressure drops shall be submitted and included as component in determining fan system total static pressure as submitted. Manufacturer's pressure drop ratings of any such equipment, developed from straight run test conditions will not be accepted.
5) Provide 2 separate variable frequency drives for fan array. Each VFD shall control half of fans in array. Provide one backup VFD for air handling unit.
6) Fan array shall be sized such that upon single fan failure, remaining fans could ramp up and provide same 100% design capacity.
7) Technology with multiple fans having individual VFDs may be considered.
8) Provide local electrical disconnect for each fan.
9) Contractor shall provide all wiring to air handling unit components that require power.

2.7 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 0513 "Motors."

2.8 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION AND ACCESS

A. Install fans level and plumb and according to fan manufacturer's instructions..

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting: Install centrifugal fans on cast-in-place concrete equipment base(s) using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**]. Comply with requirements for equipment bases specified in [**Section 03 3000 "Cast-in-Place Concrete."**] [**Section 03 3053 "Miscellaneous Cast-in-Place Concrete."**] Comply with requirements for vibration isolation devices specified in Section 23 0550 "Vibration Isolation."

1. Minimum Deflection: [1/4 inch (6 mm)] [1 inch (25 mm)].
2. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install on [4-inch- (100-mm-)] [6-inch- (150-mm-)] high concrete base.

E. Equipment Mounting: Install centrifugal fans using [**elastomeric pads**] [**elastomeric mounts**] [**restrained spring isolators**]. Comply with requirements for vibration isolation devices specified in Section 23 0550 "Vibration Isolation."

1. Minimum Deflection: [1/4 inch (6 mm)] [1 inch (25 mm)].

F. Equipment Mounting: Install centrifugal fans on vibration isolation equipment base. Comply with requirements specified in Section 23 0550 "Vibration Isolation."

G. Equipment Mounting: Install continuous-thread hanger rods and [**elastomeric hangers**] [**spring hangers**] [**spring hangers with vertical-limit stop**] of size required to support weight of dehumidification unit.

1. Comply with requirements for seismic-restraint devices specified in Section 23 0550 "Vibration Isolation."
2. Comply with requirements for hangers and supports specified in Section 23 0529 "Mechanical Supporting Devices."

H. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction.[**Secure units to curb support with anchor bolts.**]

I. Unit Support: Install centrifugal fans level on structural [**curbs**] [**pilings**]. Coordinate wall penetrations and flashing with wall construction.[**Secure units to structural support with anchor bolts.**]

J. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install[**flexible duct connectors**] and vibration isolation devices.

1. Comply with requirements in Section 23 3314 "Ductwork Specialties" for flexible duct connectors.
2. Comply with requirements in Section 23 0550 "Vibration Isolation" for vibration isolation devices.

K. Install units with clearances for service and maintenance.

L. Pipe housing drains to nearest point of proper discharge.

M. Label fans according to requirements specified in Section 23 0553 "Mechanical System Identification."

N. Provide/build OSHA approved engineered platforms for preventative maintenance for items not accessible from a normal area standing position.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 3314 "Ductwork Specialties."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: University will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 23 0594 "Testing, Adjusting, and Balancing (TAB)" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train University maintenance personnel to adjust, operate, and maintain the equipment of this section.

END OF SECTION 23 3400

THIS PAGE IS INTENTIONALLY BLANK