Please note that although this section follows the MasterFormat numbering convention and layout, it is not a specification. Instead, it describes standard requirements that the Architect of Record and/or Engineer of Record must incorporate into project specifications.

PART 1 - INTRODUCTION

A. Description
   1. This standard specifies material and application requirements for different types of air terminal units intended for use in fan-powered HVAC systems within both laboratory and non-laboratory environments.

PART 2 - GENERAL DESIGN REQUIREMENTS

A. Definition Non-Laboratory and Laboratory Spaces.
   1. Non-laboratory Spaces
      a. These are typically spaces that fall under the application of support spaces, clinical spaces, offices, classrooms, and conditions that do not require air terminals with a fast acting response time.

   2. Laboratory Spaces
      a. These are typically spaces with or without fume hoods and areas that require air terminals with a fast-acting response time, and precise space pressure management. Spaces are typically classified as wet and dry-labs, and animal room vivarium's.

B. Non-Laboratory and Laboratory Spaces.
   1. Drawing Deliverable
      a. Specify the required maximum and minimum supply, exhaust and offset airflow for each space and air terminal. The contract documents shall include schedules and a separate plan view drawing with each respective supply, exhaust and offset CFM value for the maximum and minimum operating set-point. This information shall also be included in Table 1 of the BOD document. See Part 3 Minimum Installation and Product Requirements for additional requirements to be part of contract deliverables.

C. Non-Laboratory Requirements
   1. Specify air-terminal shut-off boxes with hot water reheat coils.
   2. Zoning for air-terminal boxes shall follow the suggested guidelines.
      a. Conference rooms shall be provided with a dedicated air terminal.
      b. Corner offices, or spaces with multiple exposures shall be provided with a dedicated air terminal.
      c. There shall be no more than three similar office spaces served by a single VAV box.
      d. Spaces with different load profiles shall not be served by the same air terminal.
      e. Spaces with different occupancy schedules shall not be served by the same air terminal.

3. Air terminals should not serve IT spaces
4. Specify air terminals with Yale approved controls, heating valves, and actuators. Controls to be provided and installed by Yale approved BMS manufacture.

D. Laboratory Requirements

1. Owner Project Requirements, Features and Operating Strategies
   a. Room pressurization shall be achieved using a volumetric offset strategy approach
   b. Fume hood average face velocities shall be maintained along the entire operating range of the fume hood sash. A face velocity of 100 FPM shall be maintained throughout the entire operating range of the sash position.
   c. Separate air terminals shall be provided for vented biological safety and bottled gas cabinets. The EoR shall confirm with the appropriate stakeholders when and what types of cabinets are required to be part of the process exhaust system.
   d. Fail-Safe Requirement
      1) Actuators for supply, exhaust and fume hoods shall be fail-safe or fail-in-place, EoR shall confirm requirements with the appropriate stakeholders.
   e. Where required, include an operational mode to maintain the required air flow during a purge requirement during a normal, emergency power, and smoke purge mode of operation.
   f. Air-terminal devices shall have the following performance characteristics and features.
      1) Air terminals shall be capable of a minimum turn down ratio of not less than 20:1
      2) No minimum length of inlet and outlet duct diameter requirements.
      3) High-precision air flow measuring and control
      4) Air terminals, when required, shall be specified to be compatible with corrosive and hazardous process exhaust.
      5) Fume hood air terminals shall be capable of 100 percent shut-off when commanded closed.
      6) Each supply air terminal shall include a reheat coil installed at the discharge of the terminal. The reheat coil shall have a maximum air pressure drop of 0.1 inches of w.c.
      7) Air terminal reheat coils shall be sized to compensate for the incoming supply air temperature from a central air handling system, which is set at 55°F (adjustable), and have sufficient heating capacity to maintain space heating set-point during occupied and unoccupied air flow requirements, and for each operating season.
      8) Reheat coils shall be sized for 120 F maximum entering water temperature and a minimum 20°F delta-T
      9) Use of electric resistance reheat coils is prohibited.

E. Controls

1. Control Integration and Strategy, Lab and Non-Lab spaces.
   a. Provide the sequences of operation for occupied, unoccupied, and standby modes to

maintain the required laboratory air change rate, space pressurization, and environmental thermal conditions. This should include the purge mode as well. Ensure that the interactive control sequences for the associated chilled beams, fin tube radiation, and fan-coil units are detailed. The control sequences must be specific to the Statement of Work (SOW) for each project; a generic sequence of operations is not acceptable.

b. Specified controls shall be a Yale University-approved vendor, product, and model number. Hardware and software shall comply with the university's communication and security protocols.

2. Laboratory fume hood controller requirements.
   a. A room-level controller shall be specified to manage the supply, exhaust, and fume hood air terminals. The controller shall be capable of standalone operation to maintain laboratory operating parameters and interface with the building BMS. Fume hood controllers and supporting hardware shall be hardwired to the BMS, and shall not rely on a network communication. The room-level controller shall be capable of stand-alone operation.

3. Laboratory control point requirement: The following information shall be monitored via the BMS, provide the required control points and programming :
   a. Fume hood average face velocity, and high/low alarm.
   b. Fume hood open face area.
   c. Fume hood exhaust airflow, and high/low alarm.
   d. Laboratory room supply minimum airflow limits, and high/low alarm
   e. Laboratory room supply maximum airflow limits, and high/low alarm
   f. Laboratory room general exhaust minimum airflow limits, and high/low alarm.
   g. Laboratory room general exhaust maximum airflow limits, and high/low alarm.
   h. Laboratory supply air temperature.
   i. Laboratory room ambient temperature, and high/low alarm.
   j. Laboratory room relative humidity, and high/low alarm.
   k. Laboratory room differential airflow.
   l. Laboratory room differential pressure (in. w.c.), and high/low alarm.
   m. Exhaust system static pressure (in w.c.), and high/low alarm.
   n. Exhaust system fan status, damper position, and associated alarm parameters.
   o. Exhaust system stack velocity.
   p. Air terminal supply minimum airflow limits, and high/low alarm
   q. Air terminal supply maximum airflow limits, and high/low alarm
   r. Air terminal exhaust minimum airflow limits, and high/low alarm.
   s. Air terminal exhaust maximum airflow limits, and high/low alarm.
   t. Air terminal supply air temperature, downstream of RH coil.

4. Non-laboratory air terminals and control requirements.
   a. Provide a controller and associated sensors, control valve, actuator, and air flow station to

monitor and control flow, and temperature through the BMS interface.

PART 3 - MINIMUM INSTALLATION AND PRODUCT REQUIREMENTS

A. General
1. Air Terminal Units shall be VAV type. Use of other types of terminal units, such as fan-powered boxes, requires approval by Yale.
2. Air terminals shall be equipped with 10” x 10” minimum low leakage, gasketed access door between the air damper and reheat coil for access and cleaning.
3. When internal liner is provided, provide liner which is resistant to mechanical damage, resistant to mold, and shall not shed fibers. Fibers shall not be exposed to the air-stream.
4. Location of all boxes shall be accessible for maintenance. Access areas shall be shown on the drawings.
5. Ductwork elbows and size transitions should be avoided within five duct diameters of a VAV or dual duct box inlet if possible.
6. Flexible ductwork before VAV boxes is not allowed.

B. Schedules
1. The VAV box schedule shall include: box identifier; manufacturer; model number; inlet size; maximum and minimum design cfm for cooling; design heating cfm; minimum heating and cooling cfm for unoccupied mode; reheat coil EAT, LAT, EWT, LWT, GPM, MBH rating, maximum water pressure drop, and maximum air pressure drop; and maximum NC level.
2. The VAV box schedule shall include total airflows for all boxes connected to an AHU. The total airflows shall be calculated for the maximum cooling, minimum cooling, and unoccupied minimum airflows.

C. Box Identifiers
1. VAV box identifier numbering shall be coordinated with University so duplicate numbering from previous projects does not occur.
2. Return and exhaust boxes that are paired/controlled by a supply box shall use the same supply VAV box identifier along with a letter, such as VAV-202E or VEV202.

D. Acceptable Manufacturers

1. Non-Laboratory Applications:
   a. Single-duct, series, and parallel fan-powered air terminals with blade dampers
      1) Price Industries
      2) Titus

2. Laboratory Applications
   a. Blade and butterfly type air-valves
      1) Siemens:, GOLO 2
      2) Accutrol: Series 6000 Accuvalve

3) Johnson Controls: EcoAir valve

b. Venturi type air-valves
   1) Siemens: Conical
   2) Johnson Controls: Venturi
   3) Honeywell: Phoenix

Date	Description of Change	Pages / Sections Modified	ID
04/28/25	Entire document	-	Yale Engineering and Operations