



**SEQUENCE OF OPERATIONS:**

**LAB CONTROL MODULE**

THE TOTAL SUPPLY AIR VOLUME AND THE TOTAL EXHAUST AIR VOLUME FOR EACH SPACE IS MONITORED AND CONTROLLED TO MAINTAIN SLIGHT NEGATIVE PRESSURIZATION. (50-100 L/S OFFSET, DEPENDING ON LAB AIR FLOW)

THE SPACE GOES INTO OCCUPIED MODE BASED ON A TIME OF DAY SCHEDULE.

**VARIABLE VOLUME FUME HOOD CONTROL**

THE NEW VARIABLE VOLUME FUME HOOD CONTROL WILL MAINTAIN A CONSTANT FACE VELOCITY OF 30m/min AT ALL TIMES AT ANY SASH OPENING HEIGHT, BY VARYING THE FUME HOOD EXHAUST FLOW. THE FUME HOOD CONTROLLER CALCULATES THE TOTAL FUME HOOD OPEN AREA BASED ON THE FUME HOOD'S FIXED OPENINGS, LEAKAGE AREA AND SASH POSITION AS INDICATED BY THE SASH POSITION SENSOR. THE FUME HOOD CONTROLLER CONTINUOUSLY CALCULATES THE FUME HOOD EXHAUST AIR VOLUME REQUIRED TO MAINTAIN THE AVERAGE FACE VELOCITY BASED ON THE TOTAL OPEN AREA OF THE FUME HOOD AND THE AVERAGE FACE VELOCITY (ADJUSTABLE) SET POINT. THE FUME HOOD CONTROLLER USES A DIFFERENTIAL PRESSURE SENSOR MONITORING THE "HIGH" AND "LOW" AIR VOLUME PORTS ON THE EXHAUST TERMINAL AND MODULATES THE FUME HOOD EXHAUST DAMPER TO CONTROL AND MAINTAIN A CONSTANT FACE VELOCITY AT THE OPEN SASH. THE FACE VELOCITY IS CALCULATED AND DISPLAYED ON THE OPERATOR'S DISPLAY PANEL (ODP) AND SHOULD BE BALANCED TO MAINTAIN SET-POINT OF 30 m/min(LINEAR AIR VALVES MAY BE USED IN LIEU OF HIGH SPEED DAMPERS AND DIFFERENTIAL PRESSURE SENSORS OF FUME HOOD EXHAUST)

THE SASH IS LIMITED TO 500MM (20") OF VERTICAL MOTION BY A PHYSICAL STOPPER BEFORE GOING INTO ALARM. IF THE SASH OPENS PAST THE STOPPER AN ALARM IS GENERATED INDICATING THAT THE FACE AREA HAS EXCEEDED THE MAXIMUM FACE AREA AS SET UP IN THE FUME HOOD CONTROLLER. IF THE FACE AREA IS IN ALARM AND THE FACE VELOCITY DROPS BELOW SET-POINT, AN AUDIBLE & VISUAL WARNING ARE GENERATED AT THE OPERATOR'S DISPLAY PANEL (ODP) AS WELL AS THE OPERATOR'S WORK STATION (OWS), FOLLOWED BY AN ALARM CONDITION IF THE FACE VELOCITY CONTINUES TO DROP. DISPLAY PANEL WILL DISPLAY A "GREEN" LED LIGHTING STRIP WHEN HOOD OPERATING CONDITIONS AIR NOMINAL, AND A "RED" LED LIGHTING STRIP WHEN THE HOOD IS IN ALARM.

**LABORATORY VENTILATION CONTROL**

THE LAB CONTROLLER UNIT OPERATES AT THE HIGH SUPPLY AIR VOLUME SET POINT AND HIGH EXHAUST AIR VOLUME SET POINT WHEN THE SPACE IS OCCUPIED AND WHEN THE FUME HOOD SASH IS FULLY OPENED. THE LCU'S AND DUAL DUCT TECs MODULATE THE COLD DECK DAMPERS RESPECTIVELY TO MAINTAIN A VARIABLE SUPPLY AIR VOLUME, WHEN THE HOT DECK DAMPER MODULATES FOR TEMPERATURE CONTROL. THE COLD DECK DAMPER IS POSITIONED TO MAINTAIN THE VARIABLE SUPPLY AIR FLOW FOR THE SYSTEM. EACH LCU'S MODULATES ITS GENERAL EXHAUST BOX DAMPER TO ENSURE THAT A MINIMUM TOTAL ROOM EXHAUST NECESSARY TO MEET THE REQUIRED ROOM VENTILATION RATE IS CONTINUOUSLY MAINTAINED USING A PROPORTIONAL, INTEGRAL AND DERIVATIVE (PID) CLOSED LOOP CONTROL ALGORITHM. WITH A VAV FUME HOOD, THE GENERAL EXHAUST WILL ALSO MAINTAIN A NEGATIVE PRESSURE IN LAB. WHEN THE FUME HOOD SASH IS NOT FULLY OPEN, THE DUAL DUCT-DUCT BOX VOLUME IS MODULATED TO MAINTAIN A NEGATIVE PRESSURE IN THE ROOM, AND THE GENERAL EXHAUST BOX REMAINS CLOSED. WHEN THE SPACE COOLING DEMAND IN THE LAB REQUIRES THE SUPPLY AIR FLOW TO BE GREATER THAN THE FUME HOOD EXHAUST FLOW, THE G.E. BOX WILL MODULATE OPEN TO MAINTAIN A NEGATIVE PRESSURE IN THE LAB. WHEN THE SUPPLY AIR FLOW EXCEEDS THE FUME HOOD EXHAUST FLOW, THE G.E. FLOW WILL BE CALCULATED AS FOLLOWS : (G.E. = S.A. - FH (CANOPY) + DIFFERENTIAL (25 L/S)). WHEN THE SUPPLY AIR FLOW IS LESS THEN THE FH AIR FLOW, THEN SUPPLY AIR FLOW WILL BE CALCULATED AS FOLLOWS : ( S.A. = FH + CANOPY - DIFFERENTIAL (50L/S))

**ROOM PRESSURIZATION CONTROL - NEGATIVE**

SPACES WITHOUT FUME HOODS ARE CONTROLLED TO MAINTAIN SLIGHTLY LESS SUPPLY AIR VOLUME RELATIVE TO THE GENERAL EXHAUST AIR VOLUME; INITIALLY SET AT -50 LPS. ALL SUGGESTED SET POINTS AND SETTINGS ARE ADJUSTABLE.

CALCULATE THE REQUIRED GENERAL EXHAUST AIR VOLUME NECESSARY TO MAINTAIN A PREDETERMINED AIR VOLUME TRACKING DIFFERENTIAL (50 L/S) (EXHAUST TRACKS SUPPLY) BY SUBTRACTING THE TRACKING DIFFERENTIAL AIR VOLUME SET POINT (ADJUSTABLE) FROM THE TOTAL ROOM SUPPLY AIR VOLUME. LCU'S MODULATES THE GENERAL EXHAUST AIR VOLUME DAMPER TO ENSURE THAT THE VOLUME TRACKING DIFFERENTIAL IS ALWAYS MAINTAINED BY A PROPORTIONAL, INTEGRAL AND DERIVATIVE (PID) CLOSED LOOP CONTROL ALGORITHM.

**ROOM TEMPERATURE CONTROL - OCCUPIED**

THE LCU MEASURES THE TEMPERATURE IN THE ROOM AND SENDS THIS SIGNAL ACROSS THE NETWORK TO THE SLAVED CONTROLLERS. THE CONTROLLERS MODULATE IN SEQUENCE THE REQUIRED HOT DECK VALVES USING A PROPORTIONAL, INTEGRAL AND DERIVATIVE (PID) CLOSED LOOP CONTROL ALGORITHM TO MAINTAIN THE ROOM TEMPERATURE AT SET POINT AS PER THE SET POINT ON THE ROOM SENSOR.

WHEN COOLING IS REQUIRED, THE HOT DECK DAMPERS ARE MODULATED CLOSED AND THE COLD DECK DAMPER MODULATED OPEN TO MAINTAIN THE VOLUME SUPPLY TO THE SPACE AND MAINTAIN THE SPACE TEMPERATURE AT SET-POINT. ( INDIVIDUAL CONTROL CONTRACTORS MAY USE DIFFERENT CONTROL STRATEGIES FOR COOLING AS LONG AS ROOM PRESSURIZATION AND SPACE TEMPERATURE PERFORMANCE CRITERIA ARE MET)

**ROOM TEMPERATURE CONTROL - UNOCCUPIED**

THE LCU IS CONTROLLED USING THE UNOCCUPIED SPACE TEMPERATURE. THE CONTROLLER MAY RESET TO THE OCCUPIED MODE FOR A PREDETERMINED TIME PERIOD (INITIALLY SET AT 1 HOUR) UPON A SIGNAL FROM THE ROOM SENSOR OVERRIDE BUTTON.

**CONTROL PRIORITY**

A PRIORITY STRUCTURE APPLIES TO THE ABOVE CONTROL APPLICATIONS TO ENSURE THAT SAFETY IS MAINTAINED AS THE HIGHEST CONTROL PRIORITY WHEN, HVAC SYSTEMS OR INDIVIDUAL COMPONENTS CANNOT MEET ALL DEMANDS PLACED UPON THE SYSTEM.

1. FUME HOOD CONTROL IS THE HIGHEST CONTROL PRIORITY.
2. ROOM PRESSURIZATION IS THE SECOND LEVEL OF PRIORITY.
3. ROOM VENTILATION IS THE THIRD LEVEL OF PRIORITY. (MINIMUM 6.0 AIR CHANGES PER HOUR)
4. ROOM TEMPERATURE CONTROL IS THE FOURTH LEVEL OF PRIORITY.

**LABORATORY VENTILATION MINIMUMS:**

THE DUAL DUCT BOX SUPPLY AIR VOLUME SHALL OPERATE WITH A MINIMUM SETTING OF 6.0 AIR CHANGES PER HOUR

