SEQUENCE OF OPERATION

MAU-5

RUN CONDITIONS:
- THE UNIT SHALL RUN CONTINUOUSLY.
- OCCUPIED MODE
  - o THE UNIT SHALL MAINTAIN A 64°F (ADJ) HEATING SET POINT AND A 66°F (ADJ) COOLING SETPOINT.
- UNOCCUPIED MODE
  - o THE UNIT SHALL MAINTAIN A 60°F (ADJ) HEATING SET POINT AND A 70°F (ADJ) COOLING SETPOINT.

SPEED CONTROL:
- THE UNIT FAN SPEED SHALL BE CONTROLLED BY A VFD TO MAINTAIN SPACE PRESSURE CONTROL.

SMOKE DETECTION:
- THE UNIT GENERATES AN ALARM UPON RECEIVING A SMOKE DETECTOR STATUS.

OUTSIDE AIR DAMPER:
- THE OUTSIDE AIR DAMPER SHALL OPEN ANYTIME THE UNIT RUNS AND SHALL CLOSE ANYTIME THE UNIT STOPS. THE SUPPLY FAN SHALL START ONLY AFTER THE DAMPER STATUS HAS PROVEN THE DAMPER IS OPEN.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- OUTSIDE AIR DAMPER FAILURE: COMMANDED OPEN, BUT THE STATUS IS CLOSED.

SUPPLY FANS:
- THE SUPPLY FANS SHALL RUN CONTINUOUSLY TO MAINTAIN ROOM PRESSURE RELATIONSHIP.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- SUPPLY FAN FAILURE: COMMANDED ON, BUT THE STATUS IS OFF.

COOLING COIL VALVE:
- THE CONTROLLER SHALL MEASURE THE UNIT DISCHARGE TEMPERATURE AND MODULATE THE DELTA P VALVE TO MAINTAIN ITS COOLING SETPOINT.
- THE COOLING SHALL BE ENABLED WHENEVER:
  - o OUTSIDE AIR TEMPERATURE IS GREATER THAN 70°F (ADJ) AND THE EVAPORATIVE COOLING SECTION CANNOT MAINTAIN SETPOINT.
- PUMPS P-11A OR P-11B SHALL START:
  - o ALARM SHALL BE SET TO BAS UPON PUMP START.
  - o PUMPS SHALL ALTERNATE.
  - o PUMP SHALL RUN TO MAINTAIN SETPOINT FOR FREEZE PROTECTION WHEN DISCHARGE TEMPERATURE IS BELOW 45°F (ADJ).
  - o 2-WAY CONTROL VALVE THAT IS NORMALLY CLOSED SHALL OPEN, AND 2-WAY CONTROL VALVE THAT IS NORMALLY OPEN SHALL CLOSE.

EVAPORATIVE COOLING:
- EVAPORATIVE COOLER PUMPS SHALL STAGE ON TO MAINTAIN 70°F DISCHARGE TEMPERATURE (ADJ).

HEATING COIL VALVE:
- THE CONTROLLER SHALL MEASURE THE UNIT DISCHARGE TEMPERATURE AND MODULATE THE DELTA P VALVE TO MAINTAIN ITS HEATING SETPOINT.
- THE HEATING SHALL BE ENABLED WHENEVER:
  - o OUTSIDE AIR TEMPERATURE IS LESS THAN 70°F (ADJ).
- PUMPS P-9A OR P-9B SHALL START:
  - o ALARM SHALL BE SET TO BAS UPON PUMP START.
  - o PUMPS SHALL ALTERNATE.
  - o PUMP SHALL RUN TO MAINTAIN SETPOINT FOR FREEZE PROTECTION WHEN DISCHARGE TEMPERATURE IS BELOW 45°F (ADJ).
  - o 2-WAY CONTROL VALVE THAT IS NORMALLY CLOSED SHALL OPEN, AND 2-WAY CONTROL VALVE THAT IS NORMALLY OPEN SHALL CLOSE.

HEAT RECOVERY COIL VALVE:
- THE 2-WAY CONTROL VALVE SHALL OPEN TO PROVIDE MAXIMUM ENERGY RECOVERY AVAILABLE.
- PUMPS P-5 OR P-6 SHALL START:
  - o PUMPS SHALL ALTERNATE.
  - o PUMPS SHALL SHUT OFF WHEN AMBIENT TEMPERATURE IS BETWEEN 65°F AND 75°F (ADJ).

FILTER DIFFERENTIAL PRESSURE MONITOR:
- THE CONTROLLER SHALL MONITOR THE DIFFERENTIAL PRESSURE ACROSS THE FILTER.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- FILTER CHANGE REQUIRED: FILTER DIFFERENTIAL PRESSURE EXCEEDS A USER DEFINABLE LIMIT (ADJ).

DISCHARGE AIR TEMPERATURE:
- THE CONTROLLER SHALL MONITOR THE DISCHARGE AIR TEMPERATURE
- ALARMS SHALL BE PROVIDED AS FOLLOWS:
  - o HIGH DISCHARGE AIR TEMP: IF THE DISCHARGE AIR TEMPERATURE IS GREATER THAN 95°F (ADJ).
  - o LOW DISCHARGE AIR TEMP: IF THE DISCHARGE AIR TEMPERATURE IS LESS THAN 50°F (ADJ).

EAU-5:

RUN CONDITIONS:
- TEMPERATURE SENSORS AIR & WATER.
- FILTER DIFFERENTIAL PRESSURE MONITOR.

FILTER DIFFERENTIAL PRESSURE MONITOR:
- THE CONTROLLER SHALL MONITOR THE DIFFERENTIAL PRESSURE ACROSS THE FILTER.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- FILTER CHANGE REQUIRED: FILTER DIFFERENTIAL PRESSURE EXCEEDS A USER DEFINABLE LIMIT (ADJ).

GLYCOL FEEDER:

RUN CONDITIONS:
- SELF-CONTAINED CONTROLS.
- AUXILIARY CONTACT FOR REMOTE LOW PRESSURE ALARM.
- MANUAL FEED OPERATION.

EXHAUST VALVES E-VAV-101-A, B, C, D, E:

RUN CONDITIONS:

THE UNIT SHALL OPERATE WHEN EF 5A OR 5B IS ENABLED.
- ENABLED SETPOINT: THE UNIT SHALL MAINTAIN A NEGATIVE ZONE PRESSURE SETPOINT OF -0.05 IN WC (ADJ) IN LAB 101 & -0.1 IN WC (ADJ) IN CONTAINMENT CELL.
- E-VAV-101-A SHALL BE INTERLOCKED WITH ALL GAS CABINET DOORS. IF ANY DOOR OPENS, E-VAV-101-A SHALL MODULATE CLOSED.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH ZONE PRESSURE: IF THE ZONE PRESSURE IS GREATER THAN THE PRESSURE SETPOINT BY 10% FOR ONE MINUTE (ADJ).
- LOW ZONE PRESSURE: IF THE ZONE PRESSURE IS LESS THAN THE PRESSURE SETPOINT BY 10% FOR ONE MINUTE (ADJ).

ZONE SETPOINT ADJUST:
- EXHAUST VALVE SHALL OPEN TO MAINTAIN A CONSTANT EXHAUST AIR FLOW GIVEN A DUCT INLET PRESSURE FROM -1.0 IN WC TO -3.0 IN WC.
- THE VALVES E-VAV-101-B, C & E SHALL MODULATE AIRFLOW FROM MIN TO MAX AS REQUIRED TO MAINTAIN A CONSTANT FACE VELOCITY ACROSS THE ASSOCIATED FUME HOOD SASH OPENING OF 100 FPM.
- VALVES E-VAV-101-A & D SHALL MODULATE TO MAINTAIN ROOM STATIC PRESSURE.
- VALVE E-VAV-101-D AND E SHALL OPERATE FROM A 2 POSITION WALL SWITCH AND SHALL BE BE WIRED FOR A NIGHTTIME FLOW REDUCTION.

FANCOIL FCU 101:

RUN CONDITIONS:

THE UNIT SHALL RUN ACCORDING TO A USER DEFINABLE TIME SCHEDULE IN THE FOLLOWING MODES:
- OCCUPIED MODE, THE UNIT SHALL MAINTAIN A 74°F (ADJ) COOLING SETPOINT AND A 70°F (ADJ) HEATING SETPOINT.
- UNOCCUPIED MODE, THE UNIT SHALL MAINTAIN A 85°F (ADJ) COOLING SETPOINT AND A 60°F (ADJ) HEATING SETPOINT.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH ZONE TEMP: IF THE ZONE TEMPERATURE IS GREATER THAN THE COOLING SETPOINT BY A USER DEFINABLE AMOUNT (ADJ).

SUPPLY FAN:
- THE SUPPLY FAN SHALL RUN ANYTIME THE UNIT IS COMMANDED TO RUN, UNLESS SHUTDOWN ON SAFETIES. TO PREVENT SHORT CYCLING, THE SUPPLY FAN SHALL HAVE A USER DEFINABLE (ADJ) MINIMUM RUNTIME.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- SUPPLY FAN FAILURE, COMMANDED ON, BUT THE STATUS IS OFF.

COOLING COIL VALVE:
- THE CONTROLLER SHALL MEASURE THE ZONE TEMPERATURE AND MODULATE THE COOLING COIL VALVE TO MAINTAIN ITS COOLING SETPOINT.

HEATING COIL VALVE:
- THE CONTROLLER SHALL MEASURE THE ZONE TEMPERATURE AND MODULATE THE HEATING COIL VALVE TO MAINTAIN HEATING SETPOINT.

SUPPLY AIR TEMPERATURE:
- THE CONTROLLER SHALL MONITOR THE SUPPLY AIR TEMPERATURE.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH SUPPLY AIR TEMP: IF THE SUPPLY AIR TEMPERATURE IS GREATER THAN 90°F (ADJ).
- LOW SUPPLY AIR TEMP: IF THE SUPPLY AIR TEMPERATURE IS LESS THAN 60°F (ADJ).

EXHAUST FANS 5A & 5B:

GENERAL:

- THE LEAD EXHAUST FAN SHALL BE ENERGIZED BY THE BAS. LAG EXHAUST FAN SHALL BE OFF UNLESS COMMANDED ON BY THE BAS DURING FAN ROTATION OR IN THE EVENT OF LEAD FAN FAILURE. WHEN A FAN IS COMMANDED OFF, IT'S RESPECTIVE ISOLATION DAMPER SHALL BE CLOSED. WHEN A FAN IS COMMANDED ON, THE ISOLATION DAMPER SHALL OPEN AND THE EXHAUST FAN START FOLLOWING PROOF OF DAMPER OPEN.

LABORATORY FAN STARTUP:

- ON INITIAL START OF A FAN, THE BYPASS AIR DAMPER SHALL BE ENERGIZED AND PROVEN FULLY OPEN PRIOR TO START OF THE FANS TO ENSURE ADEQUATE AIRFLOW TO THE FAN (PREVENTING SURGE OR STALL OF THE FAN). AS THE FAN REACHES FULL VFD SPEED, THE BYPASS DAMPER WILL BE CLOSED TO DEVELOP THE NECESSARY NEGATIVE STATIC PRESSURE REQUIRED FOR CONTROL OF THE SYSTEM AS DESCRIBED IN "EXHAUST SYSTEM CONTROL" BELOW.

EXHAUST SYSTEM CONTROL:

- THE EXHAUST FAN SHALL OPERATE TO MAINTAIN A NEGATIVE STATIC PRESSURE OF 5" IN THE COMMON INTAKE OF THE ENERGY RECOVERY PLENUM (ON THE ROOM SIDE OF THE ENERGY RECOVERY FILTERS AND THE ENERGY RECOVERY COILS). AS THE EXHAUST PLENUM STATIC PRESSURE INCREASES (BECOMES POSITIVE IN REFERENCE TO THE SETPOINT), THE EXHAUST FAN VFD SHALL MODULATE THE FAN FROM THE MAXIMUM CAPACITY AIRFLOW OF 15,000 CFM DOWN TO THE MINIMUM PERMISSIBLE LAB AIRFLOW OF 12,950 CFM. NOTE: THE MINIMUM PERMISSIBLE LAB AIRFLOW CORRESPONDS TO THE MINIMUM AIRFLOW REQUIRED TO MAINTAIN BETWEEN 2,500 (12,950 CFM) AND 3,000 FPM (15,000 CFM) AT THE DISCHARGE NOZZLE OF THE FAN. ONCE THE LABORATORY EXHAUST FAN REACHES THE MINIMUM ALLOWABLE FAN AIRFLOW, THE FAN AIRFLOW CANNOT BE REDUCED. IF THERE IS A FURTHER INCREASE IN THE PLENUM STATIC PRESSURE MEASUREMENT, THE BYPASS AIR DAMPER SHALL BE ENGAGED AND MODULATED OPEN TO MAINTAIN THE PLENUM STATIC PRESSURE SETPOINT WHILE KEEPING THE EXHAUST FAN AT THE MINIMUM AIRFLOW. AS THE STATIC PRESSURE SETPOINT DROPS AWAY FROM SETPOINT (BECOMES NEGATIVE IN REFERENCE TO THE SETPOINT), THE REVERSE OF THE SEQUENCE SHALL OCCUR.

FAN CHANGEOVER ON FAN FAILURE:

- UPON FAN FAILURE OF THE LEAD FAN, AS SENSED BY THE BAS, LAG FAN SHALL BE ENERGIZED ACCORDING TO THE LABORATORY FAN STARTUP SEQUENCE ABOVE. LEAD (FAILED) FAN SHALL BE DE-ENERGIZED CLOSING THE FAN'S ISOLATION DAMPER.

FAN CHANGEOVER ON FAN ROTATION:

- FANS SHALL BE PROVIDED WITH LEAD/LAG ROTATION CAPABILITIES. DURATION OF ROTATION PERIOD TO BE PROVIDED BY NREL.

- MAINTAINING EXHAUST PLENUM STATIC PRESSURE IS CRITICAL DURING CHANGEOVER. AS LAG FAN IS ENERGIZED AND BROUGHT UP TO SPEED, BAS CONTRACTOR MUST COORDINATE DECELERATION OF LEAD FAN, BYPASS AIR DAMPER POSITION, FAN ISOLATION DAMPERS TO MAINTAIN THE EXHAUST PLENUM STATIC PRESSURE SETPOINT.

VAV BOX

SHALL MODULATE IN UNISON WITH FUME HOODS, EXHAUST FANS, AND EXHAUST VALVES TO MAINTAIN SPACE PRESSURE RELATIONSHIPS

FAN LOFT PENTHOUSE VENTILATION EF-308, LVR-3 & 4:

RUN CONDITIONS:
- EXHAUST FAN CONTROLLED BY THERMOSTAT.
- THE SYSTEM CONSISTS OF AN EXHAUST FAN, OSA DAMPER AND EXHAUST AIR DAMPER.

TEMPERATURE CONTROL:
- AS SPACE TEMPERATURE RISES ABOVE SETPOINT (ADJ) OUTSIDE AIR DAMPER AND EXHAUST AIR DAMPER SHALL OPEN. EXHAUST FAN SHALL ENERGIZE. CONVERSELY AS TEMPERATURE FALLS BELOW SETPOINT FAN SHALL DE-ENERGIZE AND BOTH DAMPERS SHALL CLOSE AT APPROXIMATELY 3 DEGREES BELOW THE ENABLE POINT. IF OUTSIDE AIR TEMPERATURE IS GREATER THAN THE SPACE TEMP, TURN OFF THE FAN BUT LEAVE THE DAMPERS OPEN FOR AIR CIRCULATION.

FAN CONTROL:
- FAN OPERATION WILL BE SCHEDULED THROUGH THE OPERATOR WORKSTATION INTERFACE. SHOULD FAN STATUS AND FAN COMMAND NOT MATCH, GENERATE AN ALARM AT THE OPERATOR WORKSTATION.

FAR EAST FAN LOFT SYSTEM CONTROL SEQUENCES

NO.	REVISIONS	DATE	BY	APP'D.	BAE
0	50% CONSTRUCTION DOCUMENTS	8-25-11	.	.	.
1	90% CONSTRUCTION DOCUMENTS	9-30-11	.	.	.
2	100% CONSTRUCTION DOCUMENTS	11-3-11	.	.	.
3	FOR CONSTRUCTION	1-20-12	.	.	.
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USER: DLD	DATE: 1/20/12	TIME: .	XREF'S: .
DWG. FILE:		LAYOUT: .	
DWG. FOLDER:			
ACAD VERSION: AUTOCAD 2010			
PLATFORM: WINDOWS XP			
BORDER: ZB02234D-3.DWG	PLOT SCALE: 1:1		UNITS: ARCH
PLOT INFO.: NREL.STB			

ENGINEERING REVIEW		
	APPROVAL	DATE
DESIGNER		
ENGINEER		
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A/E APPROVED BY	.	.
NREL APPROVED BY	.	.
BLDG. AREA ENG.	.	.

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THERMO-CHEM LABORATORY 101 CONVERSION
TASK ORDER 13
CONTROL SEQUENCES

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FLTB-135-	M-11	3
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