Execututive Summary

Charles E. and Mary Parente Life Sciences Center

Existing Conditions Analysis for Building Mechanical Systems

Prepared by

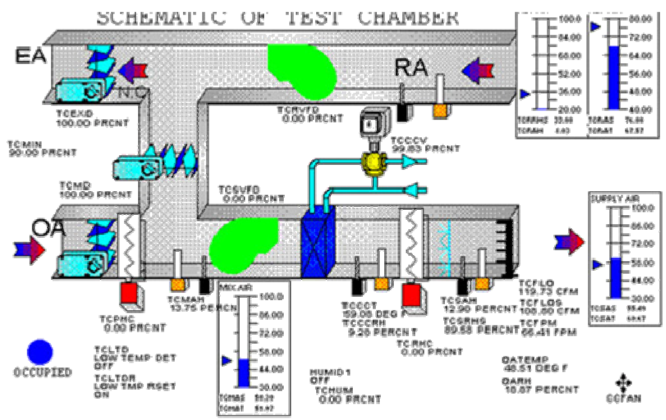
Ryan J. Wanko

The Charles E. and Mary Parente Life Science Center is a 46,000 sf addition to the existing sciences center at King's College. The addition houses both laboratory and lecture hall type spaces. The building contains four air handling units, two air-cooled chillers, two hot water boilers and multiple terminal units. One interesting point is that 3 of the four air handlers and 100% outdoor air applications with out any type of heat recovery. This report finds the heating and cooling plants to be slightly undersized. It also finds that the units do not use enough heat recovery for the amount of outdoor air being brought in. In general the entire building is over ventilated. Recommended solutions include the use of a dedicated outdoor air unit, and resizing of cooling and heating plants.

Charles E. And Mary Parente Life Sciences Building
King's College
Wilkes-Barre Pa

Existing Conditions Report for Heating, Ventilation, Air Conditioning and Refrigeration Applications

Prepared by
Ryan J. Wanko



<u>**Table of Contents**</u>

Introduction

The Charles E. and Mary Parente Life Science Center is a 46,000 sf addition to the existing sciences center at King's College. The addition houses both laboratory and lecture hall type spaces. The building contains four air handling units, two air-cooled chillers, two hot water boilers and multiple terminal units. One interesting point is that 3 of the four air handlers and 100% outdoor air applications with out any type of heat recovery. This report will analyze the operation and physicality of the current environmental control system. Equipment listings, space load calculations and sequence of operations should be considered in order to achieve an overall understanding of the entire application. It is important to remember that it is the application that we as engineers are most concerned with. It's not too difficult to specify equipment but knowing how to apply that equipment to a certain application in order to achieve thermal comfort, ventilation requirements and acceptable indoor air quality can be somewhat of a challenge.

Design Conditions, Considerations and Objectives

With any HVAC design project the first thing that must be considered is the design conditions for the geographical location of the building. After that we must consider the type of building and start to formulate a “plan of attack” to assure all codes are met as well as basic design standards.

The Charles E. and Mary Parente Life Sciences Building is located in Wilkes-Barre PA. Wilkes-Barre is located in the northeastern part of the state. Typically the city will experience more heating degree days than cooling degree days. Therefore it might not be surprising to see the heating plant size exceeding the cooling plant size. The area is not incredibly dense, which is a good indicator that carbon monoxide levels in the outdoor air will be acceptable. The building also contains offices that are able to be accessed 24 hours a day 7 days a week which implies that there should not be an “unoccupied” setting on the control sequence. In other words set point is to be constantly maintained. The following section will go step by step through design conditions and considerations for The Charles E. and Mary Parente Life Sciences center.

<u>Design Conditions</u>

As scheduled, the outdoor air design conditions were taken to be

Cooling Season: 92°F db/75°F wb

Heating Season: 0°F/60%RH

Room air conditions for both heating and cooling seasons are taken to be at 75°F db/50%RH.

Supply air discharge temperatures for all air handlers is taken at 55°F/100%RH for both heating and cooling seasons. The remainder of the load for winter heating is picked up local to the space via the variable air volume reheat boxes.

Judging by the outdoor air design conditions its fairly clear that the heating season might be stressed more than the cooling season. We can infer this based of the temperature difference between the room air conditions and the outdoor air design conditions. Where $\Delta T(\text{summer}) = 17°F < \Delta T\ (\text{winter}) = 75°F$

Design Considerations

The building has a mix of usage groups such as classrooms, laboratories and offices. Each of these groups will have a direct effect on the type of application that is used. For instance, something acoustically pleasing would be desirable for all three space types, the labs will need some special exhaust considerations based off the type of work that is being done, and the offices should have independent temperature control with a wide range of set points to meet the individuals comfort level. Since it is in essence a classroom building implies a high building density and thus the possibility of a large internal load.

The labs in this particular building do not utilize any local exhaust, but the general exhaust is not returned but directly exhausted out the roof. Some of the lecture halls do utilize return air others are part of 100% outdoor air applications *where they share an air handler with a laboratory*. Therefore, space location within the building obviously played a critical part in selecting the type of application best suited.

The site itself is adjacent to buildings on all sides that are of equal or greater height, there are also trees around the building. Both of these factors will imply high shading coefficients and thus a reduction in solar radiated heat.

Design Objectives:

It's difficult to say exactly what the design engineer wanted to achieve with this particular design. Based off of the given information the objectives can be assumed as follows:

- Low Initial Cost
- Assurance of minimum outdoor air requirements
- Proper ventilation requirements for a dilution type contaminant reduction
- Precise temperature control for each individual space
- Easy to maintenance
- Easy to operate

This of course is only an assumption based off of construction documents and should not be taken as the actual objectives as defined by the design engineer.

Energy Sources and Cost

This building uses no district heating applications. The boilers are fed by a natural gas main and the remaining equipment is electric. In general electricity prices in the Wilkes-Barre area are fairly reasonable. Exact cost information is not available at this time but is currently being compiled and should be posted soon!

However it has been made clear that there are no cost factors associated with power prices.

Design Load Conditions

By definition the design load should be the worst case scenario that the application will see during the course of one year. Based off this number all the equipment is to be specified. The total load scene by the heating and cooling plant is the summation of the space load and the ventilation load. The space load is defined as the amount of heat being directly transfer to the space. The ventilation load is the amount of energy needed to bring the required outdoor air to supply conditions. (See A.1) for specific details on this application. Blow is a short numerical summary:

Total Space Load (Heating): 974,746 Btu/Hr

Total Space Load (Cooling): 873,483 Btu/Hr

Design Total Cooling Load: 1,320,000 Btu/hr

Design Total Heating Load: 5,218,000 Btu/Hr

The total load numbers are based off design sizes of the boiler and chiller units. We can quickly estimate the actual ventilation load to check the accuracy of the equipment sizing in the following manner:

$\dot{Q}_{OA} = \dot{m}_{OA} \bullet \Delta i_{O,R}$ where the term Δi is the absolute difference in enthalpy from the outdoor air to the room air.

Winter:

$$\dot{Q}_{OA} = \dot{V}_{OA} \bullet \rho_{OA} \bullet \Delta i_{O,R} = 33{,}789.35 cfm \bullet .086 \frac{lb}{ft^3} \bullet 27.64 \frac{btu}{lb} \bullet 60 \frac{\min}{hr} = 4819118.2 \frac{btu}{hr}$$

$$\dot{Q}_{Tot} = \dot{Q}_{OA} + \dot{Q}_{Space} = 4819118.2 \frac{btu}{hr} + 974{,}746 \frac{btu}{hr} = 5{,}793{,}864.2 \frac{btu}{hr}$$

Summer:

$$\dot{Q}_{OA} = \dot{V}_{OA} \bullet \rho_{OA} \bullet \Delta i_{O,R} = 33{,}789.35 cfm \bullet .07 \frac{lb}{ft^3} \bullet 10.28 \frac{btu}{lb} \bullet 60 \frac{\min}{hr} = 1458889 \frac{btu}{hr}$$

$$\dot{Q}_{Tot} = \dot{Q}_{OA} + \dot{Q}_{Space} = 1{,}458{,}889 \frac{btu}{hr} + 873{,}483 \frac{btu}{hr} = 2{,}332{,}372 \frac{btu}{hr}$$

We can see that there is a possibility that the equipment is under sized!

The following table is an estimation of design conditions in the spaces based off of resulting humidity ratios. All floors except the ground floor are only monitored my thermostats therefore the relative humidity is a result of the mixed air conditions.

Building Conditions Assessment:

Cooling Season

Average Room T	Ave Room w	Ave RH
F Db	Gr/lb	%
75	67.13162168	5170.00%

Heating Season

Ave Room T	Ave Room w	Ave RH
F Db	Gr/Lb	%
75F	3.4	<10%

The resulting relative humidity for the heating season is *not* surprising! There is not humidifier section on the air handlers. Only mechanical and animal storage rooms receive humidification.

HVAC Equipment Descriptions and Modes of Operations

The Life Sciences Center uses a combination of 2 different types of applications. The first of which is a Constant Air Volume (CAV) used in conjunction with duct mounted reheat coils and duct mounted humidification units (See A.3). The rest of the building is treated with a Variable Air Volume Application (VAV) with terminal VAV/reheat boxes (See A.3). The CAV application is 100% outdoor air, there are three VAV units and 2 of which are 100% outdoor, the remaining unit uses return air as a method of heat recovery. The VAV supply fans are monitored by pressure sensors within the duct work that will reduce the fan speed when enough pressure builds due to VAV dampers closing at part load conditions.

The water side consisted of two air cooled chillers, two hot water boilers, pumping equipment and all associated hydronic specialties (compression tanks, air separators etc.) There is also a heat exchanger that services a loop specific for glycol solution preheat.

For a complete list of equipment and details please reference page A.1.

To analyze the modes of operation for each individual application we will proceed by the air handling unit. For airside analysis breaking the building down per AHU will give the clearest view into over all performance characteristics.

AHU-1

Services: Ground floor storage areas (See A.2)

Unit Type: Modular, Constant Air Volume, 100% OA

Supply Air: 55°F/100%RH (cooling and heating) with terminal reheat and humidification, 1510 cfm

(See A.1 for reheat and humidifier details)

Description of operation: When the unit is energized the supply fan will run at constant speed. Exhaust air is removed through EF-1a and b through the roof. At part load conditions the reheats are activated to adjust the local space supply temperature as needed. Reheats are controlled by local T-stat (adjustable) and humidifiers are controlled by local humidistat. The unit has a freezestat located in the OA duct to trigger the unit to de-energize in the event of frost formation. When de-energized the OA damper will close and coil valves modulate to full bypass. When economization mode is engaged the supply fan will run full speed and coil valves will modulate to full bypass.

AHU-2

Services: First floor (See Space Load Calculations Work Sheet)

Unit Type: Modular, Variable Air Volume, Return Air (33%OA)

Supply Air: 55°F/100%RH (cooling and heating) with terminal reheat and volume dampers, 7695 cfm

(See A.1 for terminal unit details)

Description of operation: When the unit is energized at design conditions the supply fan will run at maximum speed and coil valves will modulate to full open. General exhaust air is pumped through the return fan and then out a side wall louver. Lavatory exhaust is removed via EF-2 through the roof. Motor dampers in the duct work will determine the amount of air returned and exhausted as needed.

At part load conditions the local dampers will reduce air to the space and trigger the supply fan to reduce speed quadratically to maintain pressure (See page AHU-2). If space is still over heated or cooled once the damper hits the box minimum reheats are adjusted as needed to maintain set point. The terminal units are controlled by local T-stat (adjustable). The unit has a freezestat located in the OA duct to trigger the unit to de-energize in the event of frost formation. When de-energized the OA damper will close and coil valves modulate to full bypass. When economization mode is engaged the supply fan will run full speed and coil valves will modulate to full bypass. Return air damper will modulate fully closed and outdoor air damper will modulate to full open (enabling 100%OA)

AHU-3

Services: Second and Third and Second Floors (See Space Load Calculations Work Sheet)

Unit Type: Modular, Variable Air Volume, 100% OA

Supply Air: 55°F/100%RH (cooling and heating) with terminal reheat and volume dampers, 23,040 cfm

(See A.1 for terminal unit details)

Description of operation: When the unit is energized at design conditions the supply fan will run at maximum speed and coil valves will modulate to full open. All general exhaust is removed via EF-1a and b. Lavatory and storage exhaust is removed via EF-2. At part load conditions the local dampers will reduce air to the space and trigger the supply fan to reduce speed quadratically to maintain pressure (See page AHU-3). If space is still over heated or cooled once the damper hits the box minimum reheats are adjusted as needed to maintain set point. The terminal units are controlled by local T-stat (adjustable). The unit has a freezestat located in the OA duct to trigger the unit to de-energize in the event of frost formation. When de-energized the OA damper will close and coil valves modulate to full bypass. When economization mode is engaged the supply fan will run full speed and coil valves will modulate to full bypass.

AHU-4

Services: Second and Third and Second Floors (See A.2)

Unit Type: Modular, Variable Air Volume, 100% OA

Supply Air: 55°F/100%RH (cooling and heating) with terminal reheat and volume dampers, 23,040 cfm

(See A.1 for terminal unit details)

Description of operation: When the unit is energized at design conditions the supply fan will run at maximum speed and coil valves will modulate to full open. All general exhaust is removed via EF-1a and b as well as EF-3. At part load conditions the local dampers will reduce air to the space and trigger the supply fan to reduce speed quadratically to maintain pressure (See A.3). If space is still over heated or cooled once the damper hits the box minimum reheats are adjusted as needed to maintain set point. The terminal units are controlled by local T-stat (adjustable). The unit has a freezestat located in the OA duct to trigger the unit to de-energize in the event of frost formation. When de-energized the OA damper will close and coil valves modulate to full bypass. When economization mode is engaged the supply fan will run full speed and coil valves will modulate to full bypass.

Chillers 1 and 2

When the system calls for cooling, chillers 1 and 2 will energize in a lead-lag manner. The pumps are variable speed and controlled by pressure sensors upstream (See A.5). Chiller water is treated with a glycol solution then sent to the AHU cooling coils.

Boilers 1 and 2

When the system calls for heating boilers 1 and 2 will energize in a lead-lag manner. Hot water is treated with glycol solution and then sent to the required load. Pumps are run at constant speed (See A.4).

For specific details on refrigeration and hot water boiler units please reference the Equipment Listings Appendix.

System Evaluation/Conclusion

- The existing HVAC system for The Charles E. and Mary Parente Life Sciences Center may be undersized in both cooling and heating applications. It appears that the cooling and heating plants are not large enough to meet the actual total load at the design conditions specified per schedule.

- Auxiliary humidification device is required for the entire building. Probably the quickest remedy would be to use a humidification module in the air handlers themselves.

- Ventilation requirements are clearly met, unfortunately there is not method of heat recovery besides a mixing box on one of the air handling units.

- Application of dedicated outdoor air unit would be more appropriate

- Ductwork and equipment location is agreeable.

- Elimination of the cabinet unit heaters in the entrance vestibules in exchange for integration with the air system to avoid an extra piece of equipment would be favorable.

- Indoor Air Quality is probably not an issue due to the excessive amount of ventilation air supplied to the building. However actual internal (contaminant) source amounts and types are not known.

The following is tabulation of existing equipment, the information provided is **not** a copy of design schedules:

Air Handling Units: All units are have a provided econimization mode

Tag	Air Flow	Cooling Coil	Heating Coil	Type	Basis Of Design	%OA
	cfm	MBH	MBH			
AHU-1	1510	103.2	89.6	CAV	Trane HDTU 03B	100
AHU-2	7695	314.2	637	VAV	Trane HDTU 14B	33
AHU-3	23,040	1575.2	1368.4	VAV	Trane HBTU 50B	100
AHU-4	5700	389.7	338.5	VAV	Trane HBTU 12B	100

Terminal VAV Supply Units (HW reheat and damper only)

Tag	Air Flow	Air Pressure Drop	Air Temp Rise	Water Flow	Basis of Design
	cfm	in. H2O	°F	gpm	
S001	250-100	0.29	20	1.1	Trane 03
S018	760	0.25	20	3.3	Trane 11
S101	1200-180	0.24	20	5.2	Trane 17
S104	680-275	0.7	20	2.9	Trane 06
S107	290-115	0.37	20	1.3	Trane 03
S109	230-95	0.25	20	1	Trane 03
S110	200-80	0.19	20	0.9	Trane 03
S111	400-160	0.28	20	1.7	Trane 06
S112	225-90	0.24	20	1	Trane 03
S113	80-40	0.1	20	0.4	Trane 03
S114	450-180	0.35	20	0.5	Trane 06
S115	120-50	0.1	20	0.5	Trane 03
S117	120-50	0.1	20	0.5	Trane 03
S118	1130-285	0.69	See RH-118		Phoenix MAV 12
S119	215-215	0.22	20	0.9	Trane 03
S120	150-60	0.12	20	0.7	Trane 03
S124	375-230	0.28	20	1.6	Trane 06
S125	390-160	0.27	20	1.7	Trane 06
S127	430-175	0.32	20	1.9	Trane 06
S201	2260-570	0.69	See RH-203		Phoenix MAV 12
S203	270	0.28	20	1.1	Trane 03
S204	450-115	0.63	See RH-203		Phoenix MAV 10
S205	650	0.62	20	2.7	Trane 06
S206A	1130-285	0.69	See RH-206A		Phoenix MAV 12
S206B	1130-285	0.69	See RH-206B		Phoenix MAV 12
S207	480	0.32	20	1.9	Trane 06
S209A	1130-285	0.69	See RH-209A		Phoenix MAV 12
S209B	1130-285	0.69	See RH-209B		Phoenix MAV 12
S210	480	0.32	20	1.9	Trane 06
S212A	1130-285	0.69	See RH-212A		Phoenix MAV 12
S212B	1130-285	0.69	See RH-212B		Phoenix MAV 12
S218	270-110	0.33	20	1.2	Trane 03
S219A	150-40	0.12	20	0.7	Trane 03
S219B	150-40	0.12	20	0.7	Trane 03
S220	430-175	0.32	20	1.9	Trane 06
S301	690-175	0.67	See RH-301		Phoenix MAV 10
S302	640-255	0.66	20	2.8	Trane 06
S304	470-120	0.65	See RH-304		Phoenix MAV 10
S305	640-250	0.66	20	2.8	Trane 06
S307	470-120	0.65	See RH-307		Phoenix MAV 10
S308	640-250	0.66	20	1.1	Trane 06
S310	470-120	0.65	See RH-310		Phoenix MAV 10
S311	320-130	0.44	20	0.6	Trane 03
S313	440-175	0.33	20	1.9	Trane 06
S314A	1130-285	0.69	See RH-314A		Phoenix MAV 12
S314B	1130-285	0.69	See RH-314B		Phoenix MAV 12
S315	240	0.27	20	1	Trane 03
S316	260	0.31	20	1.1	Trane 03
S318	180	0.16	20	0.8	Trane 03
S319	970-390	0.64	See RH-319		Phoenix MAV 12
S320	300	0.4	20	1.3	Trane 03
S324	300-120	0.4	20	0.5	Trane 03
S229A	200-50	0.19	20	0.8	Trane 03
S229B	200-50	0.19	20	0.8	Trane 03
S333	200-80	0.5	See RH-333		Phoenix MAV 10
S334	440-170	0.63	See RH-334		Phoenix MAV 10
S335	340-135	0.6	See RH-335		Phoenix MXV 10
S401	110-40	0.1	20	0.4	Trane 03
S402	800-320	0.3	20	3.5	Trane 11
S403	800-390	0.3	20	3.5	Trane 11
S404	2400-960	0.26	20	10.4	Trane 32
S405	1600-640	0.17	20	6.9	Trane 17

Terminal VAV Exhaust Regulation Units

Tag	Air Flow	Air Pressure Drop	Basis of Design
	cfm	in. H2O	
E010	930	0.11	Trane 11
E004	835	0.08	Trane 11
E012B	635	0.36	Trane 06
E118	1250-315	0.7	Phoenix EXV 12
E119	240	0.25	Trane 03
E201A	1250-315	0.7	Phoenix EXV 12
E201B	1250-315	0.7	Phoenix EXV 12
E203	270	0.25	Trane 03
E204	450-115	0.63	Phoenix EXV 10
E205	680	0.38	Trane 06
E206A	1250-315	0.7	Phoenix EXV 12
E206B	1250-315	0.7	Phoenix EXV 12
E207	480	0.2	Trane 06
E209A	1250-315	0.7	Phoenix EXV 12
E209B	1250-315	0.7	Phoenix EXV 12
E210	480	0.2	Trane 06
E212A	1250-315	0.7	Phoenix EXV 12
E212B	1250-315	0.7	Phoenix EXV 12
E301	760-190	0.68	Phoenix EXV 10
E304	760-190	0.68	Phoenix EXV 10
E307	760-190	0.68	Phoenix EXV 10
E210	760-190	0.68	Phoenix EXV 10
E314A	1250-315	0.7	Phoenix EXV 12
E314B	1250-315	0.7	Phoenix EXV 12
E315	265	0.24	Trane 03
E316	285	0.28	Trane 03
E318	200	0.14	Trane 03
E319	880-350	0.78	Phoenix EXV 10
E320	270	0.25	Trane 03
E333	200-80	0.5	Phoenix EXV 10
E334	420-170	0.62	Phoenix EXV 10
E335	340-135	0.6	Phoenix EXV 10
E402	800-320	0.04	Trane 03
E403	800-320	0.14	Trane 17
E404	2400-960	0.26	Trane 32
E405	1600-640	0.1	Trane 03

Exhaust/Relief Fans

Tag	Air Flow	Type	Fan RPM	Basis Of Design
EF-1A	15,125	SW	682	Trane CBID 33
EF-1B	15,125	SW	682	Trane CBID 33
EF-2	2090	SW	1661	Trane CBID 33
EF-3	5000	Dome		Penn CB18
EF-4	2100	Dome		Penn BB45
RF-1	5380	SW	835	Trane CUBA 24

* SW - Side Wall

Compression Tanks:

Tag	Volume	Fill Pressure	Basis of Design
	m^3	psi	
T-1	110	12	Amtrol AX-200
T-2	77	12	Amtrol AX-144
T-3	77	12	Amtrol AX-114

Heat Exchanger (Water to Glycol):

Tag	Water Flow	Glycol Flow
	gpm	gpm
HX-1	220	240

Duct Mounted Reheat Coils:

Tag	Air Flow	Water Flow	Air Pressure Drop	Air Temp Rise
	cfm	gpm	in H2O	°F
RH010	265	1.1	0.08	20
RH011	265	1.1	0.08	20
RH012A	100	0.5	0.05	20
RH012B	230	1	0.09	20
RH013	500	2.2	0.09	20
RH014	75	0.3	0.05	20
RH015	75	0.3	0.05	20
RH118	1130	4.8	0.15	20
RH201	2260	9.8	0.13	20
RH204	450	1.9	0.08	20
RH206A	1130	4.8	0.15	20
RH206B	1130	4.8	0.15	20
RH209A	1130	4.8	0.15	20
RH209B	1130	4.8	0.15	20
RH212A	1130	4.8	0.15	20
RH212B	1130	4.8	0.15	20
RH301	690	3	0.11	20
RH304	470	2	0.1	20
RH307	470	2	0.1	20
RH310	470	2	0.1	20
RH314A	1130	4.8	0.15	20
RH314B	1130	4.8	0.15	20
RH319	970	4.2	0.11	20
RH333	200	0.8	0.1	20
RH334	440	1.9	0.15	20
RH335	340	1.5	0.1	20

Cabinet Unit Heaters (Hot Water):

Tag	Air Flow	Fan RPM	Water Flow	Air Temp Rise	Load	Basis of Design
	cfm		gpm	°F	Mbh	
CAB-1	600	1075	3.2	50	32	Trane
CAB-2	600	1075	3.2	50	32	Trane
CAB-3	600	1075	3.2	50	32	Trane

Diffusers, Registers and Grilles:

Tag	Size	Type	Basis of Design
D-1	24"x24"	Perferated	Titus
D-2	12"x12"	Perferated	Titus
D-3	4'-0"	Winter Slot	Anemostat
D-4	24"x24"	Lay-In	Krueger
D-5	21"x36"	Louver	Titus
R-1		Sidewall	Titus
R-2	24"x48"	Perferated	Titus
R-3	12"x12"	Perferated	Titus
R-4	24"x24"	Perferated	Titus
R-5	21"x36"	Louver	Titus
G-1		Perferated	Titus

Pumps:

Tag	Flow Rate	Total Head
	gpm	ft. of H20
P-1A	341	65
P-1B	341	65
P-2A	240	60
P-2B	240	60
P-3	30	45
P-4A	158	55
P-4B	158	55
P-5	517	65
P-6	517	40

Hot Water Boiler:

Tag	Fuel	Input	Water Flow
		Mbh	gpm
B-1	Gas	3753	261
B-2	Gas	3753	261

Electric Humidifiers:

Tag	Capacity	Basis of Design
	Lb/Hr	
H010	20	Nortec NHMC
H011	20	Nortec NHMC
H012A	10	Nortec NHMC
H12B	20	Nortec NHMC
H013	30	Nortec NHMC
H014	10	Nortec NHMC
H015	10	Nortec NHMC
H402	30	Nortec NHMC
H403	30	Nortec NHMC
H404	100	Nortec NHMC
H405	75	Nortec NHMC

Fin-Tube Radiator

Tag	Load/Ft	Water Temp Drop	Basis of Design
	Btuh/ft	°F	
FT-1	1145	20	Trane
FT-2	1145	20	Trane

Hot Water Unit Heater:

Tag	Air Flow	Water Flow	Air Temp Rise
	cfm	gpm	°F
UH-1	591	2	30
UH-2	2381	12	43

Air Cooled Chillers:

Tag	Capacity	Water Flow	Compressor Type
	Tons	gpm	
CH-1	110	257	Scroll
CH-2	110	257	Scroll

Basis of Design
Weil Mclain
Weil Mclain

Load
Mbh
19.1
115.3

Basis Of Design
Trane CGACD
Trane CGACD

Charles E. and Mary Parente Life Sciences Building, Kings College, Wilkes-Barre Pa.

Design Cooling and Heating/Humidification Load Analysis

The following tables are a tabulation of each space load in the Life Science Center. The load is calculated based on sensible and total considerations. The method of calulation is the basic energy balance about the space : **Q(tot)=m(dot)*(Delta i)** where **(Delta i)** signifies the difference in enthalpy between supply air and room air. The sensible load will be calculated using the same equation by substituting **Cp(Delta T)** for **(Delta i)**. This adjustment will calculate the change in energy with constant humidity ratio, thus sensible only. The latent portion is calculated by using the equation **Q(l)=.64*(Vdot)*(Delta w)**. **(Delta w)** being the difference in humidity ratio between room and supply air.

Cooling

Ground Floor: The ground floor latent loads were estimated since the spaces are all storage types.

Room	Space Type	Design Room T	Design Room w	Design Supply T	Design Supply w	Supply Flow	Sensible Load	Latent Load	Total Load
		F Db	Gr/Lb	F Db	Gr/Lb	cfm	Btu/Hr	Btu/Hr	Btu.Hr
1	Lobby	75	64.89	55	64.59	250	5400	48	5448
18 & 6	Corridor	75	64.89	55	64.59	720	15552	138.24	15690.24
10	Rat Storage	75	64.89	55	64.59	265	5724	50.88	5774.88
11	Mice	75	64.89	55	64.59	265	5724	50.88	5774.88
12a	Wash	75	64.89	55	64.59	100	2160	19.2	2179.2
12b	Feed	75	64.89	55	64.59	230	4968	44.16	5012.16
13	Vestubule	75	64.89	55	64.59	350	7560	67.2	7627.2
14	Frogs	75	64.89	55	64.59	75	1620	14.4	1634.4
15	Rabits	75	64.89	55	64.59	75	1620	14.4	1634.4

First Floor: First floor HVAC application is only monitered by T-Stats. Therefore the latent load will be calculated by (population*205btu/hr) And then using the equation above we will determine the resulting room humidity ratio.

Room	Space Type	Design Room T	Resulting Room w	Design Supply T	Design Supply w	Supply Flow	Sensible Load	Latent Load	Total Load
		F Db	Gr/Lb	F Db	Gr/Lb	cfm	Btu/Hr	Btu/Hr	Btu.Hr
101	Seminar	75.00	72.60	55.00	64.59	1200.00	25920.00	6150.00	32070.00
103	Storage	75.00	64.59	55.00	64.59	160.00	3456.00	0.00	3456.00
104	Office	75.00	66.80	55.00	64.59	145.00	3132.00	205.00	3337.00
105	Office	75.00	65.98	55.00	64.59	230.00	4968.00	205.00	5173.00
106	Office	75.00	66.80	55.00	64.59	145.00	3132.00	205.00	3337.00
107	Office	75.00	66.80	55.00	64.59	145.00	3132.00	205.00	3337.00
108	Office	75.00	66.80	55.00	64.59	145.00	3132.00	205.00	3337.00
109	Office	75.00	65.98	55.00	64.59	230.00	4968.00	205.00	5173.00
110	Copy/Storage	75.00	66.19	55.00	64.59	200.00	4320.00	205.00	4525.00
111	Classroom	75.00	76.60	55.00	64.59	400.00	8640.00	3075.00	11715.00
112	Observation	75.00	66.01	55.00	64.59	225.00	4860.00	205.00	5065.00
113	Observation	75.00	68.59	55.00	64.59	80.00	1728.00	205.00	1933.00
114	Classroom	75.00	77.40	55.00	64.59	500.00	10800.00	4100.00	14900.00
115	Observation	75.00	69.93	55.00	64.59	60.00	1296.00	205.00	1501.00
116	Observation	75.00	69.93	55.00	64.59	60.00	1296.00	205.00	1501.00
117	Observation	75.00	67.26	55.00	64.59	120.00	2592.00	205.00	2797.00
118	Lab	75.00	70.26	55.00	64.59	1130.00	24408.00	4100.00	28508.00
119	Observation	75.00	65.92	55.00	64.59	240.00	5184.00	205.00	5389.00
120	Observation	75.00	66.73	55.00	64.59	150.00	3240.00	205.00	3445.00
124	Lobby	75.00	66.42	55.00	64.59	175.00	3780.00	205.00	3985.00
125126	Corridor	75.00	64.59	55.00	64.59	390.00	8424.00	0.00	8424.00
127	Lounge	75.00	72.04	55.00	64.59	430.00	9288.00	2050.00	11338.00

Fourth Floor:	Fourth floor HVAC application is only monitered by T-Stats. Therefore the latent load will be calculated by (population*205btu/hr). Then using the equation above we will determine the resulting room humidity ratio.								
Room	Space Type	Design Room T	Resulting Room w	Design Supply T	Design Supply w	Supply Flow	Sensible Load	Latent Load	Total Load
		F Db	Gr/Lb	F Db	Gr/Lb	cfm	Btu/Hr	Btu/Hr	Btu.Hr
401	Lobby	75.00	64.59	55.00	64.59	200.00	4320.00	0.00	4320.00
402	Headhouse	75.00	66.59	55.00	64.59	800.00	17280.00	1025.00	18305.00
403	Growth Area	75.00	66.59	55.00	64.59	800.00	17280.00	1025.00	18305.00
404	Growth Area	75.00	65.26	55.00	64.59	2400.00	51840.00	1025.00	52865.00
405	Growth Area	75.00	65.73	55.00	64.59	1400.00	30240.00	1025.00	31265.00

Cooling Totals:

Total Sensible	**Total Latent**	**Total**	**SHF**
Btu/hr	**Btu/hr**	**Btu/hr**	
806004	**67482.36**	**873486.36**	**0.92**

Note: Exact room design conditions are not known. But based off of the given supply air conditions it apears that 75F dry bulb at 50%RH was the basis of design. In order to achieve a lower drybulb temperature with a reasonable RH the air handlers would have to cool to sub 55F DB then reheat back to 55F DB to achieve greater dehumidification capacity.

Heating

Ground Floor:					
Room	Space Type	Design Room T	Design Supply T	Supply Flow	Sensible Load
		F Db	F Db	cfm	Btu/Hr
1	Lobby	75	95	250	5400
4 (UH)	Trash	60	90	591	19148.4
5 (UH)	Trash	60	90	591	19148.4
18 & 6	Corridor	75	95	720	15552
7 (UH)	Water	60	90	591	19148.4
9 (UH)	Electrical	60	90	591	19148.4
10	Rat Storage	75	95	265	5724
11	Mice	75	95	265	5724
12a	Wash	75	95	100	2160
12b	Feed	75	95	230	4968
13	Vestubule	75	95	350	7560
14	Frogs	75	95	75	1620
15	Rabits	75	95	75	1620
16 (UH)	Fan Room	60	90	591	19148.4

First Floor:

Room	Space Type	Design Room T	Design Supply T	Supply Flow	Sensible Load
		F Db	F Db	cfm	Btu/Hr
101	Seminar	75.00	95.00	1200.00	25920.00
101 (FT)					13000.00
103	Storage	75.00	95.00	160.00	3456.00
103 (FT)					1500.00
104	Office	75.00	95.00	145.00	3132.00
104 (FT)					1500.00
105	Office	75.00	95.00	230.00	4968.00
105 (FT)					2000.00
106	Office	75.00	95.00	145.00	3132.00
106 (FT)					1500.00
107	Office	75.00	95.00	145.00	3132.00
107 (FT)					1500.00
108	Office	75.00	95.00	145.00	3132.00
108 (FT)					
109	Office	75.00	95.00	230.00	4968.00
109 (FT)					2000.00
110	Copy/Storage	75.00	95.00	200.00	4320.00
111	Classroom	75.00	95.00	400.00	8640.00
112	Observation	75.00	95.00	225.00	4860.00
112 (FT)					2000.00
113	Observation	75.00	95.00	80.00	1728.00
114	Classroom	75.00	95.00	500.00	10800.00
115	Observation	75.00	95.00	60.00	1296.00
116	Observation	75.00	95.00	60.00	1296.00
117	Observation	75.00	95.00	120.00	2592.00
118	Lab	75.00	95.00	1130.00	24408.00
119	Observation	75.00	95.00	240.00	5184.00
120	Observation	75.00	95.00	150.00	3240.00
124	Lobby	75.00	95.00	175.00	3780.00
125126	Corridor	75.00	95.00	390.00	8424.00
127 (FT)	Lounge				12000.00
127		75.00	95.00	430.00	9288.00

Second Floor:

Room	Space Type	Design Room T	Design Supply T	Supply Flow	Sensible Load
		F Db	F Db	cfm	Btu/Hr
201	Lab	75.00	95.00	2260.00	48816.00
202	Prep	75.00	95.00	375.00	8100.00
203	Equipment	75.00	95.00	270.00	5832.00
204	Autoclave	75.00	95.00	450.00	9720.00
205	Dark Room	75.00	95.00	280.00	6048.00
206	Lab	75.00	95.00	2260.00	48816.00
207	Prep	75.00	95.00	280.00	6048.00
208	Equipment	75.00	95.00	200.00	4320.00
209	Lab	75.00	95.00	2260.00	48816.00
210	Prep	75.00	95.00	240.00	5184.00
211	Equipment	75.00	95.00	240.00	5184.00
212	Lab	75.00	95.00	2260.00	48816.00
218	Office	75.00	95.00	270.00	5832.00
219	Corridor	75.00	95.00	300.00	6480.00
220	Lounge				12000.00
220		75.00	95.00	430.00	9288.00

Third Floor:

Room	Space Type	Design Room T	Design Supply T	Supply Flow	Sensible Load
		F Db	F Db	cfm	Btu/Hr
301	Lab	75.00	95.00	690.00	14904.00
302	Office	75.00	95.00	320.00	6912.00
302 (FT)					1500.00
303	Office	75.00	95.00	320.00	6912.00
303 (FT)					1500.00
304	Lab	75.00	95.00	470.00	10152.00
305	Office	75.00	95.00	320.00	6912.00
305 (FT)					1500.00
306	Office	75.00	95.00	320.00	6912.00
306 (FT)					1500.00
307	Lab	75.00	95.00	470.00	10152.00
308	Office	75.00	95.00	320.00	6912.00
308 (FT)					1500.00
309	Office	75.00	95.00	320.00	6912.00
309 (FT)					1500.00
310	Lab	75.00	95.00	470.00	10152.00
311	Office	75.00	95.00	320.00	6912.00
311 (FT)					3000.00
313	Lounge	75.00	95.00	440.00	9504.00
313 (FT)					12000.00
314	Lab	75.00	95.00	2260.00	48816.00
315	Prep	75.00	95.00	240.00	5184.00
316	Equipment	75.00	95.00	260.00	5616.00
318	Prep	75.00	95.00	180.00	3888.00
319	Lab	75.00	95.00	970.00	20952.00
320	Lab	75.00	95.00	300.00	6480.00
324	Office	75.00	95.00	300.00	6480.00
329	Corridor	75.00	95.00	400.00	8640.00
334	Telecom	75.00	95.00	260.00	5616.00
335	Lab	75.00	95.00	500.00	10800.00

Fourth Floor:

Room	Space Type	Design Room T	Design Supply T	Supply Flow	Sensible Load
		F Db	F Db	cfm	Btu/Hr
401	Lobby	75.00	95.00	200.00	4320.00
402	Headhouse	75.00	95.00	800.00	17280.00
403	Growth Area	75.00	95.00	800.00	17280.00
404	Growth Area	75.00	95.00	2400.00	51840.00
405	Growth Area	75.00	95.00	1400.00	30240.00
406 (UH)	Mechanical	60.00	90.00	591.00	19148.40
406 (UH)	Mechanical	60.00	105.00	2381.00	115716.60

Heating Total: 974746 Btu/Hr

Note: The air handling units are only sized to heat the mixed air to 55F db. The reheat coils on all the terminal units are then sized to apply a 40F Delta T to supply at 95F to the spaces if need be. The designation UH signifies that that the space is serviced by a unit heater this implicitly implies that the "Supply Flow is actually a recirculation flow through the appliance. The designation (FT) signifies load through a fin tube radiator.

Humidification

Room	Space Type	Lb/Hr H2O
16	Mechanical	120
406	Mechanical	235
	Total:	**355 Lb/Hr**

Building Conditions Assessment:

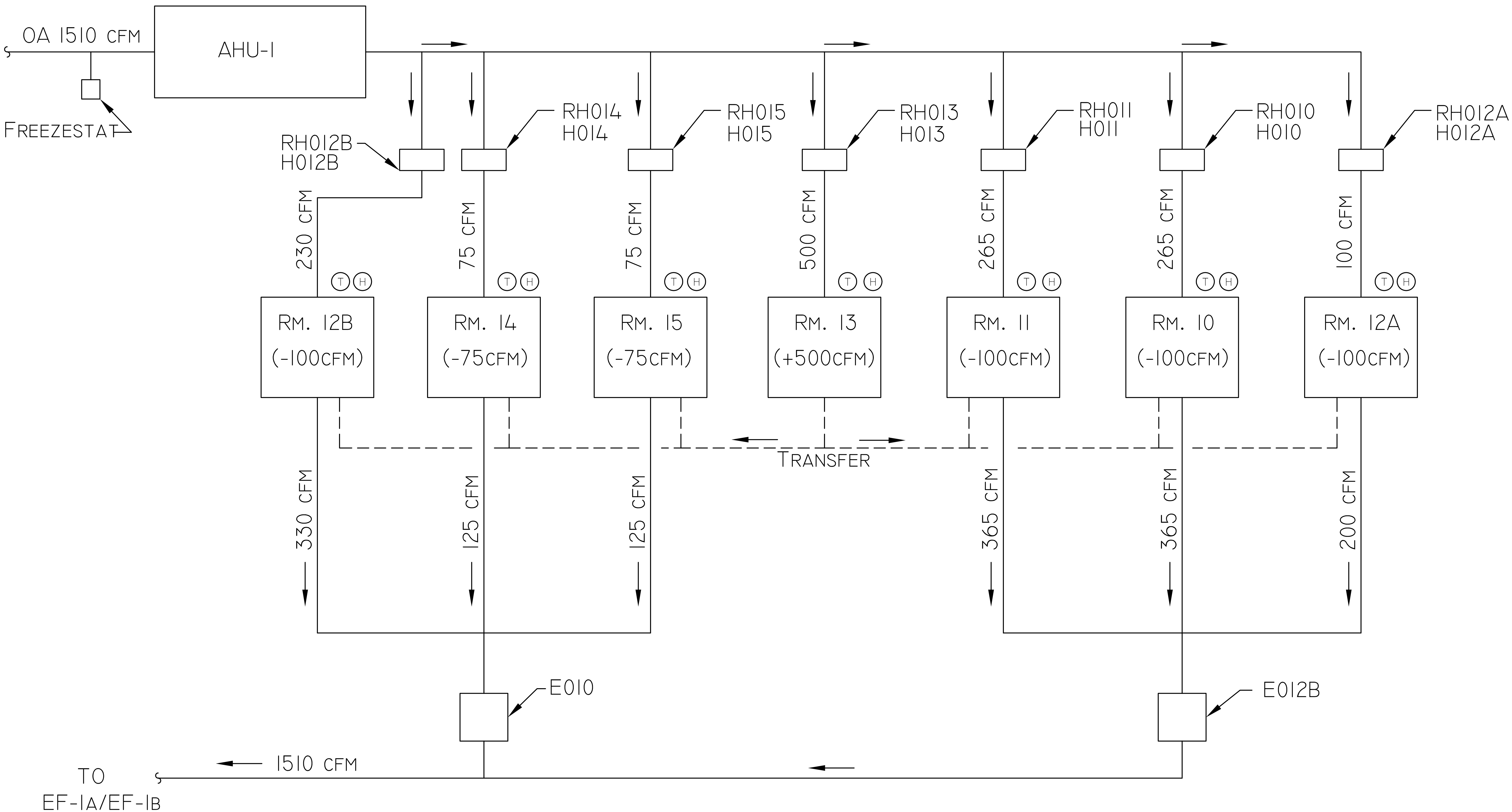
Cooling Season

Average Room T	Ave Room w	Ave RH
F Db	Gr/lb	%
75	67.13162168	5170.00%

Heating Season

Ave Room T	Ave Room w	Ave RH
F Db	Gr/Lb	%
75F	3.4	<10%

The humidity level durring the heating season brings alarm. Keep in mind that this building is serviced by 100% outside air units. The units do not have a humidification section scheduled. This maybe a scheduling typo.



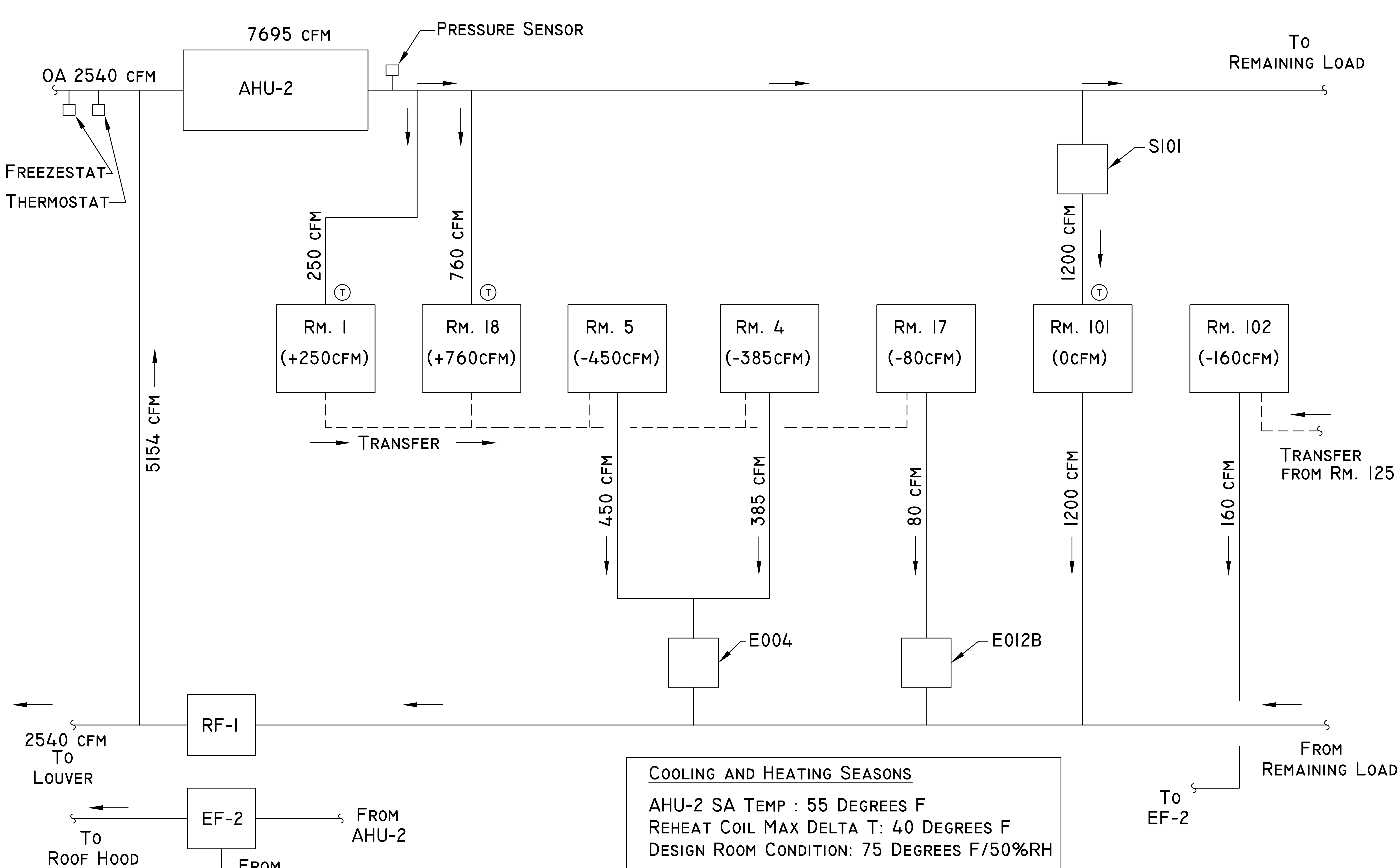
OA DESIGN CONDITIONS:

COOLING SEASON: 92FDB/75F WB
HEATING SEASON: 0FDB/60%RH

COOLING AND HEATING SEASONS

AHU-1 SA TEMP : 55 DEGREES F
REHEAT COIL MAX DELTA T: 40 DEGREES F
DESIGN ROOM CONDITION: 75 DEGREES F/50%RH

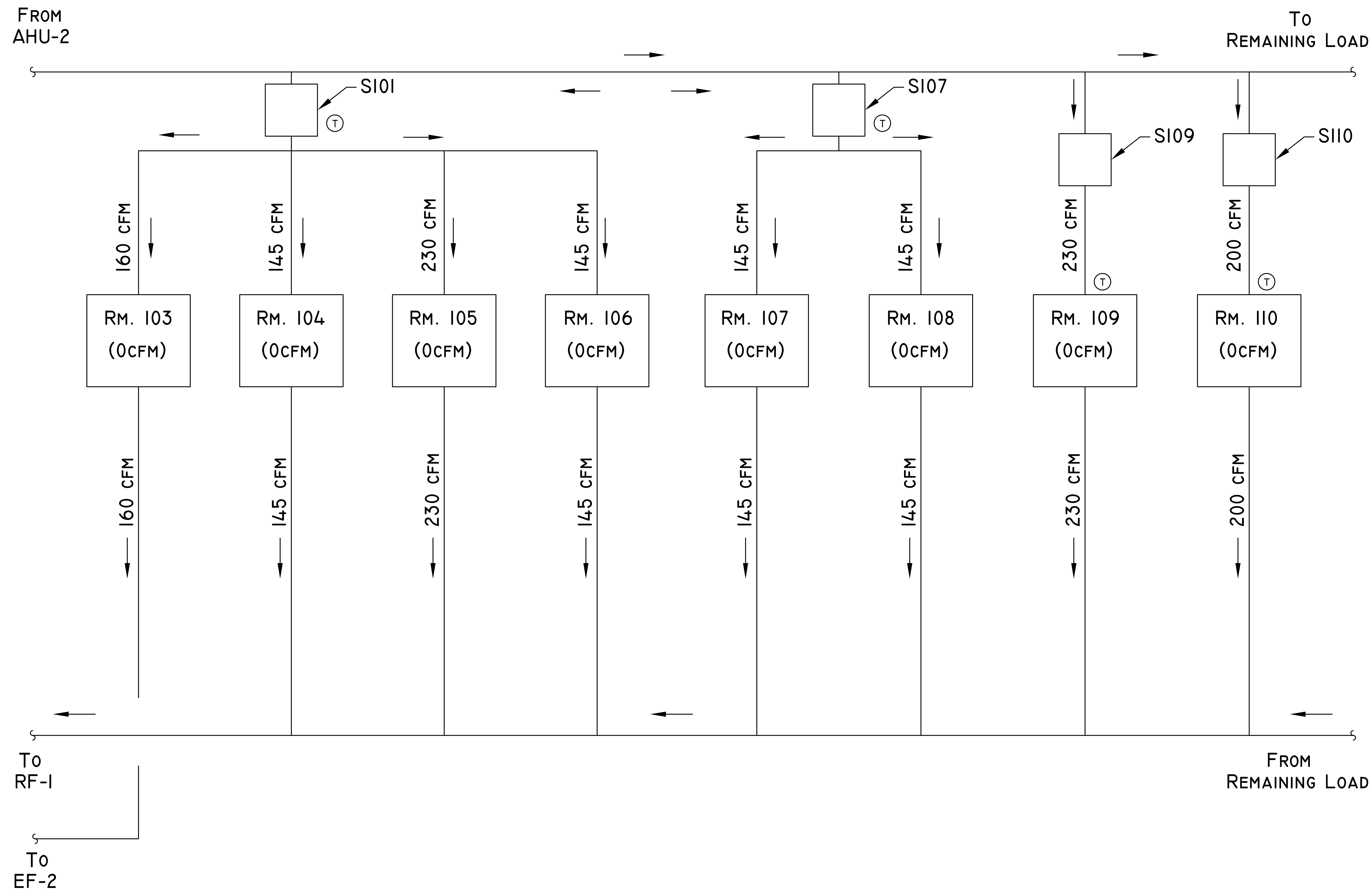
A.3) AHU-1/1



COOLING AND HEATING SEASONS

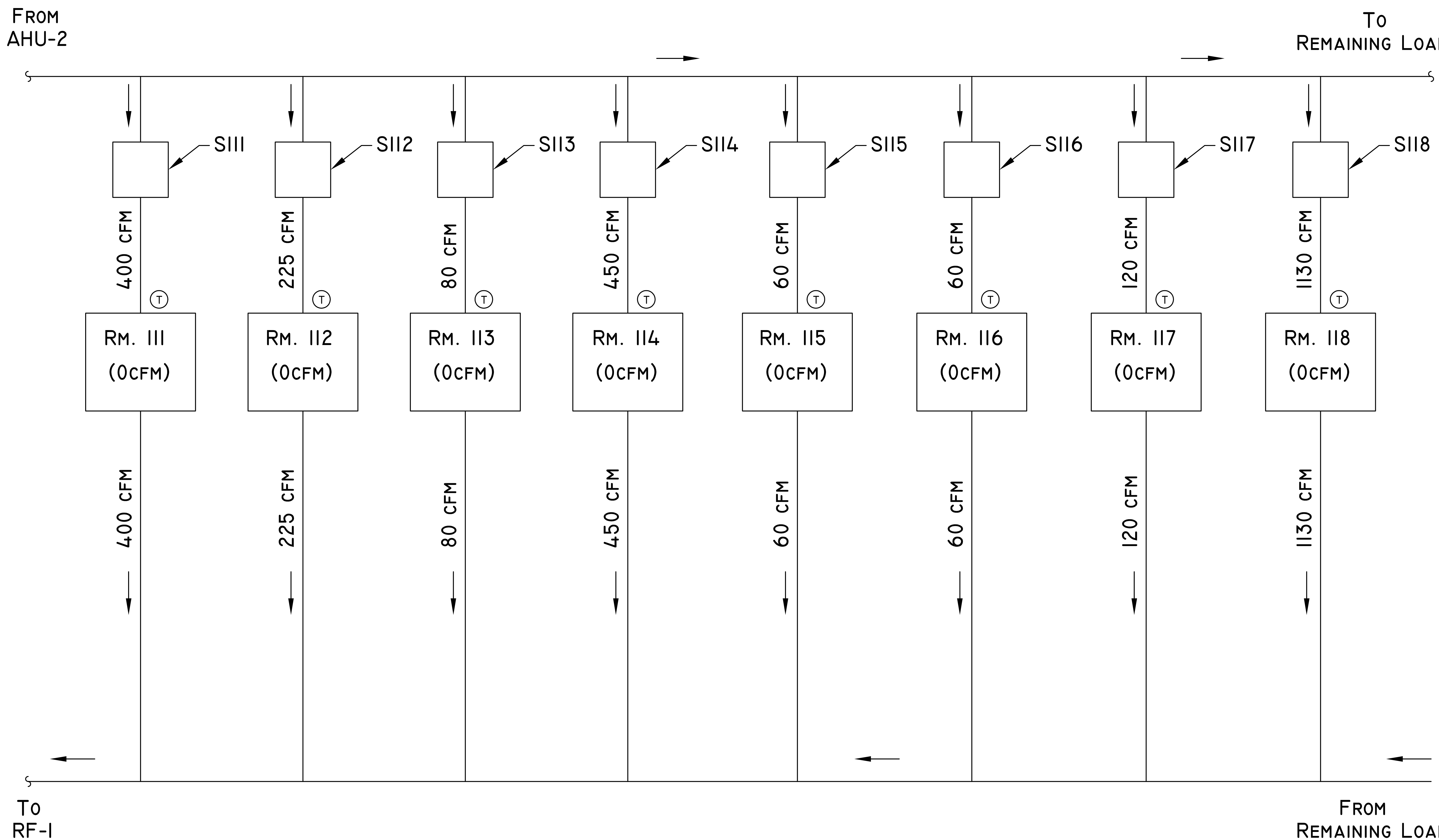
AHU-2 SA TEMP : 55 DEGREES F
REHEAT COIL MAX DELTA T: 40 DEGREES F
DESIGN ROOM CONDITION: 75 DEGREES F/50%RH

A.3) AHU-2/1

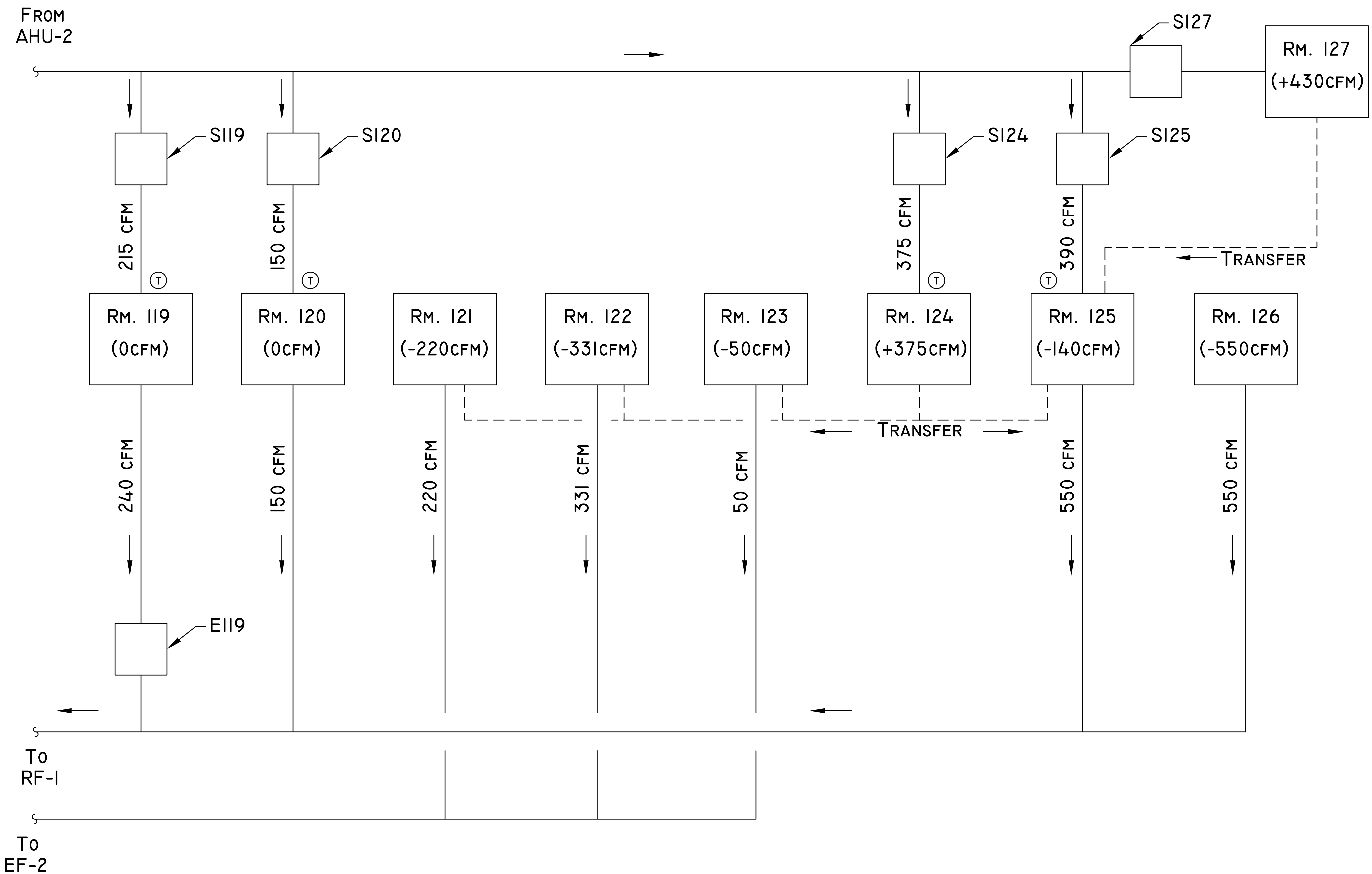


FROM AHU-2
TO REMAINING LOAD
S101
S107
S109
S110
160 CFM
145 CFM
230 CFM
145 CFM
145 CFM
145 CFM
230 CFM
200 CFM
RM. 103 (0CFM)
RM. 104 (0CFM)
RM. 105 (0CFM)
RM. 106 (0CFM)
RM. 107 (0CFM)
RM. 108 (0CFM)
RM. 109 (0CFM)
RM. 110 (0CFM)
160 CFM
145 CFM
230 CFM
145 CFM
145 CFM
145 CFM
230 CFM
200 CFM
TO RF-1
FROM REMAINING LOAD
TO EF-2

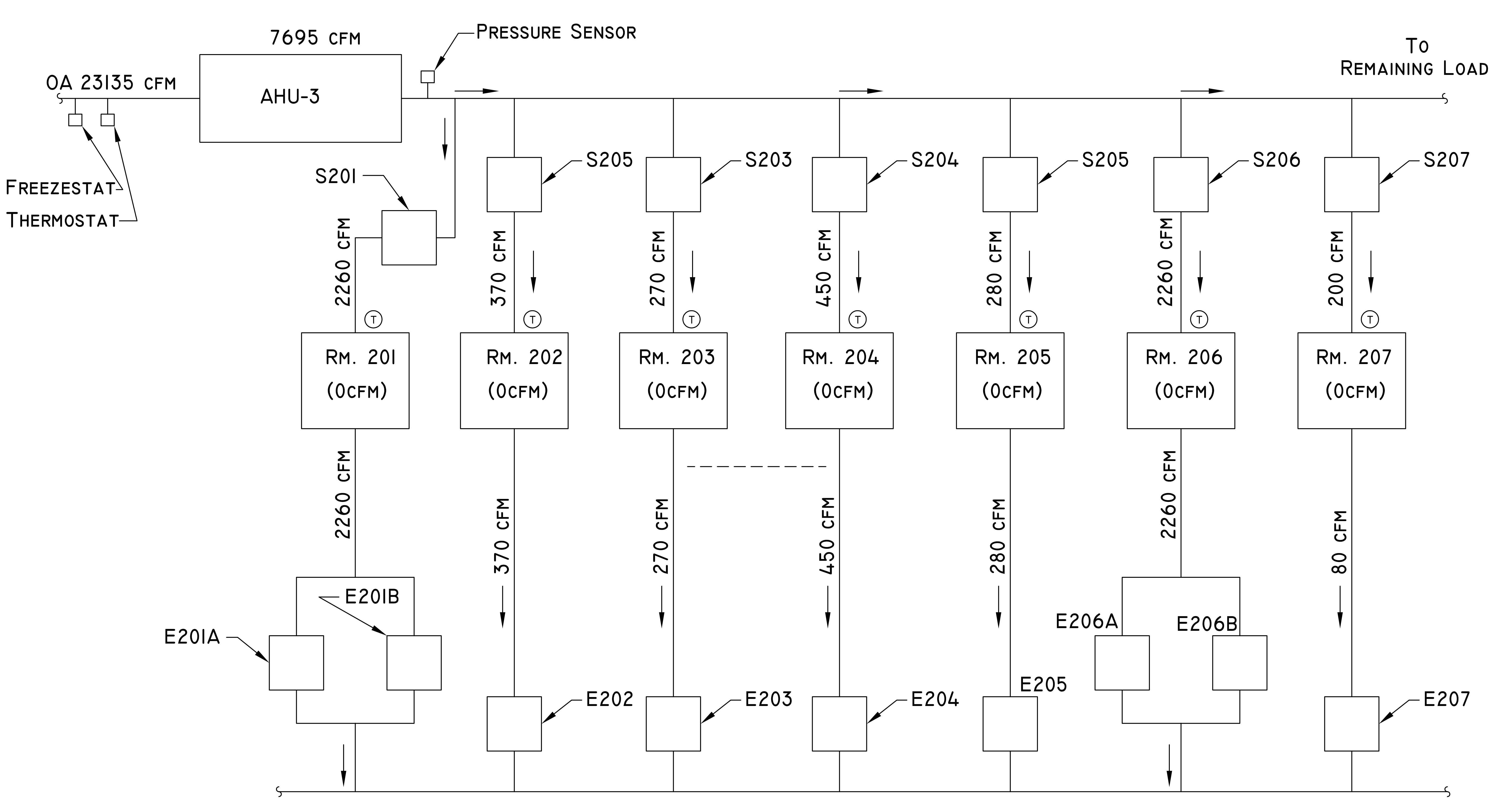
A.3) AHU-2/2


From AHU-2
To Remaining Load
S111
S112
S113
S114
S115
S116
S117
S118
400 CFM
225 CFM
80 CFM
450 CFM
60 CFM
60 CFM
120 CFM
1130 CFM
Rm. 111 (0CFM)
Rm. 112 (0CFM)
Rm. 113 (0CFM)
Rm. 114 (0CFM)
Rm. 115 (0CFM)
Rm. 116 (0CFM)
Rm. 117 (0CFM)
Rm. 118 (0CFM)
400 CFM
225 CFM
80 CFM
450 CFM
60 CFM
60 CFM
120 CFM
1130 CFM
To RF-1
From Remaining Load

A.3) AHU-2/3


FROM
AHU-2
S127
RM. 127
(+430CFM)
S119
S120
S124
S125
215 CFM
150 CFM
375 CFM
390 CFM
TRANSFER
RM. 119
(0CFM)
RM. 120
(0CFM)
RM. 121
(-220CFM)
RM. 122
(-331CFM)
RM. 123
(-50CFM)
RM. 124
(+375CFM)
RM. 125
(-140CFM)
RM. 126
(-550CFM)
TRANSFER
240 CFM
150 CFM
220 CFM
331 CFM
50 CFM
550 CFM
550 CFM
E119
TO
RF-1
TO
EF-2

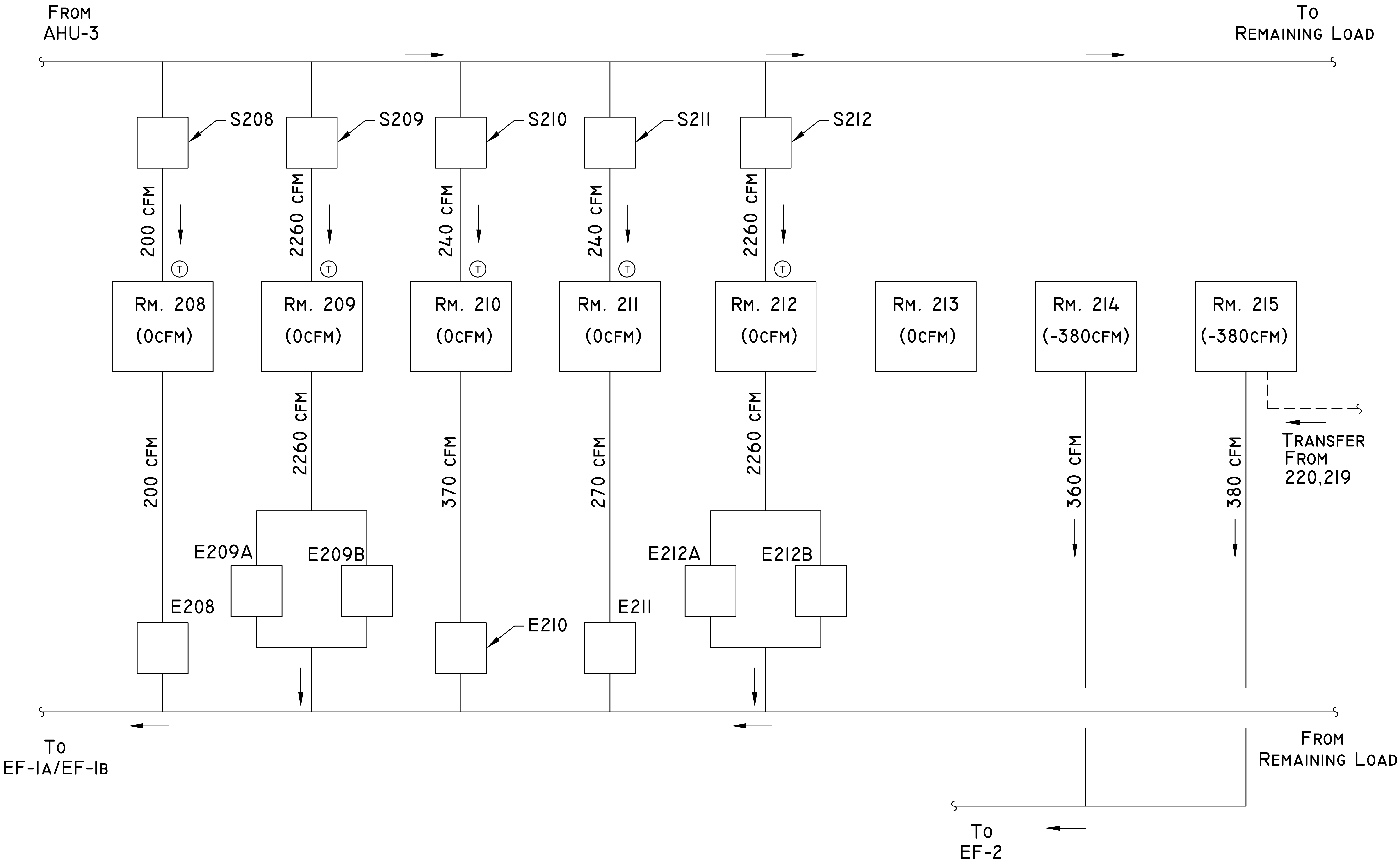
A.3) AHU-2/4



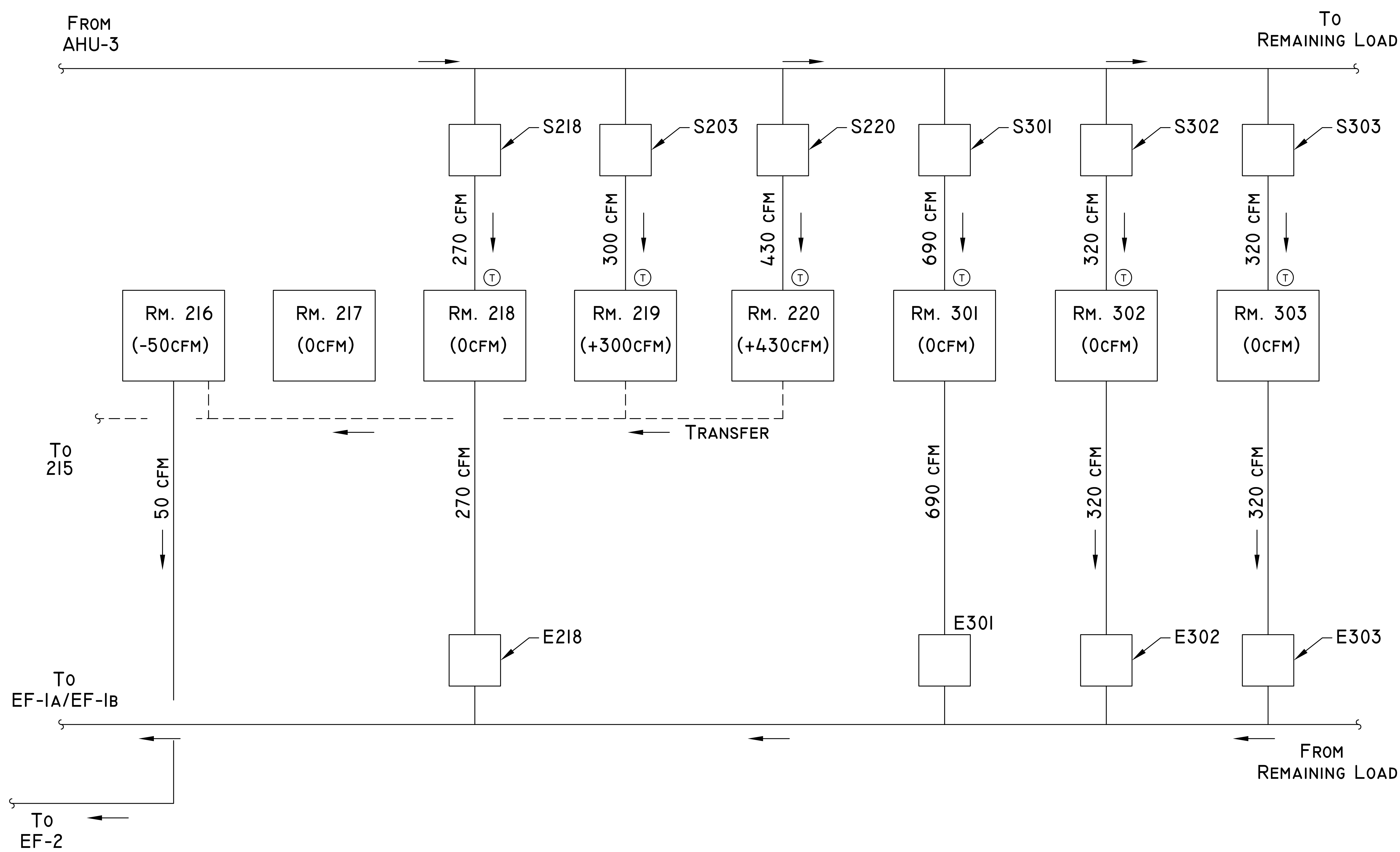
COOLING AND HEATING SEASONS

AHU-3 SA TEMP : 55 DEGREES F
REHEAT COIL MAX DELTA T: 40 DEGREES F
DESIGN ROOM CONDITION: 75 DEGREES F/50%RH

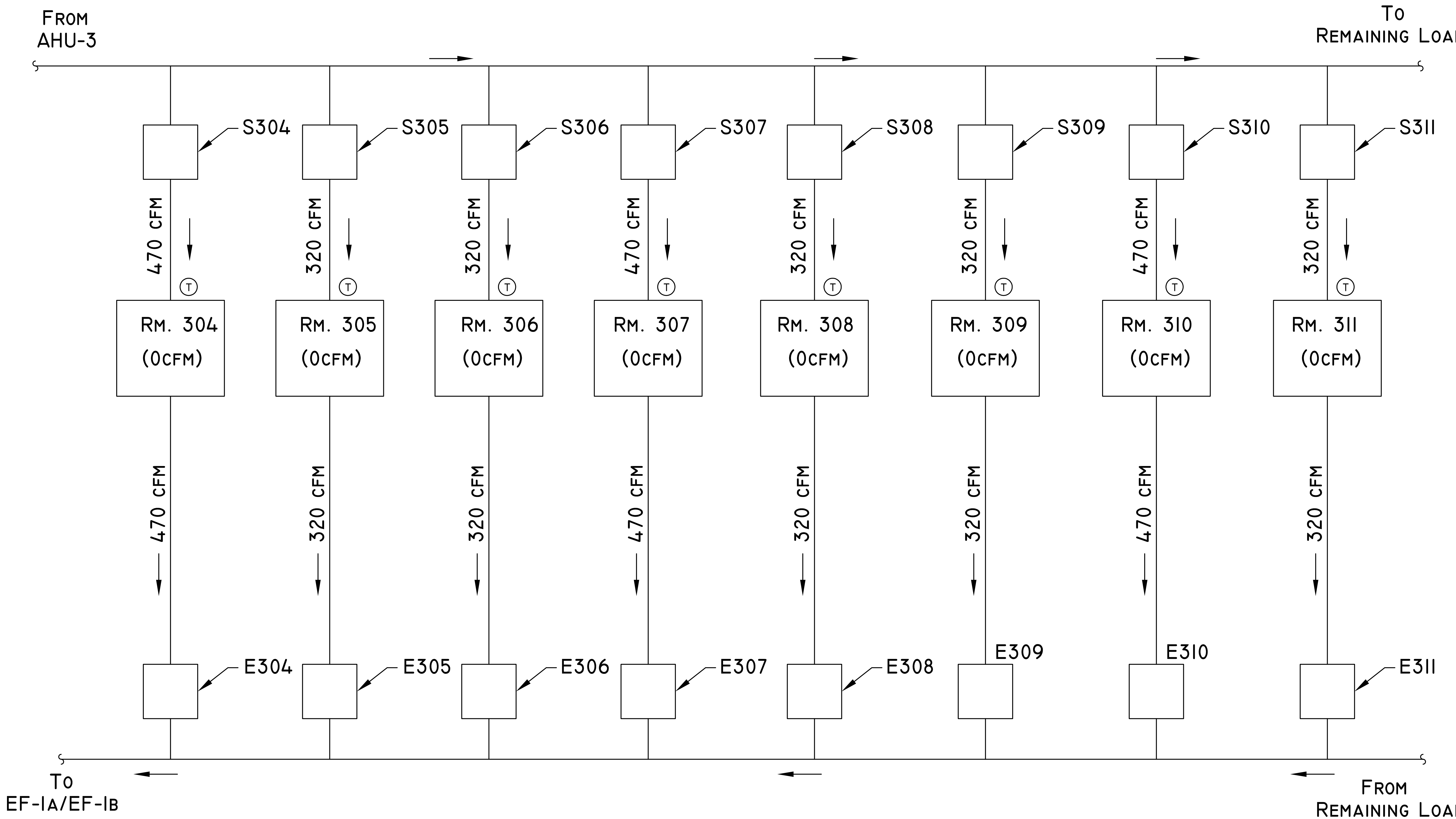
A.3) AHU-3/1


FROM AHU-3
TO REMAINING LOAD
S208
S209
S210
S211
S212
200 CFM
2260 CFM
240 CFM
240 CFM
2260 CFM
RM. 208 (0CFM)
RM. 209 (0CFM)
RM. 210 (0CFM)
RM. 211 (0CFM)
RM. 212 (0CFM)
RM. 213 (0CFM)
RM. 214 (-380CFM)
RM. 215 (-380CFM)
200 CFM
2260 CFM
370 CFM
270 CFM
2260 CFM
360 CFM
380 CFM
TRANSFER FROM 220,219
E209A
E209B
E212A
E212B
E208
E210
E211
TO EF-1A/EF-1B
FROM REMAINING LOAD
TO EF-2

A.3) AHU-3/2

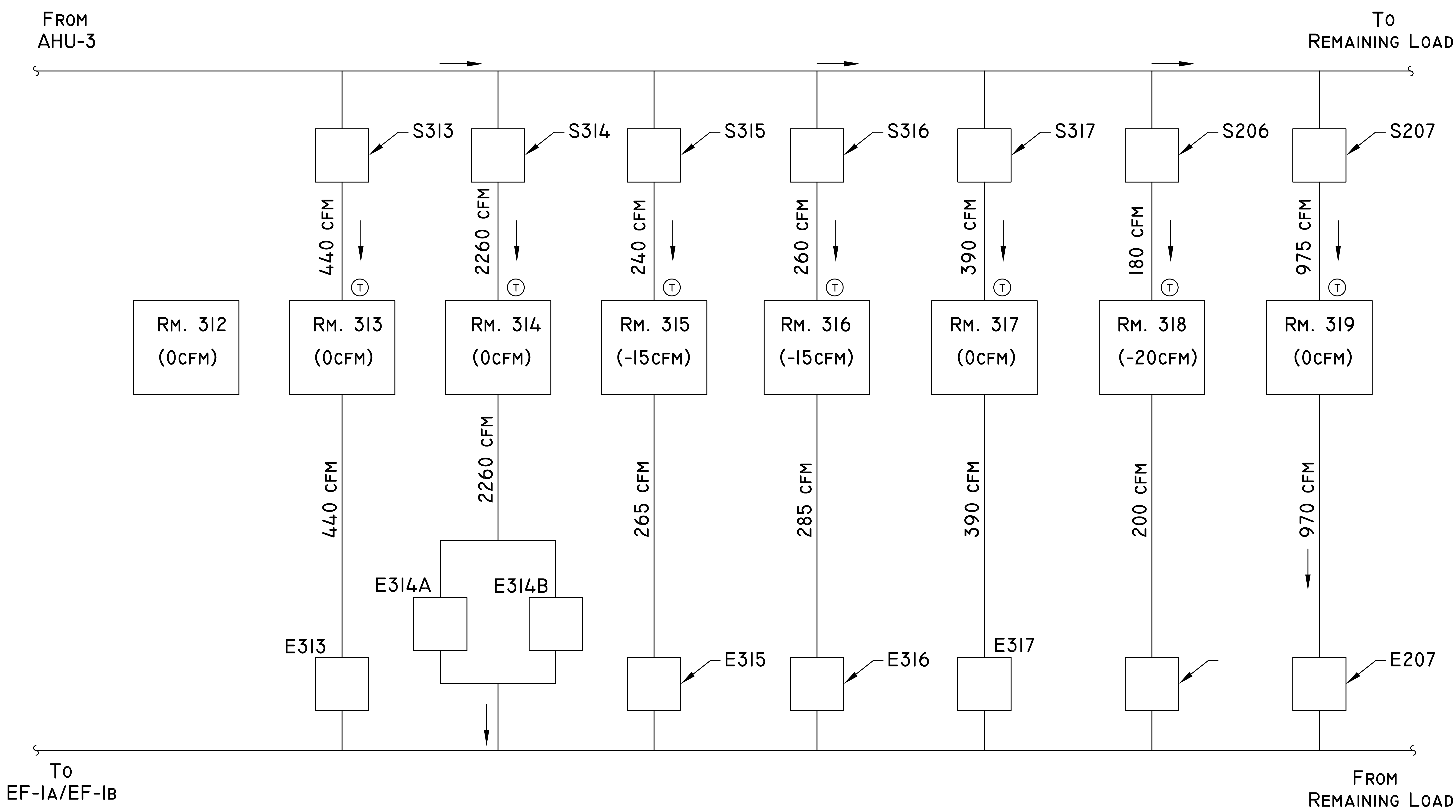

FROM
AHU-3
TO
REMAINING LOAD
S218
S203
S220
S301
S302
S303
270 CFM
300 CFM
430 CFM
690 CFM
320 CFM
320 CFM
RM. 216
(-50CFM)
RM. 217
(0CFM)
RM. 218
(0CFM)
RM. 219
(+300CFM)
RM. 220
(+430CFM)
RM. 301
(0CFM)
RM. 302
(0CFM)
RM. 303
(0CFM)
TRANSFER
TO
215
50 CFM
270 CFM
690 CFM
320 CFM
320 CFM
E218
E301
E302
E303
TO
EF-1A/EF-1B
FROM
REMAINING LOAD
TO
EF-2

A.3) AHU-3/3



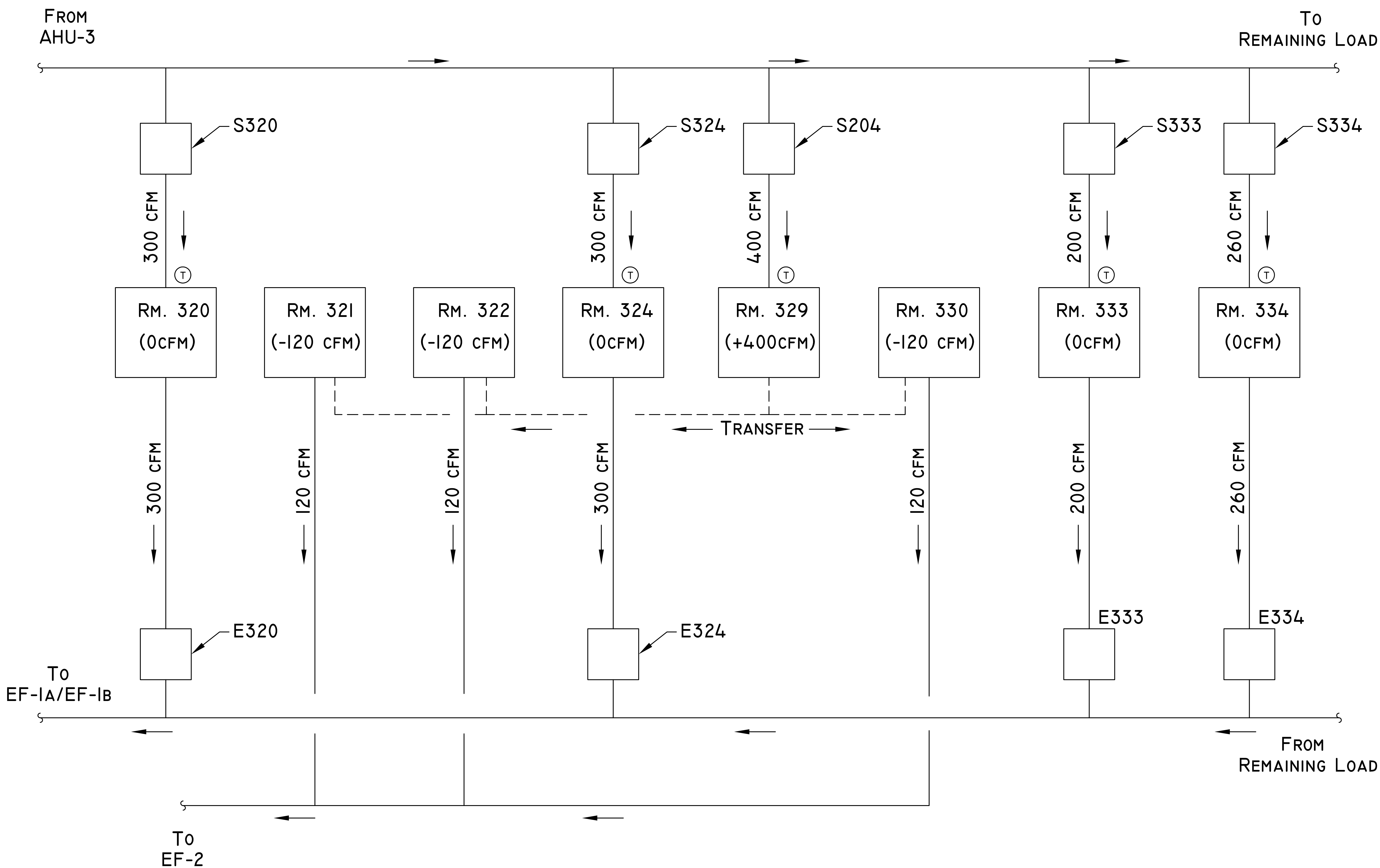
FROM AHU-3
TO REMAINING LOAD
S304
S305
S306
S307
S308
S309
S310
S311
470 CFM
320 CFM
320 CFM
470 CFM
320 CFM
320 CFM
470 CFM
320 CFM
RM. 304 (0CFM)
RM. 305 (0CFM)
RM. 306 (0CFM)
RM. 307 (0CFM)
RM. 308 (0CFM)
RM. 309 (0CFM)
RM. 310 (0CFM)
RM. 311 (0CFM)
470 CFM
320 CFM
320 CFM
470 CFM
320 CFM
320 CFM
470 CFM
320 CFM
E304
E305
E306
E307
E308
E309
E310
E311
TO EF-1A/EF-1B
FROM REMAINING LOAD

A.3) AHU-3/4

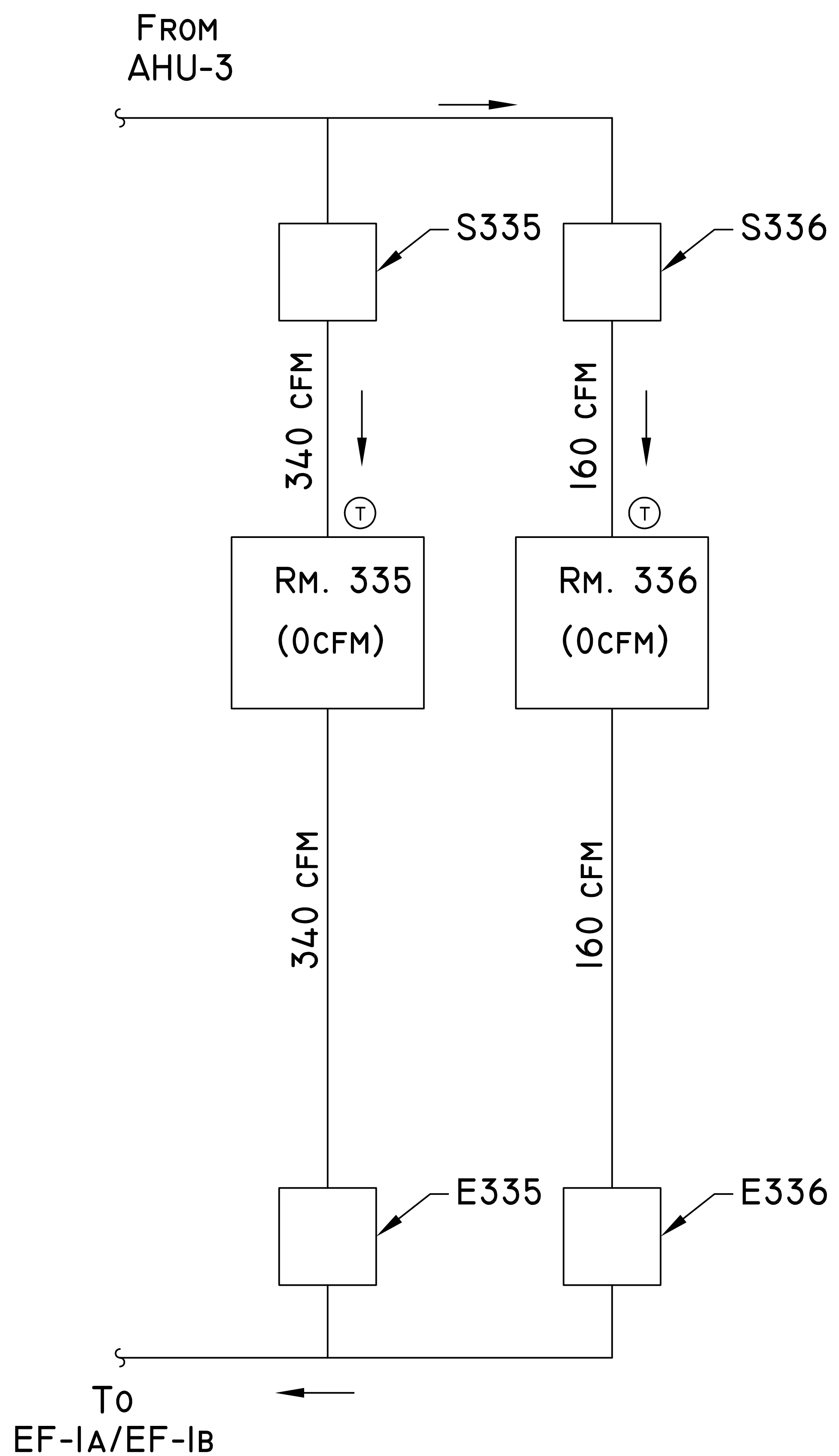


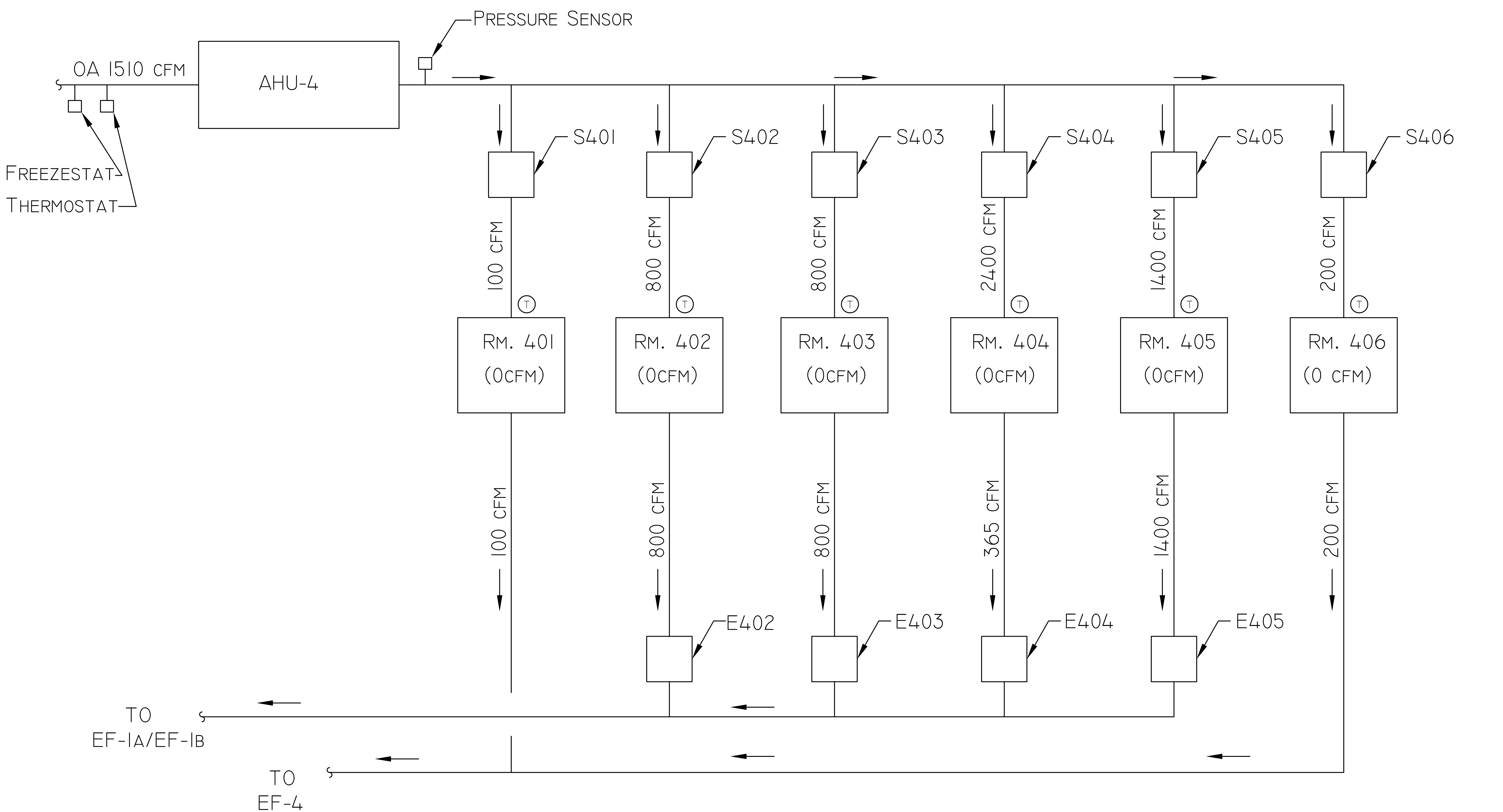
FROM AHU-3
TO REMAINING LOAD
S313
S314
S315
S316
S317
S206
S207
440 CFM
2260 CFM
240 CFM
260 CFM
390 CFM
180 CFM
975 CFM
RM. 312 (0CFM)
RM. 313 (0CFM)
RM. 314 (0CFM)
RM. 315 (-15CFM)
RM. 316 (-15CFM)
RM. 317 (0CFM)
RM. 318 (-20CFM)
RM. 319 (0CFM)
440 CFM
2260 CFM
265 CFM
285 CFM
390 CFM
200 CFM
970 CFM
E314A
E314B
E313
E315
E316
E317
E207
TO EF-1A/EF-1B
FROM REMAINING LOAD

A.3) AHU-3/5


From AHU-3
To Remaining Load
S320
S324
S204
S333
S334
300 CFM
300 CFM
400 CFM
200 CFM
260 CFM
Rm. 320 (0CFM)
Rm. 321 (-120 CFM)
Rm. 322 (-120 CFM)
Rm. 324 (0CFM)
Rm. 329 (+400CFM)
Rm. 330 (-120 CFM)
Rm. 333 (0CFM)
Rm. 334 (0CFM)
Transfer
300 CFM
120 CFM
120 CFM
300 CFM
120 CFM
200 CFM
260 CFM
E320
E324
E333
E334
To EF-1A/EF-1B
From Remaining Load
To EF-2

A.3) AHU-3/6

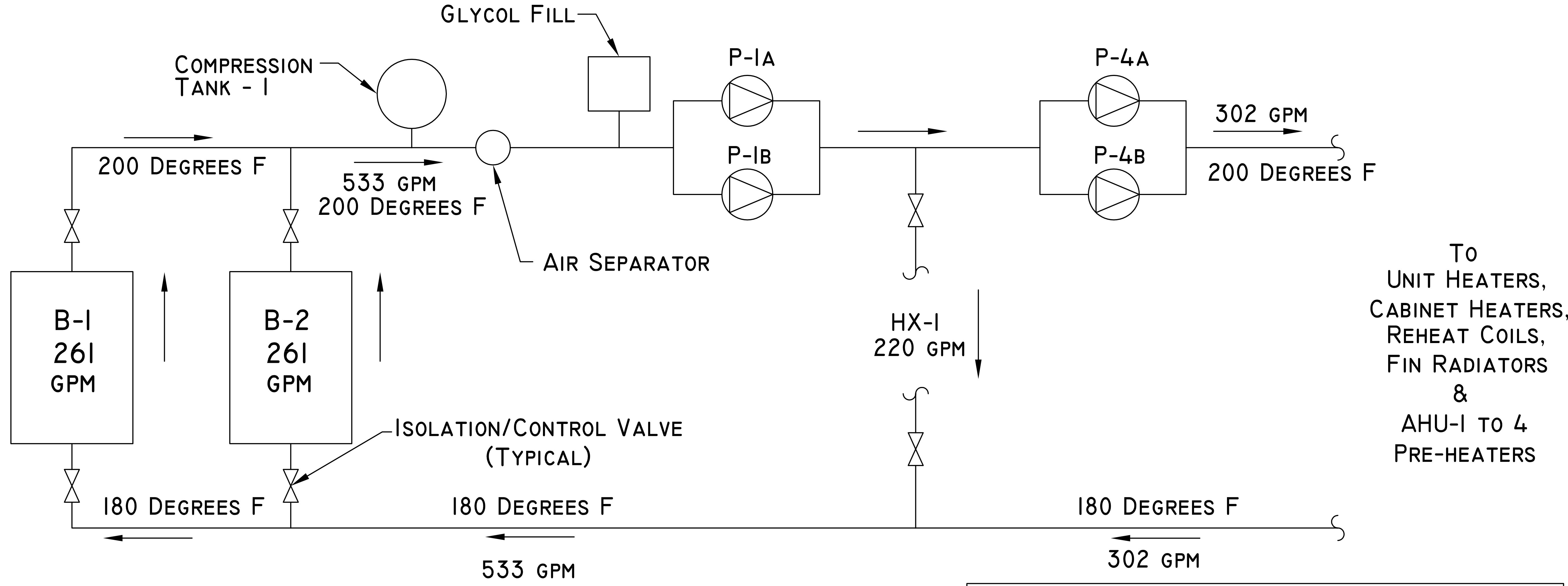

FROM
AHU-3
S335
S336
340 CFM
160 CFM
T
T
RM. 335
(0CFM)
RM. 336
(0CFM)
340 CFM
160 CFM
E335
E336
TO
EF-1A/EF-1B



COOLING AND HEATING SEASONS

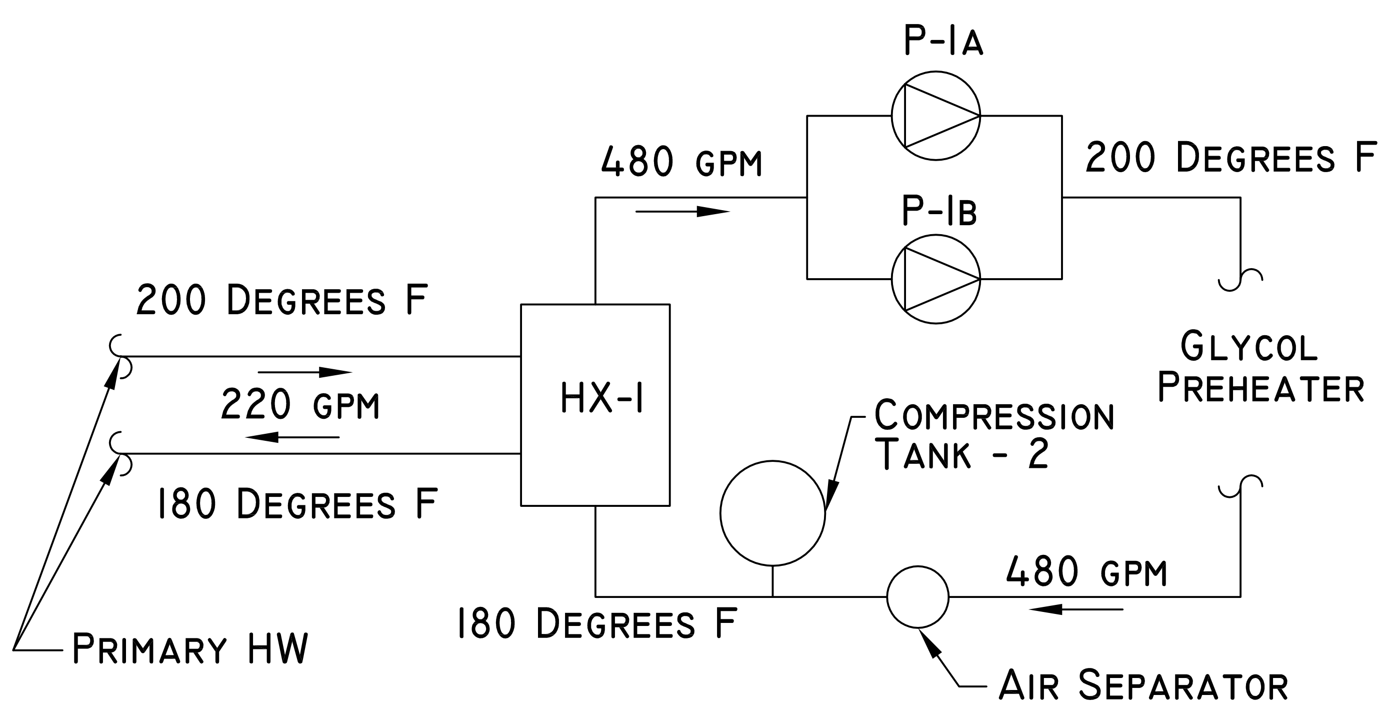
AHU-4 SA TEMP : 55 DEGREES F
REHEAT COIL MAX DELTA T: 40 DEGREES F
DESIGN ROOM CONDITION: 75 DEGREES F/50%RH

A.3) AHU-4/1

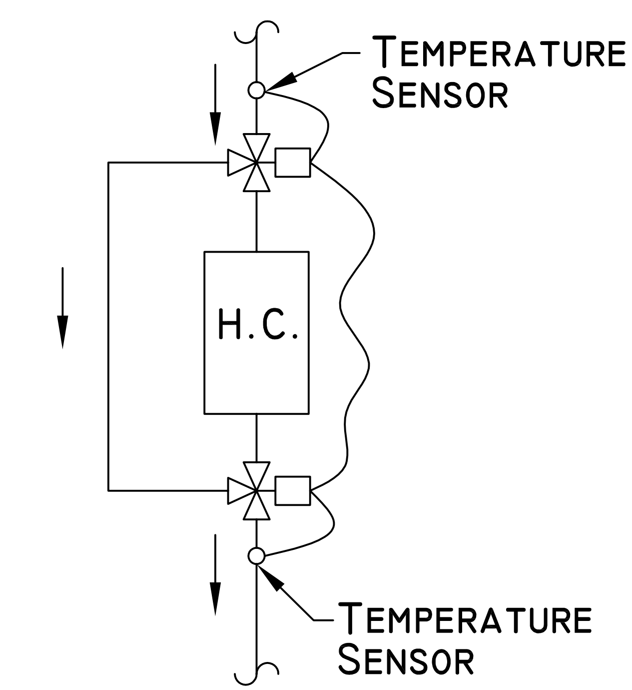


Note: Pump VFDs are monitored by down stream pressure sensors.

Primary Hot Water Flow Diagram

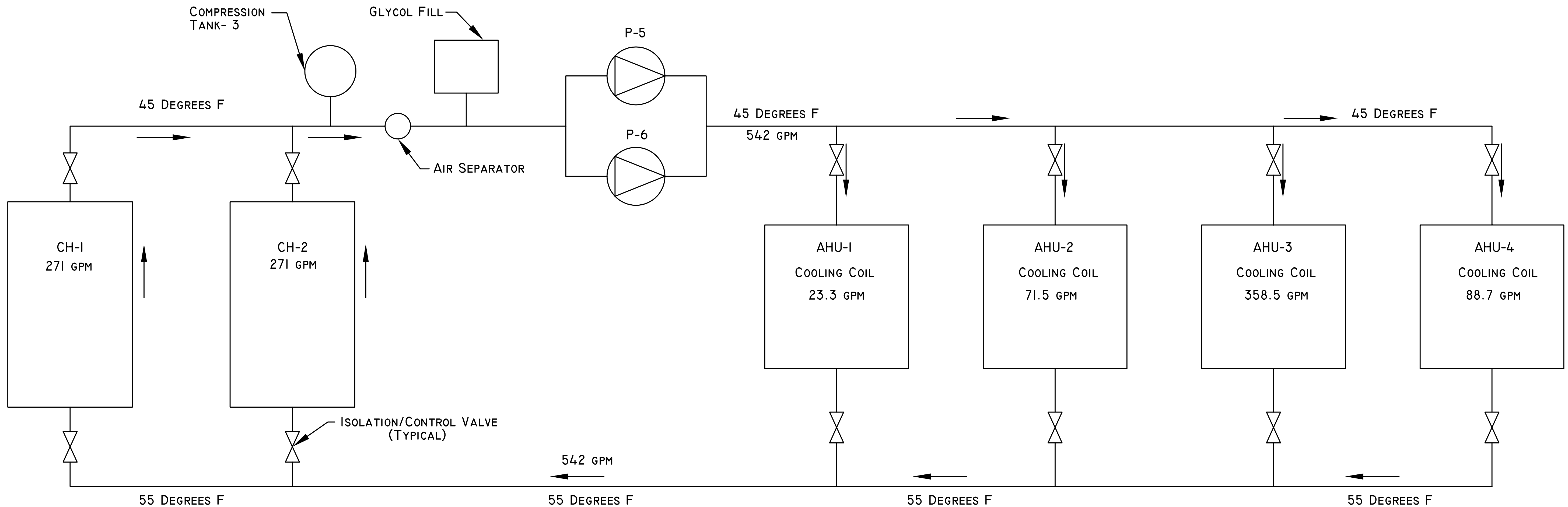


Glycol Preheat Flow Diagram



Typical Coil Bypass

A.4



Note: Pump VFDs are controled by pressure sensors up stream of pumps.

Chilled Water Flow Diagram