TECHNICAL REPORT III

Mechanical Systems Existing Conditions

TEMPLE UNIVERSITY –TYLER SCHOOL OF ART

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Executive Summary

The new 234,000 SF Temple University Tyler School of Art is a 3-story art education building located on Temple's main campus in Philadelphia, PA. The Tyler School is moving from its current location in the Philadelphia suburb of Elkins Park. The three floors and basement consist of 234,000 square feet of administration, art education, and auditorium space.

This report provides a summary of the existing Tyler School of Art mechanical systems and equipment. The major components of the systems are examined and explained.

The ventilation system was evaluated for compliance with ASHRAE Standard 62.1. The energy consumption of the Tyler School was estimated by the use of Trane Trace and utility rates for Philadelphia.

Schematic diagrams of the mechanical systems in the Tyler School were provided for greater understanding of the mechanical systems. In addition, mechanical equipment schedules were taken from Brinjac Engineering design documents and condensed in this report.

The mechanical systems used in the Temple University Tyler School of Art offer a 1st cost design solution. The VAVR and CAVR systems offer a low first cost, however, the amount of wasted energy in the system could eventually come back to haunt Temple, especially as electricity prices continue to rise in the next few years. Temple University does not try to include any type of energy recovery systems in the design of the Tyler School because of cost and building layout reasons. The possibility of energy recovery will be evaluated in future analysis of the building to determine if the systems would have proven to be a beneficial long-term investment.

Design Objectives & Requirements

The Tyler School of Art building will provide studios, classrooms, shops, assembly spaces, and office space. The new building will house the painting, printmaking, metals, ceramics, sculpture, glass, fibers, and photography departments. The Tyler School of Art will house approximately 120 faculty members and about 800 students.

The move from Elkins Park, PA will create a complete Art Campus at the Temple University Main Campus. The goal is to create a "mini arts campus" within the Temple University main campus. The Tyler School will become the signature building of the Arts Campus. As a premier art school of the Mid-Atlantic region, the Tyler School will benefit from the move into one of the largest culturally rich art cities in the country.

Much of the Tyler School curriculum is offered at the main campus, with 60% of the Tyler students are already enrolled at the main Temple campus. The art history, architecture, art, and art education departments make up most of the Tyler students at the main campus. The addition of the new building will further enhance Tyler's image as one of the preeminent art schools in the nation. The Tyler School will have the look and size of the contemporary art education school in the nation. The new building will give 40% more square footage than the Elkins Park campus. In addition, the exhibition and presentation space will increase by more than 8.000 SF. These gallery and exhibition spaces are highlighted on the first floor to invite the campus and community participation. The Tyler School of Art will feature 160,000 SF of teaching and learning space. The studios will offer very modern ventilation systems.

Architect Carlos Jimenez, known throughout the country for his work on art education buildings, will primarily lead the design team. Jimenez wants to highlight the exterior aesthetics of the building as much as possible. To do so, the amount of mechanical equipment allowed on the roof of the building was limited as much as possible. The extent of rooftop mechanical equipment is only three rooftop units and the required exhaust fans; everything else was seen as superfluous.

Site Factors

The Temple University Tyler School of Art had many design considerations to take into account. The building is only predominantly 2 stories with a third story housing the painting studio. Despite the massive amount of space needed to house the different departments in the school, the building height was limited to 64 feet high to fit the Temple University master plan.

The large footprint required for the building can cause problems for a dense urban campus, especially because the Tyler School of Art footprint uses an entire city block. This size also creates a problem for the location of entrances and loading docks. The loading dock location was a very important consideration because all departments would need to have easy access to it. A building as large as the Tyler School has several large shipments coming into the school daily.

The outdoor intakes were also important site locations. They were located on the courtyard the school is based around. This assures clean intake air away from city car exhaust. The exhaust also had to be considered. Because the building is relatively low, it is required for the roof mounted exhaust fans to project up into the atmosphere so it does not get recirculated into the building or another building.

Outdoor & Indoor Design Conditions

The outdoor design conditions in the table below for the Tyler School of Art were taken from the ASHRAE Fundamentals 2001 for Philadelphia, PA.

WEATHER CRITERIA		
SUMMER	Dry Bulb	89 F
	Wet Bulb	74 F
WINTER	Dry Bulb	11 F

The indoor design conditions were compiled by Brinjac Engineering and Temple University personnel. Appendix A summarizes the indoor design conditions that correspond with the different occupancy types.

Ventilation Requirements

The Tyler School of Art ventilation systems were evaluated for compliance with ASHRAE Standard 62.1 *Ventilation for Acceptable Indoor Air Quality*. The evaluation procedure for ASHRAE Standard 62.1 is based on floor areas, space type, occupancy, and the ventilation system. The ASHRAE Standard 62.1 procedure calculates the amount of outdoor air required for each AHU/RTU intake to ensure that the various spaces receive the minimum amount of outdoor air required. The design outdoor air percentages as well as the ventilation rates and compliance are summarized in the tables below.

	Supply Max	Outdoor Air	% OA
AHU-1	50,000	16,500	33
AHU-2	50,000	16,500	33
AHU-3/4	124,000	124,000	100
RTU-1	42,000	14,000	33.33
RTU-2	51,000	14,000	27.45
RTU-3	35,000	35,000	100
MAU-1	5,000	----	----

	Location	Areas Served	Calc. OA (CFM)	OA Min (CFM)	Supply Min	Supply Max	Complies w/62.1
AHU-1	Basement	Photo, Exhibit	12,670	13,500	26,000	50,000	Yes
AHU-2	Basement	LL/1st Floor Core	20,130	13,500	26,000	50,000	No
AHU-3/4	Basement	Ceramics, Sculp, Glass, Metals, Printmaking, LL Shops	23,200	124,000	124,000	124,000	Yes
RTU-1	Roof	2nd Flr Admin/Core, Foundations	17,990	21,000	24,750	42,000	Yes
RTU-2	Roof	Gaid, Fibers, 2nd Flr Core	25,325	14,000	28,000	51,000	No
RTU-3	Roof	Painting	13,330	35,000	31,150	35,000	Yes

The tables show that AHU-2 and RTU-2 do not comply with ASHRAE Standard 62.1-2007. These two units do not comply primarily because of design discrepancies for a few of the spaces. These spaces were possibly overdesigned to account for the large amounts of exhaust that is required in many of the studio/workshop spaces. The function of the spaces could have also been misinterpreted between the design and calculated values.

Energy Sources and Rates

The electrical service will be provided by PECO. The service will be high tension (HT) power. The table below shows the summary of the service.

Billing Demand	1st 150 hours use	Next 150 hours use	Additional use
$13.52/kW	$0.0891/kW	$0.0594/kW	$0.0303/kW

	June through September	October through May
On-peak Charge ($/kWh)	0.0058	0.0022
Off-peak Charge ($/kWh)	0.0021	0.0021

No energy rebates or incentives to reduce energy consumption and the cost of system operation were available on this project.

Annual Energy Use

The Trane Trace program is used to estimate the annual energy consumption and operating costs of the Tyler School of Art. There was no energy analysis performed by the engineer of the Tyler School. Energy consumption was not a primary design consideration.

The estimated annual energy cost of the building is listed in the table below.

	Annual Cost ($/yr)	Annual Cost/ft^2
Electric	115,225	0.49
Natural Gas	66,965	0.29
Total	182,190	0.78

Equipment Energy Consumption

	Elect Cons. (kwh)	% Total Energy	Total Source Energy (kBtu/yr)
Primary Heating	68,258.31	46.72%	117,969.23
Cooling Compressor	709,590.62	37.75%	102,662.24
Tower/Cond Fans	100,908.19	1.81%	10,333.02
Other CLG Accessories	515.70	0.01%	52.81
Lighting	763,501.19	13.72%	78,182.70
Totals	1,642,774.00	100.00%	309,200.03

Design Heating and Cooling Loads

The equipment schedules provided by Brinjac Engineering indicate the maximum heating and cooling loads of the coils in each air handling and rooftop unit. The Trane Trace program is used as the building energy simulation program, in order to estimate the design loads, annual energy consumption, and operating cost for the Tyler School of Art. The energy simulation was based on lighting and equipment loads and outdoor air ventilation rates. Appendix B contains the tables that are the basis for the simulation.

The table below shows the calculated tons for each unit and the area per ton.

	Computed Tons	Computed Load (ft^2/ton)
AHU-1	67	275.22
AHU-2	106	215.14
AHU-3/4	187	340.74
RTU-1	76	294.34
RTU-2	83	320.31
RTU-3	116	176.81

The table below shows the design loads for the Tyler School. There is a variation between the designed and calculated loads for a few of the units. The Trace calculation will need to be modified.

	Occupancy	Area (SF)	Airflow (cfm)	Sensible (Btuh)	Latent (Btuh)	Total (Btuh)
RTU - 1	Administration	5,671	6,995	179,333	60,659	239,992
	2nd Floor Core	15,953	52,602	1,063,605	167,251	1,230,856
	Foundations	10,883	10,343	471,707	283,536	755,243
		Total CFM =	**69,940**		**Total (Tons) =**	**186**
RTU - 2	2nd Floor Core	2,242	714	41,270	19,291	60,561
	Gaid	10,991	11,667	420,804	176,796	597,600
	Fibers	6,200	4,008	145,828	98,150	243,978
		Total CFM =	**16389**		**Total (Tons) =**	**75**
AHU - 1/2	Lower Level Core	10,656	15,963	540,884	381,607	922,491
	Photography	12,234	7,275	282,491	187,100	469,591
	Exhibitions	8,542	9,155	289,436	237,295	526,731
	1st Floor Core	9,330	6,494	277,992	149,455	427,447
		Total CFM =	**38887**		**Total (Tons) =**	**196**
AHU - 3/4	Sculpture (LL)	10,701	7,405	276,602	175,198	451,800
	Glass	10,626	8,212	347,434	237,662	585,096
	Sculpture (1st Flr)	14,933	15,143	625,820	364,966	990,786
	Ceramics	11,325	14,911	470,148	329,362	799,510
	Metals	7,196	7,226	254,944	120,830	375,774
	Printmaking	11,542	13,658	438,070	226,560	664,630
		Total CFM =	**66555**		**Total (Tons) =**	**322**

System of Operation

The mechanical system of the Temple University Tyler School of Art consists of air-side and water-side components.

The air-side components consist of the four basement air handling units, the three rooftop units, terminal air boxes, and rooftop exhaust fans. The constant and variable air volume terminal air boxes maintain the space temperatures and airflow rates. The terminal air boxes are controlled by direct digital (DDC) controls.

High pressure steam is supplied from the Temple University central heating plant. The building taps into the campus steam lines. The high pressure steam is reduced to low pressure steam at a pressure reducing valve station, and then the steam is sent through one of two steam-to-water heat exchangers. This hot water is then sent through the building to be used in the domestic hot water system as well as the reheat coils, unit heaters, air handling units, and for the steam in the humidifiers. Steam provides the humidification in the Tyler School. The low pressure steam from the steam-to-water heat exchangers is used in the air handling unit to humidify the air after going through the cooling coil.

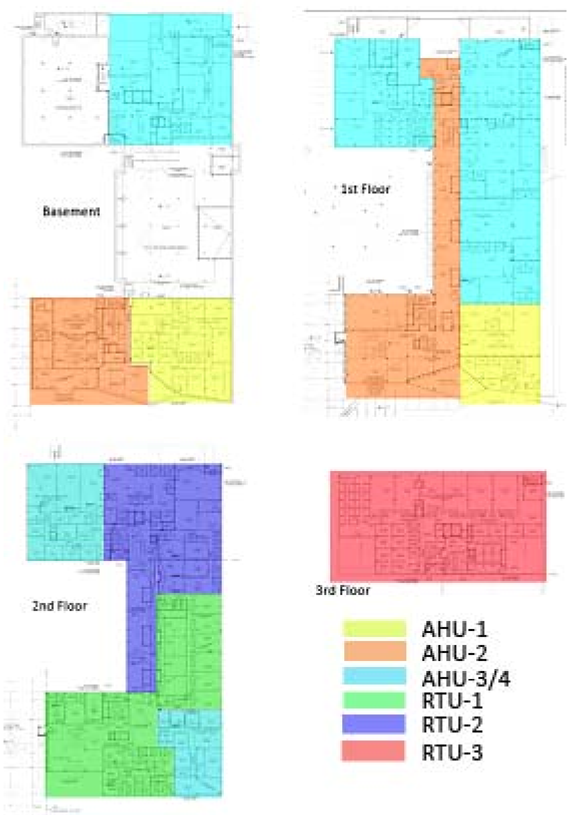
The hot water will be used as the method for space heating in the Tyler School. The water is circulated throughout the building by the use of four variable speed drive end suction pumps. The hot water supply is designed at 180 °F and the hot water return is 160 °F. Hot water reset is used to adjust the temperature of the supply water as the ambient conditions vary. Temperature control valves are used to mix the supply and returns lines to adjust to lower hot water supply temperatures.

The chilled water will be the method for cooling in the Tyler School of Art. The chilled water is taken from the Temple University central plant. The chilled water distribution is handled by four variable speed drive, vertical split-case pumps. There is also a standby pump. The pumping arrangement is a secondary pump system that delivers chilled water to the air handling units and uses direct return with two-way control valves. The chilled water system is designed to have a supply temperature of 48°F and return is 60°F.

Critique of System

The Temple University Tyler School of Art is a unique education building because the excessive amount of ventilation required. The building was treated primarily as a laboratory. The system consists of four (4) AHUs housed in the basement and three (3) RTUs. Of the seven units, AHU-1, AHU-2, RTU-1, and RTU-2 are all variable air volume reheat (VAVR) systems. The remaining units, RTU-3, AHU-3, and AHU-4, are all constant air volume reheat (CAVR) systems. These units predominantly serve the studios spaces and shops.

The system was divided into RTUs and basement AHUs primarily to limit duct diameters and shaft sizes required. Most of the ventilation is on the higher floors, so it would not make sense for the duct to run from the basement AHU when the unit could be placed on the roof. The initial plan was to use the RTUs for the 2nd and 3rd floors only and the AHUs units for the 1st floor and the basement the figure below shows the deviation from that plan.



The chart and tables below show which systems are used in each area. The CAVR systems are mostly on the 2nd and 3rd floors with the exception of the shops in the basement.

	LOCATION	AREAS SERVED
AHU-1	BASEMENT	PHOTO, EXHIBIT
AHU-2	BASEMENT	LOWER LEVEL/1ST FLOOR CORE
AHU-3	BASEMENT	CERAMICS, SCULPTURE, GLASS
AHU-4	BASEMENT	PRINTMAKING, METALS, LL SHOPS
RTU-1	ROOF	2ND FLOOR ADMIN/CORE, FOUNDATIONS
RTU-2	ROOF	GAID, FIBERS, 2ND FLOOR CORE
RTU-3	ROOF	PAINTING

Space	HVAC System
Administration & Office	Variable Air Volume Reheat (VAVR)
Classroom Spaces	Variable Air Volume Reheat (VAVR)
Conference & Presentation	Variable Air Volume Reheat (VAVR)
Workshop & Studio Areas	Constant Air Volume Reheat (CAVR)

Critique (Cont.)

The VAV allows the systems to vary the amount of airflow entering the space. Due to the large amount of ventilation in the Tyler School, the air is reheated at the terminal box to match the space temperature set point.

One of the main advantages that this system takes advantage of is the low energy cost because the terminal unit meets in the minimum comfort levels required in the room. The ductwork and central air handling equipment can be sized down because the diversity factor can be used. The diversity factor is used because the maximum loads do not occur simultaneously. This is idle because the VAVR system is used in spaces with varying usage unlike the workshops and studios, which could have people in them at all times. The energy savings from designing for the minimum is a positive, but as a negative, the spaces can seem like there is inadequate air movement. Also, several spaces have to be served by a single terminal unit, which can create balancing problems with dissimilar spaces.

The CAVR system works similarly to the VAVR system except there is a constant amount of airflow being provided for the space. There are large ventilation requirements, especially in the studios/workshops, which have a great amount of exhaust. Once again, this ventilation will require the reheat coil to allow for system temperature balancing.

The CAVR system is beneficial because it can offer a very low first cost compared to other all-airside systems. Along with this initial cost benefit, this system offers the benefit of the simplest temperature controls. However, these saving are offset by high energy consumption, larger ductwork, and often significant airflow reheating to meet the temperature set points of the rooms. The high-energy consumption is the result of the unit being designed to meet to the sum of all the peak space loads.

The VAVR and CAVR systems handle the loads required and generally offer a low first cost system option. The VAVR system works well in the areas with fluctuating load, and the CAVR system handles the space loads associated with all the equipment and exhaust in the studios. However, the system lacks in terms of energy efficiency. AHUs 3-4 and RTU-3 are 100% OA units, which are huge energy wastes. The Tyler School did not pursue the use of energy recovery units to help offset all the exhaust energy. The school did not pursue energy recovery as a first cost decision. Also, the exhaust fans are not centrally located, which would promote the use of energy recovery. The exhausts are located above the many different departments, which would have proven costly.

The Tyler School of Art uses the University's central chiller plant and taps into the available high pressure steam lines run throughout campus. This is a cost effective way of handling the heating and cooling loads by utilizing the built up mechanical network of the campus.

References

ASHRAE. 2007, ANSI/ASHRAE, Standard 62.1 – 2007, Ventilation for Acceptable Indoor Air Quality. American Society of Heating Refrigerating and Air Conditioning Engineers, Inc., Atlanta, GA, 2007.

Brinjac Engineering, Inc. 2007, Mechanical Construction Documents. Brinjac Engineering, Inc., Harrisburg, PA, 2007.

Appendix A

Design Criteria

Space	Design Temperature		Relative Humidity	Total ACH	Outdoor ACH	Exhaust Room Air	Room Pressure
	Cooling	Heating					
Administration& Offices	72	72	50-60	4	1	No	Even
Assembly Areas	72	72	50-60	6	2	No	----
Auditorium	72	72	50-60	6	2	No	Even
Cafeteria	75	75	50-60	6	2	No	Positive
Classroom	75	75	50-60	6	3	Yes	Even
Computer Lab	72	70	50-60	6	1	No	Even
Conference Rm	72	72	50-60	4	1	No	Even
Control Rm, Computer Rm	72	70	40-50	6	2	No	Even
Corridor	78	70	----	2	0.1/SF	No	Even
Electrical Rm	80	70	----	----	10	Yes	Negative
Gallery-Student	72	70	50-60	8	2 to 4	No	Even
General Storage	80	70	50-60	4	2 (min)	Yes	Negative
IDF Rm	72	72	50-60	4	1	No	Even
Kiln Rms	80	70	----	6	2 to 6	Yes	Negative
Labs	75	72	40-50	10	10	Yes	Negative
Loading Dock	----	65	----	----	----	Yes	Negative
Lobby & Atrium	75	75	50-60	4	1	No	Positive
Locker Rms	78	75	70	10	0	Yes	Even (TA)[1]
Mechanical Rm	----	80	----	----	2(min)	Yes	Negative
Music Rm	75	75	50-60	----	----	No	Even
Painting Studios Storage[2]	72	72	55-65	6	6	No	Negative
Shops	80	72	50-60	----	----	Yes	Negative
Studio	75	75	50-60	----	----	Yes	Negative
Studios, Storage	78	70	50-60	6	2	Yes	----
Telephone Rm (Main)	72	70	40-50	4	0	No	Even
Telephone Rm (Satellite)	75	70	40-50	2	0	No	Even
Toilet Rm & Janitor Closet	78	70	----	10	10	Yes	Negative (TA)[1]
Vending Area	78	70	----	4	0	Yes	Negative
Vestibule	80	65	----	4	0	No	Positive
Waiting Rm	75	75	50-60	4	1	No	Even

[1]TA = Transfer Air
[2]Room requiring humidity control

Appendix A (cont.)

Occupancy Requirements

Space	ASHRAE Max Occupancy P/1000 SF	ASHRAE OA CFM/P[1] CFM/SF[2] CFM/WC[3]	Avg People Loading Quantity[4]	Avg People Sensible Heat Gain (Btuh)
Administration & Offices	7	20	1/150 SF	245
Assembly Areas	120	15	----	----
Auditorium	150	15	1/7 SF	----
Cafeteria	100	20	1/10 SF	----
Classroom	50	15	1/20 SF	245
Computer Lab	60	20	1/16 SF	245
Conference Rm	50	20	1/20 SF	245
Control Rm, Computer Rm	40	15	1/50 SF	250
Corridor	----	0.1/SF	0	250
Electrical Rm	20	0	0	275
General Storage	10	15	0	245
Labs	30	20	1/33 SF	----
Lobby & Atrium	30	15	1/33 SF	250
Locker Rm	20	0.5/SF	0	245
Music Rm	50	15	----	----
Painting Studio Storage	50	15	1/20 SF	----
Shops	30	20	1/33 SF	----
Studios	50	15	1/20 SF	----
Telephone Rm (Main)	20	0	0	275
Telephone Rm (Satellite)	20	0	0	275
Toilet Rm & Janitors Closet	----	75/WC&Urinal	0	245
Vending Area	----	----	0	275
Vestibule	----	----	0	250
Waiting Rm	60	25	----	250

[1]Value based on people loading unless indicated otherwise based on International Mechanical Code 2003
[2]Where the value is based on area, minimum total OA is the product of value and area
[3]Where the value is based on water closets (WC), minimum OA is the product of the # of water closets and urinals in the space
[4]Where the value is based on area, minimum occupancy loading is the quotient of area and value

Appendix A (cont.)

Duct Sizing Criteria

System	Max Friction Loss (in WG/100 ft)	Max Velocity (FPM)
Main Supply Duct (upstream of terminal units)	0.1 to 0.3	1500 to 2500
Branch Supply Duct (downstream of terminal units)	0.08 or less	600 to 800
Main Return/Exhaust Air Duct	0.08	1500
OA Intake/Relief Air Duct	0.05	1000
Low Pressure Branch Return/Exhaust Duct	0.05	1000

Terminal Air Box Design

Space	Characteristics
General Interior	Each terminal unit is selected to serve up to a maximum of 1,000 SF of open area or no more than 5 enclosed offices. The units have a unit mounted sound attenuator, reheat coil (top floor only), and space temperature and humidity sensors.
General Perimeter Spaces	Each terminal unit is selected to serve up to a maximum of 600 SF of open area or no more than 3 enclosed offices. Corner spaces will be provided with a dedicated terminal unit. The units have a hot water reheat coil and unit mounted sound attenuator. Also, the terminal boxes will have a space temperature and certain boxes will have humidity sensors.
Meeting/Conference	Each terminal unit is selected to serve up to a maximum of 1,000 SF. Where room size permits, multiple spaces will be combined and served from a single unit. Units are equipped with a hot water reheat coil, unit mounted sound attenuator, a space temperature sensor, and few with humidity sensors. The corner spaces are provided with a dedicated terminal unit.
Interior/Corridor	Each terminal unit is selected to serve up to a maximum of 1,500 SF of open area or no more than 5 enclosed offices. The units are equipped with a hot water reheat coil and unit mounted sound attenuator.
Grad Studios/Student Galleries	Each terminal unit is selected to serve a maximum of 3 or 4 small studios or approximately 1,500 SF. Units are equipped with a hot water reheat coil and unit mounted sound attenuator. The units have two-position control to maximize system diversity during unoccupied times.
Shops, Labs, Studios, Work Rms	These areas required CAV large quantities of exhaust air for maintaining pressurization during operation

Appendix B

Load Considerations for Spaces

Space	Avg Space Lighting Load (W/SF)	Avg Misc. Equipment Load (W/SF)	Additional Special Equipment Load (Btuh)
Administration & Offices	3	----	----
Classroom	3	2	----
Conference Rm	3	2	----
Control Rm, Computer Rm	3	----	----
Corridor	2	0	----
Electrical Rm	2	0	----
Gallery-Students	3	1	----
General Storage	2	0	----
Labs	3	----	----
Lobby	3	1	----
Locker Rms	1.5	0.5	----
Music Rm	3	2	----
Studios	2	----	----
Studio Storage	3	----	----
Telephone Rm (Main)	3	2	36000
Telephone Rm (Satellite)	2	0	1000
Toilet Rm & Janitor Rm	1.5	0.5	----
UPS Rm	3	1	----
Vending Area	3	0	60000
Vestibule	2	0	2000
Waiting Rm	3	1	1000

Appendix C

TYPICAL FIN TUBE							
Mounting	Tube Size (in)	Fin Size (in)	Fins/ft	Capacity (Btuh/ft)	Avg Water Temp (F)	EAT (F)	# of Rows
Pedestal	0.75	2.75 x 4.25	60	920	170	65	1

PUMPS								
						Motor Data		
System	Type	Capacity (gpm)	Discharge HD (ft)	Min NPSH (ft)	Min Eff (%)	HP	RPM	V-PH
Chilled Water	End Suction	1000	140	23.8	80	50	1750	460-3
Chilled Water	End Suction	1000	140	23.8	80	50	1750	460-3
Chilled Water	End Suction	540	140	7.4	80	30	1750	460-3
Chilled Water	End Suction	540	140	7.4	80	30	1750	460-3
Hot Water Heating	End Suction	1000	140	23.8	80	50	1750	460-3
Hot Water Heating	End Suction	500	110	20	75	25	3500	460-3
Hot Water Heating	End Suction	500	110	20	75	25	3500	460-3
Hot Water Heating	End Suction	500	110	20	75	25	3500	460-3

STEAM-TO-WATER HEAT EXCHANGER (SHX)							
		Tubeside Data					
Quantity	Type	Water Flow (gpm)	Water PD (ft)	EWT (F)	LWT (F)	# of Passes	Fouling Factor
2	Shell and Tube	500	2	160	180	2	0.0025
	Shell Data		Steam Data				
Min. Heating Surface (SF)	Diam. (in)	Length (in)	Flow (lbs/hr)	Pres. (psig)	Relief Valve Setting (psig)		
195	18	48	5090	5	15		

SPLIT SYSTEM AIR CONDITIONING UNIT												
Conditioning Air Data					Cooling Data				Condensing Unit Data			
Quantity	Fan CFM	Fan MHP	FLA	Fan V-PH	EAT DB (F)	EAT WB (F)	MBH (total)	MBH (sen)	Capacity (Tons)	Air Flow (CFM)	V-PH	Notes
1	2500	1.5	7.2	460-3	75	63	60.9	52.8	5	4200	460-3	Server Room
1	310	----	0.34	115-1	75	63	12	9	1	850	115-1	Telecom

CONDENSATE PUMP											
				Receiver Data				Motor Data			
System	Type	Capacity (gpm)	Discharge Pres (psig)	Size (gal)	Inlet (in)	Disch (in)	Vent (in)	QTY	HP	RPM	V-PH
AHU-1,2	Underground	70	25	/	4	2	2	2	2	3500	460-3
AHU-3,4	Underground	70	25	/	4	2	2	2	2	3500	460-3
HHW SHX	Floor mounted	45	30	52	3	1.5	2	2	1.5	3500	460-3
DHW SHX	Floor mounted	45	30	52	3	1.5	2	2	1.5	3500	460-3
Plant Return	Elevated	150	25	342	4	2	2	3	5	3500	460-3

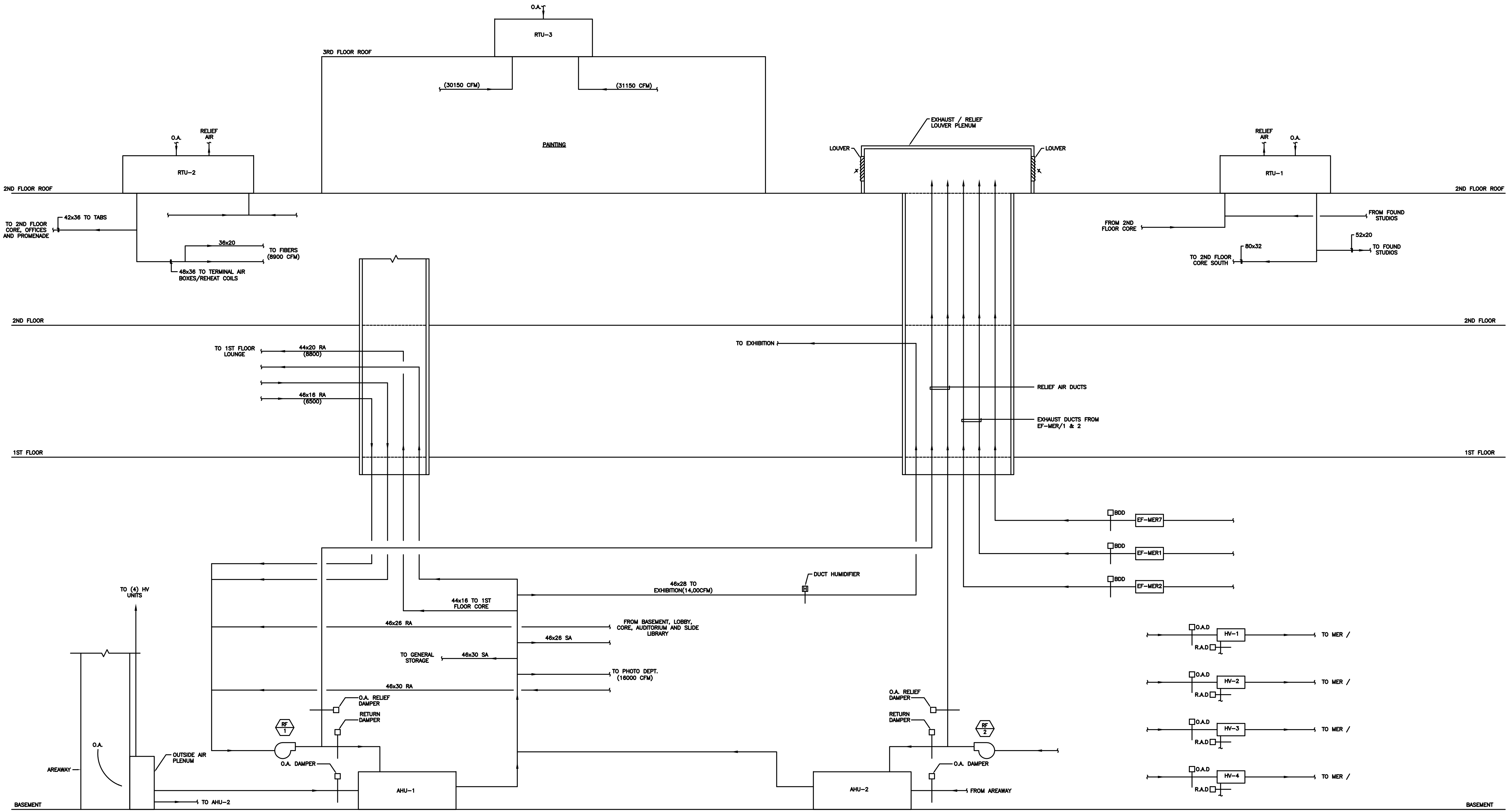
COOLING COIL (Chilled Water)					
System	Capacity (cfm)	Coils in Bank	Min Rows	Max Fins/inch	Max Face Velocity (fpm)
AHU - 1	50000	3	6	10	500
AHU - 2	50000	3	6	10	500
AHU - 3	62000	3	8	10	500
AHU - 4	62000	3	8	10	500
RTU - 1	42000	1	6	10	500
RTU - 2	51000	1	6	10	500
RTU - 3	35000	1	8	10	500
MAU - 1	5000	1	4	10	500
Airside Data					
	EAT DB (F)	EAT WB (F)	LAT DB (F)	LAT WB (F)	Air PD (in.WG)
AHU - 1	80	67	52.6	52.4	0.84
AHU - 2	80	67	52.6	52.4	0.84
AHU - 3	94	74	51.3	51.2	1.06
AHU - 4	94	74	51.3	51.2	1.06
RTU - 1	84	70	53	53	0.64
RTU - 2	81.7	67.3	53	53	0.84
RTU - 3	94	74	51	51	0.98
MAU - 1	94	74	60	59.4	0.41
Waterside Data					
	EWT (F)	LWT (F)	Flow (gpm)	Max WPD (ft)	
AHU - 1	45	57	380	10	
AHU - 2	45	57	380	10	
AHU - 3	45	57	770	20	
AHU - 4	45	57	770	20	
RTU - 1	45	57	375	10	
RTU - 2	45	57	380	10	
RTU - 3	45	57	438	20	
MAU - 1	45	55	80	2	

HEATING COIL										
						Airside Data			Steam Data	
System	Air Capacity (cfm)	Coils in Bank	Min Rows	Max Fins/inch	Max Face Velocity (fpm)	EAT DB (F)	LAT DB (F)	Air PD (in. WG)	Flow (lbs/hr)	Pres (psig)
AHU -1	50000	1	2	10	725	40	78	0.18	2172	5
AHU - 2	50000	1	2	10	725	40	78	0.18	2172	5
AHU - 3	62000	1	3	10	650	14	70	0.49	4695	5
AHU - 4	62000	1	3	10	650	10	70	0.49	4695	5
RTU - 1	42000	1	2	10	650	10	85	0.49	4695	5
RTU - 2	51000	1	3	10	650	40	85	0.49	4695	5
RTU - 3	35000	1	3	10	650	10	95	0.49	4695	5
HV - 1	10000	1	2	10	720	14	64	0.25	300	5
HV - 2	10000	1	2	10	720	14	64	0.4	600	5
HV - 3	10000	1	2	10	720	14	64	0.4	600	5
HV - 4	10000	1	2	10	720	14	64	0.4	600	5
MAU - 1	5000	1	2	10	700	14	64	0.37	306	5

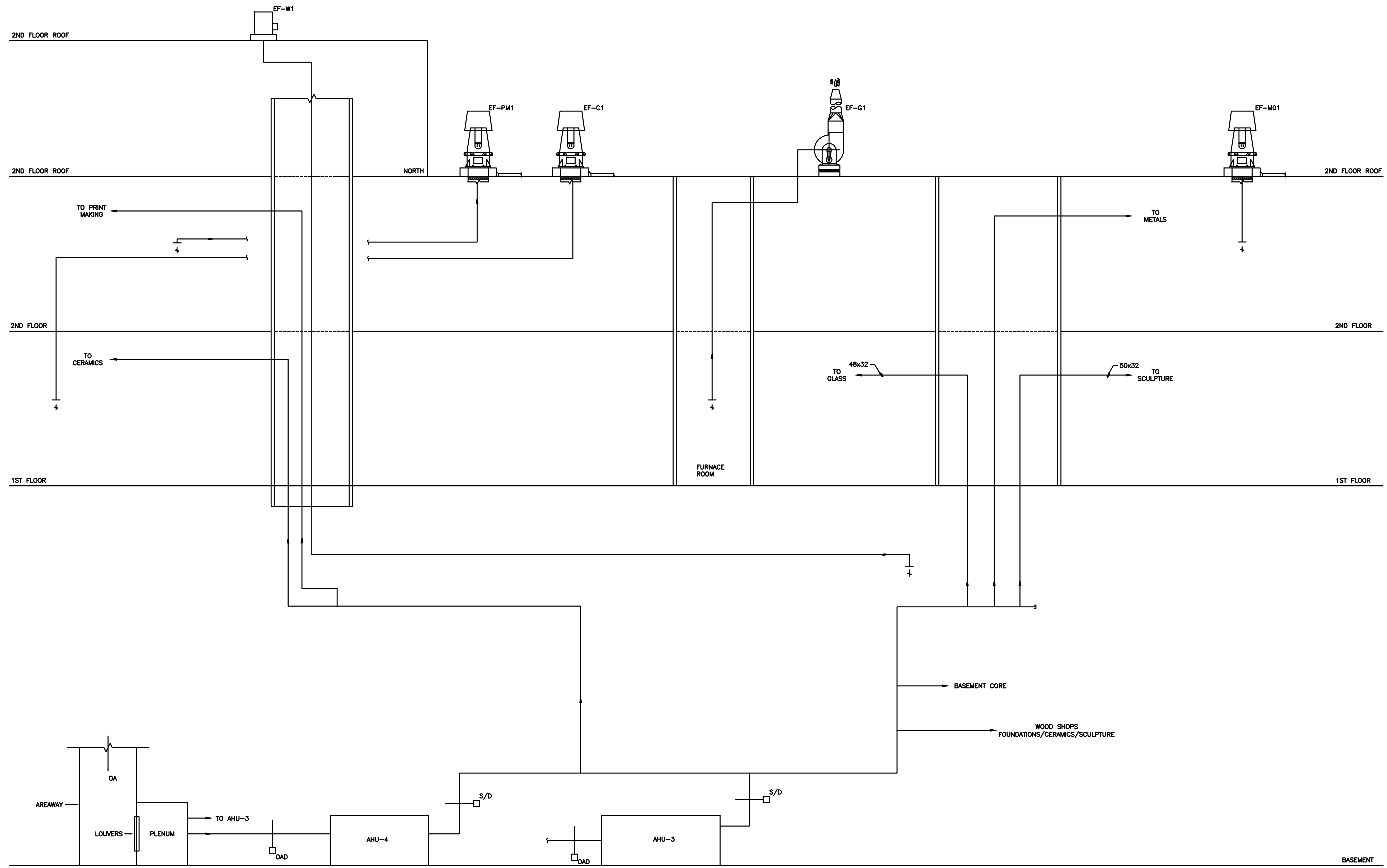
HUMIDIFIER (Steam)						
			Steam Data		Manifold Data	
System	Type	Air Capacity (cfm)	Total Flow (lbs/hr)	Pres (psig)	QTY	Length (in)
AHU - 1,2	Dispersion Tube	14000	71	12	1	144
AHU - 3	Steam Grid	62000	1233	12	2	144
AHU - 4	Steam Grid	62000	1233	12	2	144
RTU - 3	Steam Grid	35000	646	12	1	144

SUPPLY FANS											
	Air Capacity								Motor		
System	Max CFM	Min CFM	TSP/ESP (in WG)	Min Wheel Diameter (in)	Max Outlet Velocity (fpm)	Fan Discharge	Fan RPM	Control	HP	Max RPM	V-PH
AHU - 1	50000	26000	6.56/3	40	2900	TH	1161	VFD	100	1750	460-3
AHU - 2	50000	26000	6.56/3	40	2900	TH	1161	VFD	100	1750	460-3
AHU - 3	62000	62000	7.2/3	40	3700	TH	1314	VFD	125	1750	460-3
AHU - 4	62000	62000	7.2/3	40	3700	TH	1314	VFD	125	1750	460-3
RTU - 1	42000	24750	6.16/3	40	2500	TH	1046	VFD	75	1750	460-3
RTU - 2	50000	28000	8.17/5	40	2500	TH	1166	VFD	100	1750	460-3
RTU - 3	35000	31150	8.38/5	40	2000	TH	1160	VFD	75	1750	460-3
HV - 1	10000	10000	2.39/1.5	20	2200	TH	1539	VFD	10	1750	460-3
HV - 2	10000	10000	2.39/1.5	20	2200	TH	1539	VFD	10	1750	460-3
HV - 3	10000	10000	2.39/1.5	20	2200	TH	1539	VFD	10	1750	460-3
HV - 4	10000	10000	2.39/1.5	20	2200	TH	1539	VFD	10	1750	460-3
MAU - 1	5000	5000	3	15	2500	TH	1117	VFD	5	1750	460-3

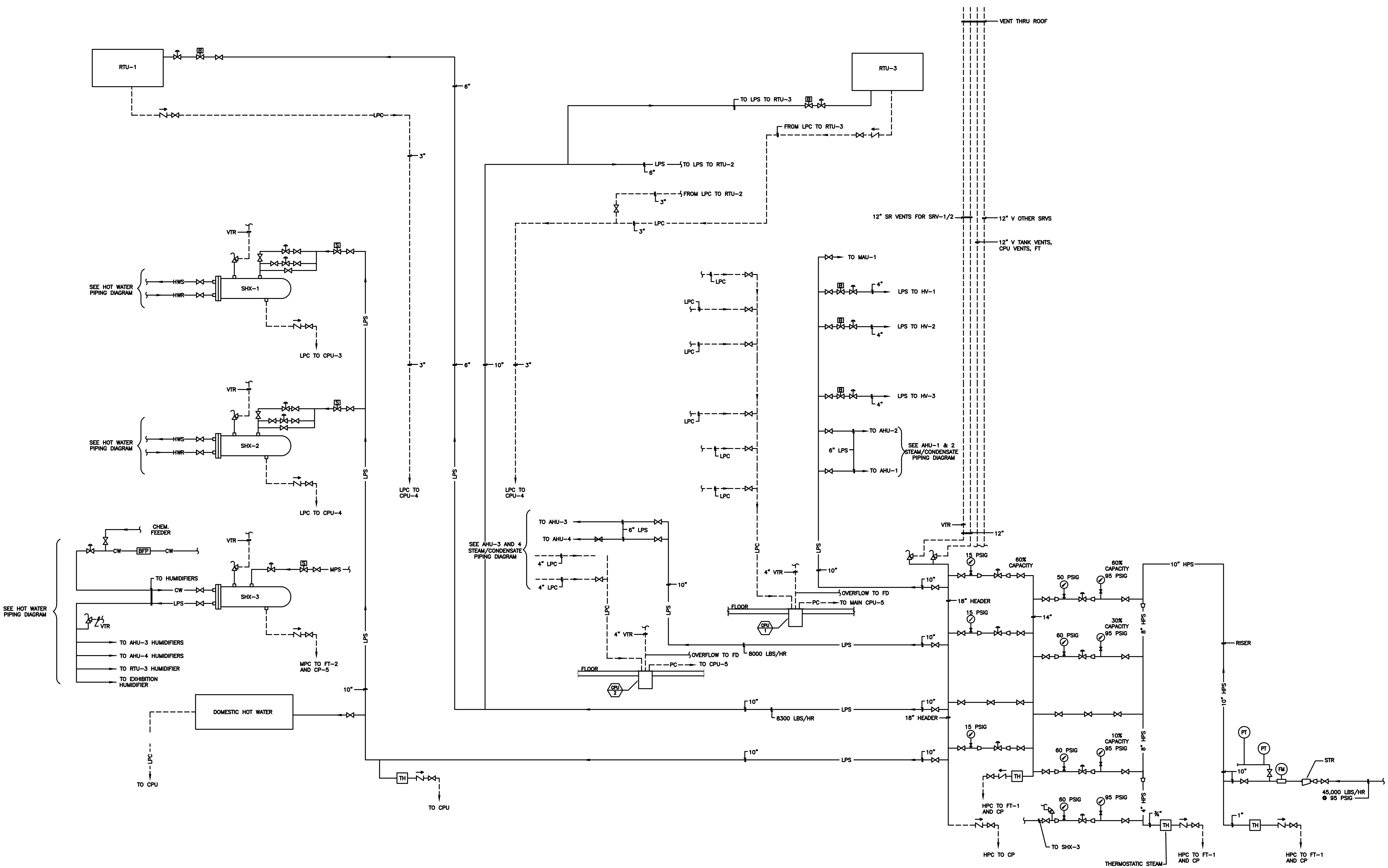
RETURN FANS												
	Air Capacity								Motor		
System	Max CFM	Min CFM	TSP/ESP (in WG)	Min Wheel Diameter (in)	Max Outlet Velocity (fpm)	Fan Discharge	Fan RPM	Control	HP	Max RPM	V-PH
AHU - 1	50000	25000	4	44.5	2500	INLINE	689	VFD	50	1750	460-3
AHU - 2	50000	25000	4	44.5	2500	INLINE	689	VFD	50	1750	460-3
RTU - 1	21000	21000	2.8/2	40	2500	TH	893	VFD	25	1750	460-3
RTU - 2	50000	17500	3.8/3	40	2500	TH	893	VFD	50	1750	460-3
RTU - 3	35000	12250	3.83/3	40	2000	TH	827	VFD	50	1750	460-3



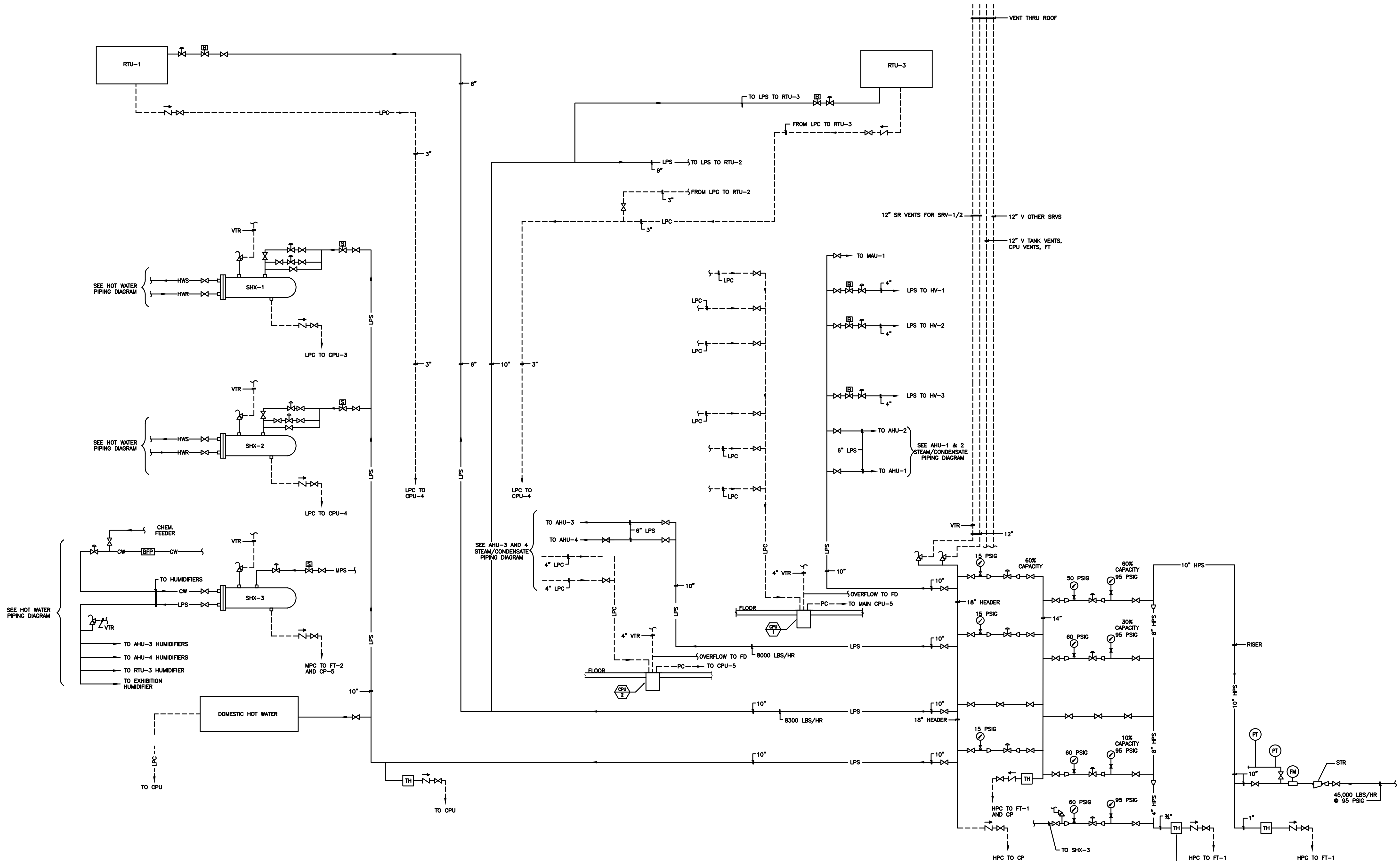
AIR FLOW DIAGRAM (AHU-1, AHU-2, RTU-1, RTU-2, RTU-3)



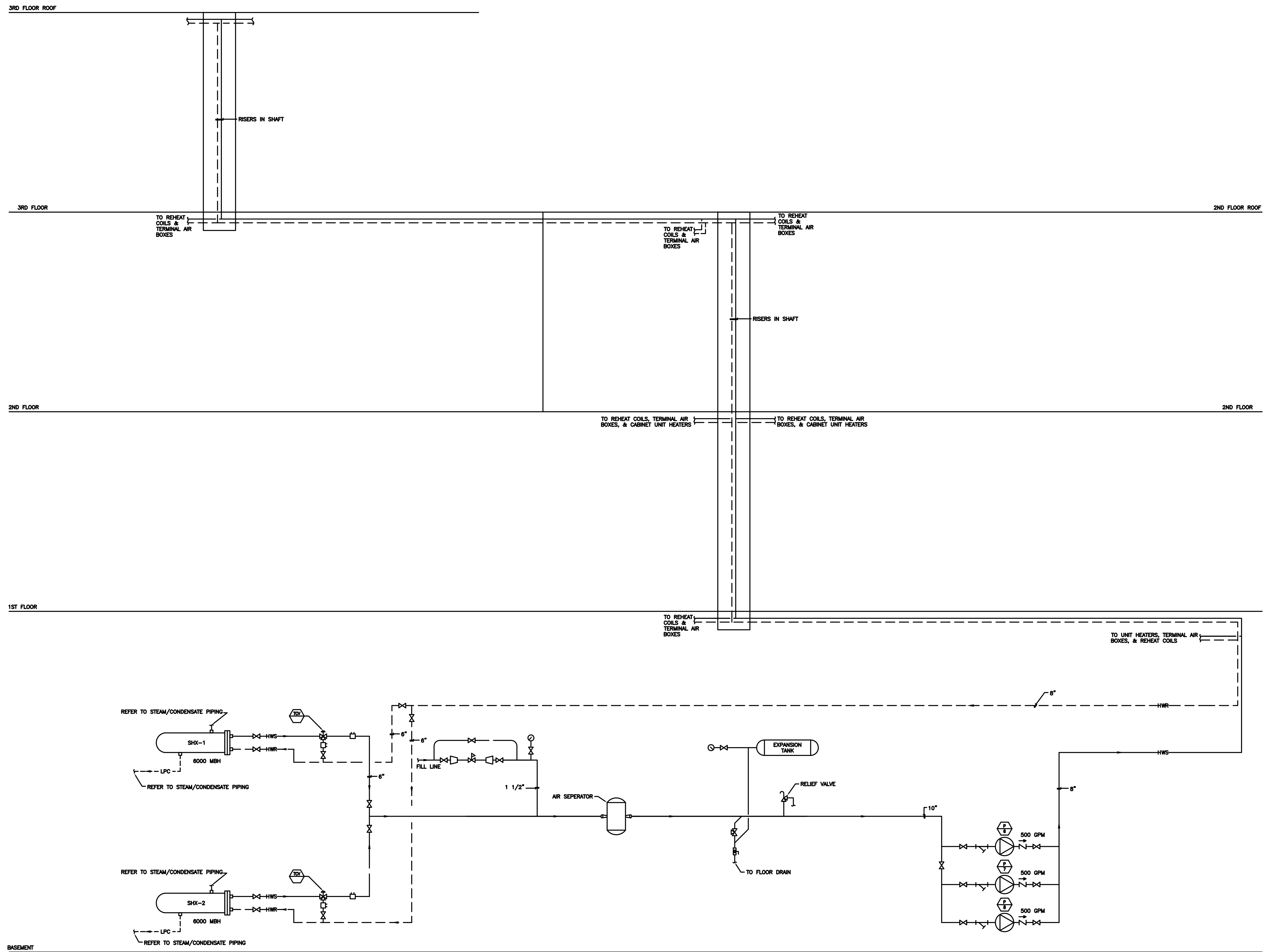
AIR FLOW DIAGRAM (AHU-3/4)



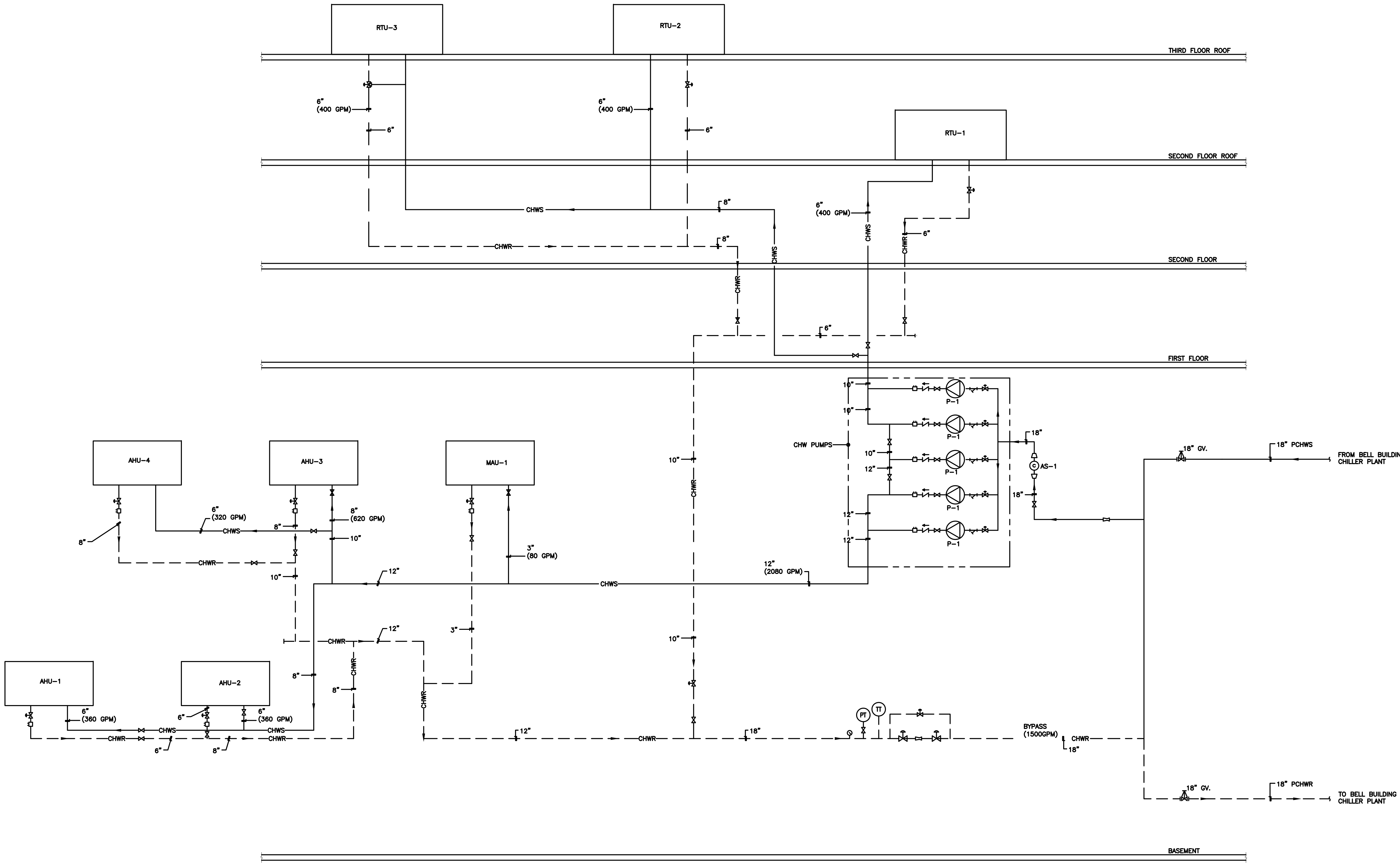
STEAM AND CONDENSATE PIPING DIAGRAM



STEAM AND CONDENSATE PIPING DIAGRAM



HOT WATER PIPING DIAGRAM



CHILLED WATER PIPING DIAGRAM