

# Technical Assignment 3

## Mechanical Systems Existing Conditions Evaluation



Rendering Courtesy of A/S/G Architects

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## Executive Summary:

This report contains an analysis of the existing conditions of the mechanical systems designed for the Center for the Arts on the University of Delaware campus. Also as part of this report is a brief summary of the previous Technical assignments, the compliance of the Center for the Arts to ASHRAE Standard 62, and the heating and cooling loads and energy analysis determined using Trane TRACE 700.

The mechanical system design was largely influenced by the location and availability of campus wide distribution of chilled water and steam as well as the design criteria of the spaces. The performance spaces in the Center for the Arts are extremely sensitive to noise levels in order to achieve the highest quality performances.

The Center for the Arts is located in Newark, Delaware and is subject to 95°F dry bulb and 78°F wet bulb for summer conditions and 0°F for winter conditions. Instrument tuning is extremely sensitive to changes in humidity levels and therefore requires that indoor conditions be maintained at fairly constant relative humidity levels.

There are six air handling units that supply air to the Center for the Arts. Two of the units are variable air volume units and four are constant volume units. One constant volume unit supplies air through an underfloor distribution system in order to lower background noise levels produced by the air distribution system and achieve the required noise level criteria of RC 15-19. The preheat and reheat coils in the air-handling units receive heating water that originates as steam from the campus main distribution system before it is converted to heating water in the basement of the Center for the Arts. The cooling coils in the air-handling units receive chilled water from the campus distribution system. Schematics for each of the air-handling units, the chilled water system, and the heating water system are contained within this report.

The system as designed attempts to balance minimizing energy use while providing air to acoustically sensitive performance spaces in a way creates minimum background noise levels.

## Design Objectives and Requirements:

The Center for the Arts is a performing arts center located on the University of Delaware campus in Newark, Delaware. The Center for the Arts consists of a Proscenium Theater, Recital Hall, Orchestra Rehearsal, and Theater Rehearsal as the major performing spaces as well as 32 practices rooms. The location of the building on the University of Delaware campus limits the energy supply system to that of the campus central distribution systems. The University of Delaware provides steam for heat generation and chilled water for cooling.

The primary factor contributing to the mechanical system design is the use of the spaces and their acoustical sensitivity. The choice of air delivery to the performing spaces plays a significant role in providing patron comfort and determining architectural volume and acoustical response time. Each of the performing spaces must meet the noise criteria specified by the University of Delaware. The noise criteria allowable noise levels affect the equipment selection and sizing.

A humidification system is required due to the impact of humidity levels on tuning and preservation of musical instruments. The humidification system is also subject to the campus central distribution system. The university will provide natural gas to the Center for the Arts to create steam, from a gas fired generator, to humidify the spaces.

## Outdoor and Indoor Design Conditions:

The outdoor design conditions the Center for the Arts are 95°F dry bulb and 78°F wet bulb for summer conditions and 0°F for winter conditions.

The indoor design conditions vary depending on the use of the space. For performance, rehearsal, practice, and instrument storage spaces, the summer conditions are 72° ± 2°F dry bulb and 50% ± 5% relative humidity, and the winter conditions are 72° ± 2°F dry bulb and 45% ± 5% relative humidity.

For public and support spaces, the summer conditions are 72° ± 2°F dry bulb and 55% ± 5% relative humidity, and the winter conditions are 72° ± 2°F dry bulb and 45% ± 5% relative humidity.

For the mechanical, electrical general storage, and shipping/ receiving spaces, the space temperature will be generally maintained for summer condition of 85°F and winter condition of 60°F.

For telecommunication rooms/ closets, the year round condition of 75°F will be maintained.

## Energy Sources and Rates:

On the campus of the University of Delaware, the buildings are heated from gas burning boilers, which generate steam at a central distribution plant. The electricity used in the buildings on the University of Delaware campus is supplied by the city of Newark. Table 1 contains the natural gas prices for Delaware according to the Delaware Division of the Chesapeake Utilities Corporation.

Table 1:

Natural Gas Utility Charges	
Customer Charge	\$17.50 / month
First 20ccf	\$0.655 / ccf
Next 30ccf	\$0.445 / ccf
Over 50ccf	\$0.195 / ccf

Table 2 contains the electricity rates for a large commercial building in Delaware according to the state deregulation rates.

Table 2:

Electric Utility Charges	
Consumer Charge	\$13.60 / month
Demand (Avg. >50 kw)	\$9.60 / kw
Energy	\$0.03796 / kwh

Due to the location of the Center for the Arts on the University of Delaware campus the choice of sources for energy is limited to those that supply the university.

## Design Ventilation Requirements:

Six air-handling units service the Center for the Arts. A summary of each of the air-handling unit's compliance with ASHRAE Standard 62 is shown in Table 3.

Table 3:

	AHU -1	AHU-2	AHU-3	AHU-4	AHU-5	AHU-6
<b>ASHRAE Std. 62.1-2004</b>						
V <sub>ou</sub> (Uncorrected OA Intake)	4250	2773	786	5028	1587	2357
E <sub>v</sub> (Distribution Effectiveness)	0.64	0.80	1.00	0.44	0.90	0.80
V <sub>ot</sub> (OA Intake)	6674	3467	786	11389	1763	2946
Σv <sub>oz</sub> (Sum of zone OA)	5312	2773	786	6314	1322	2357
Max Z <sub>p</sub> (Max OA Fraction)	0.81	0.35	0.08	0.86	0.17	0.34
Min OA %	0.35	0.44	0.08	0.33	0.17	0.42
<b>Design Conditions</b>						
AHU Total Air Flow	19200	7900	9450	35000	10500	7000
Scheduled Min OA	6700	4000	950	11700	1800	3000
% OA	0.35	0.51	0.10	0.33	0.17	0.43
<b>ASHRAE Std. 62.1-2004 Compliance</b>	Yes	Yes	Yes	Yes	Yes	Yes

AHU-1 is a variable air volume unit that supplies air to the Public Lobby and several of the performance support spaces.

AHU-2 is a constant volume unit that supplies air to the Proscenium Theater.

AHU-3 is a constant volume unit that supplies air to the Proscenium Stage.

AHU-4 is a variable air volume unit that supplies air to the Theater Rehearsal, back of house support areas and the practice rooms on the second floor.

AHU-5 provides air to the Recital Hall via an under floor distribution system.

AHU-6 is a constant volume unit that supplies air to the Orchestra Rehearsal.

### Design Heating and Cooling Loads:

The heating and cooling loads were determined using Trane Trace 700 simulation program. A comparison of the design loads and the simulation loads determined in Technical Assignment 2 are located in Appendix A.

### Annual Energy Use:

The Center for the Arts is still under construction therefore the Trane Trace 700 simulation program was used to estimate the annual energy use. Mueller Associates, the MEP firm that designed this project, did not perform an energy analysis therefore there are no design values to compare to the simulation results from Technical Assignment 2. The Trace 700 simulation found that the Center for the Arts will use approximately 305,000 kBtu/yr. Appendix B contains the summary of Energy use as simulated by Trace 700.



Schematic Drawings:

AHU-1 & 4

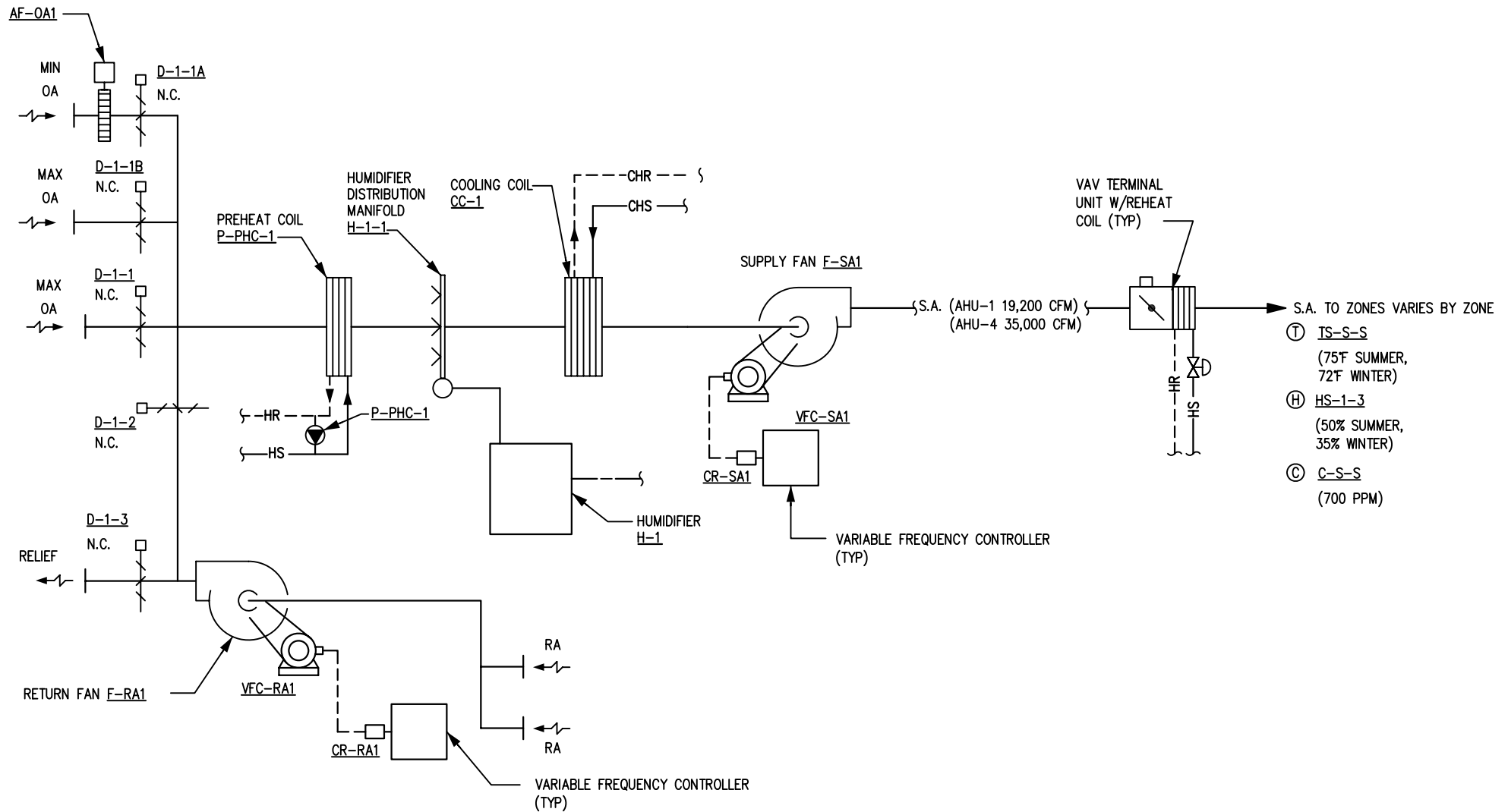
AHU-2

AHU-3 & 6

AHU-5

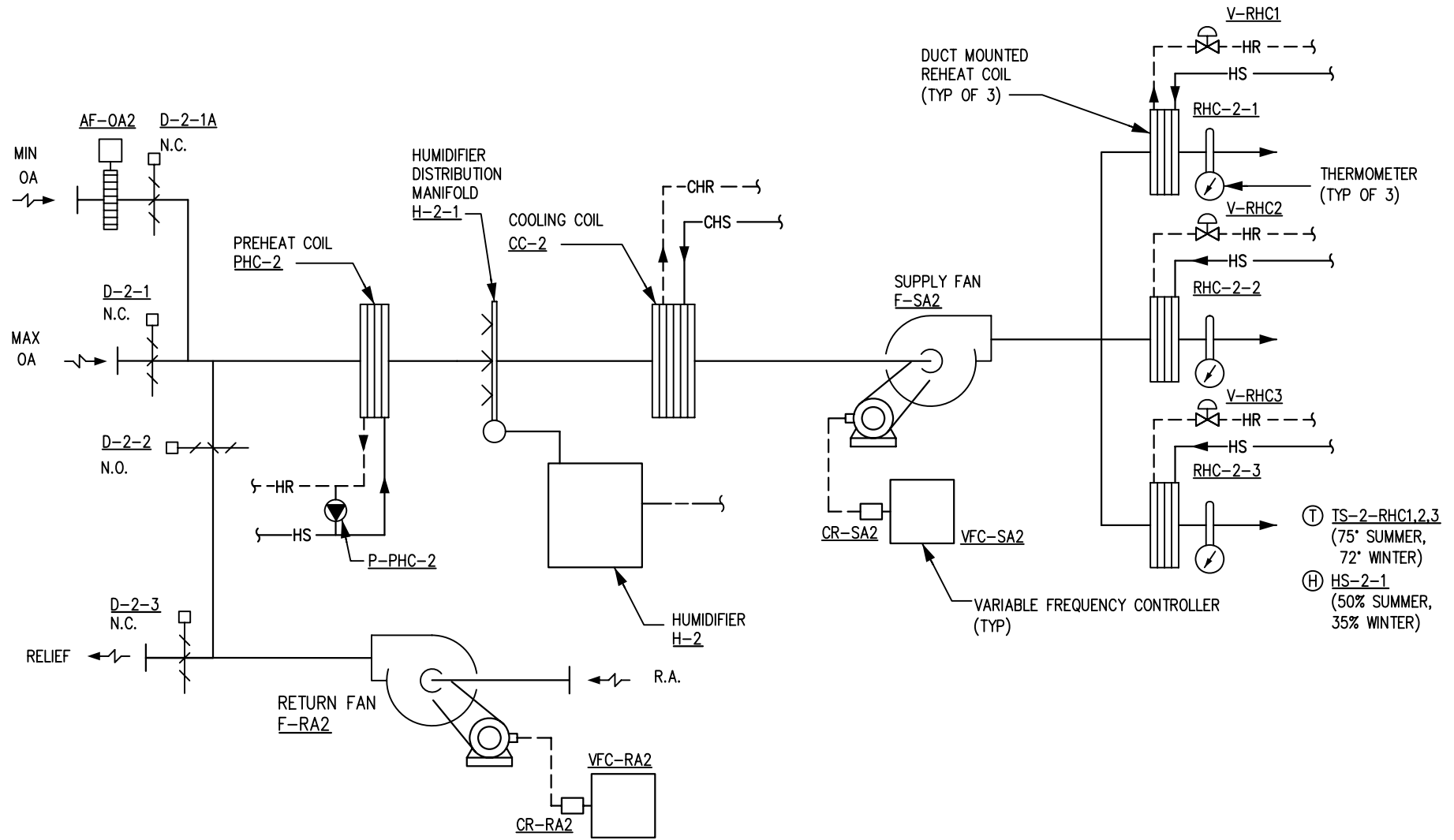
Chilled Water System

Heating Water System

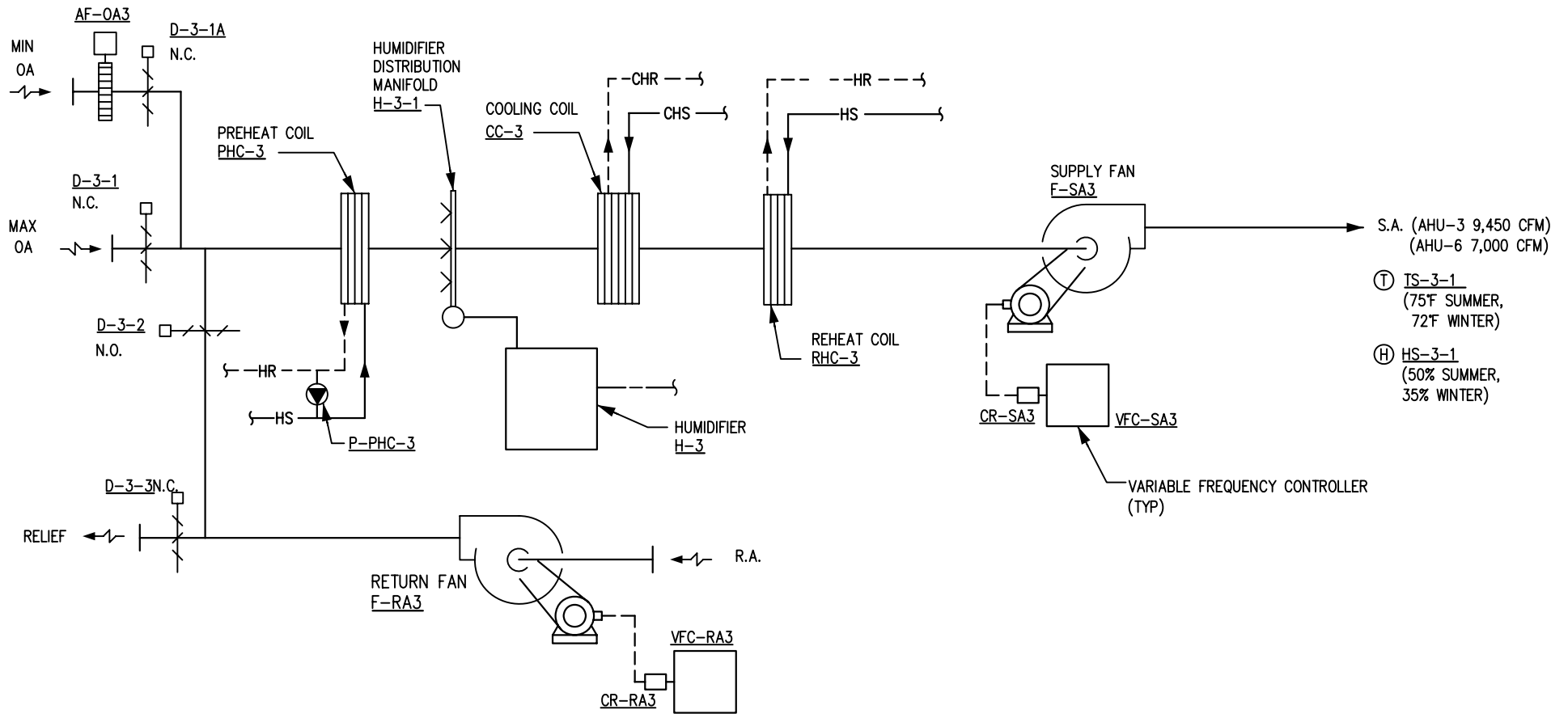


AIR HANDLING UNIT NO. 1 – PUBLIC LOBBY  
(AHU-4 – THEATER REHEARSAL & BACK OF HOUSE, SIMILAR)

N.T.S



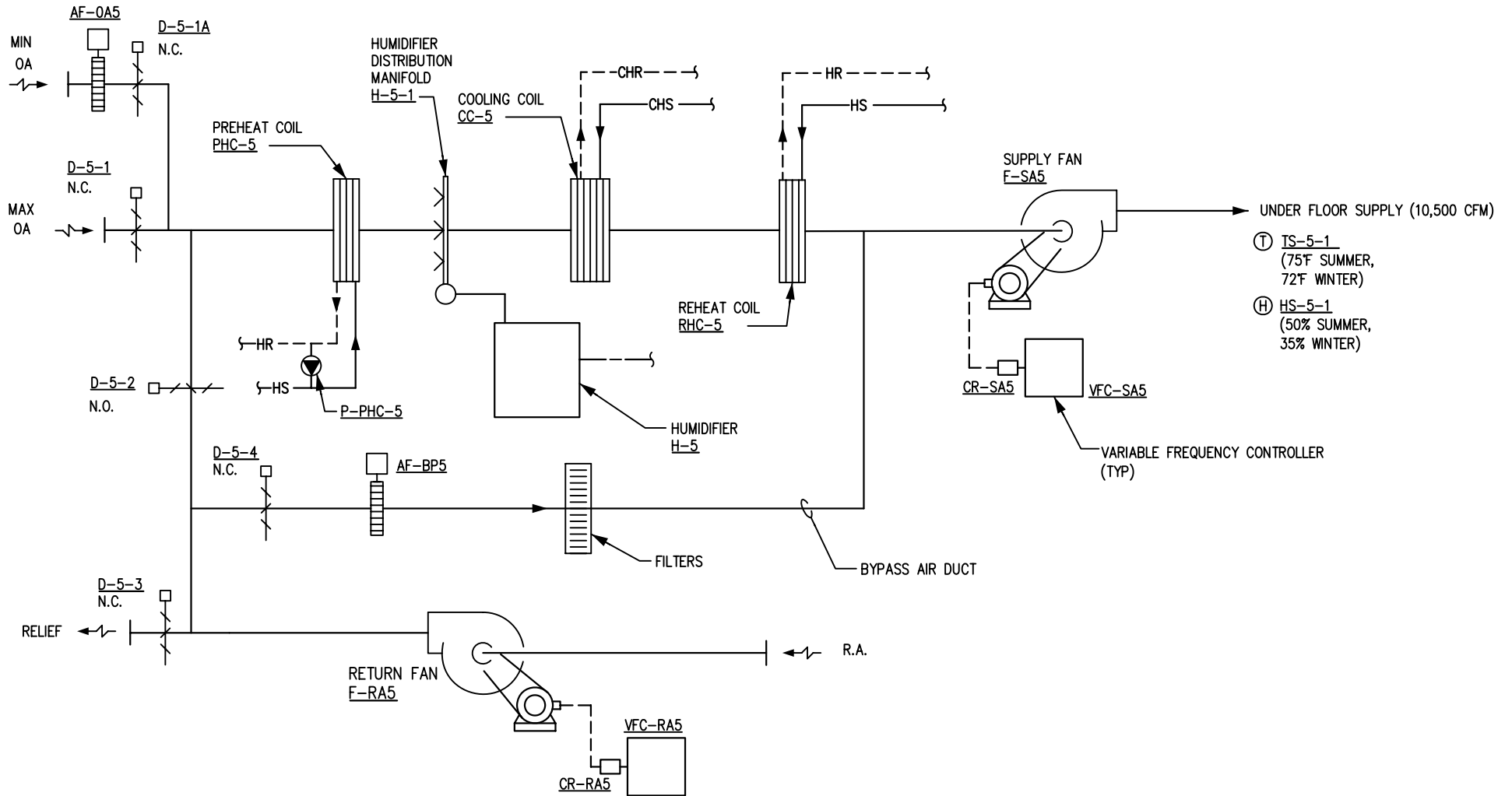
AIR HANDLING UNIT NO. 2 – PROSCENIUM THEATER  
N.T.S



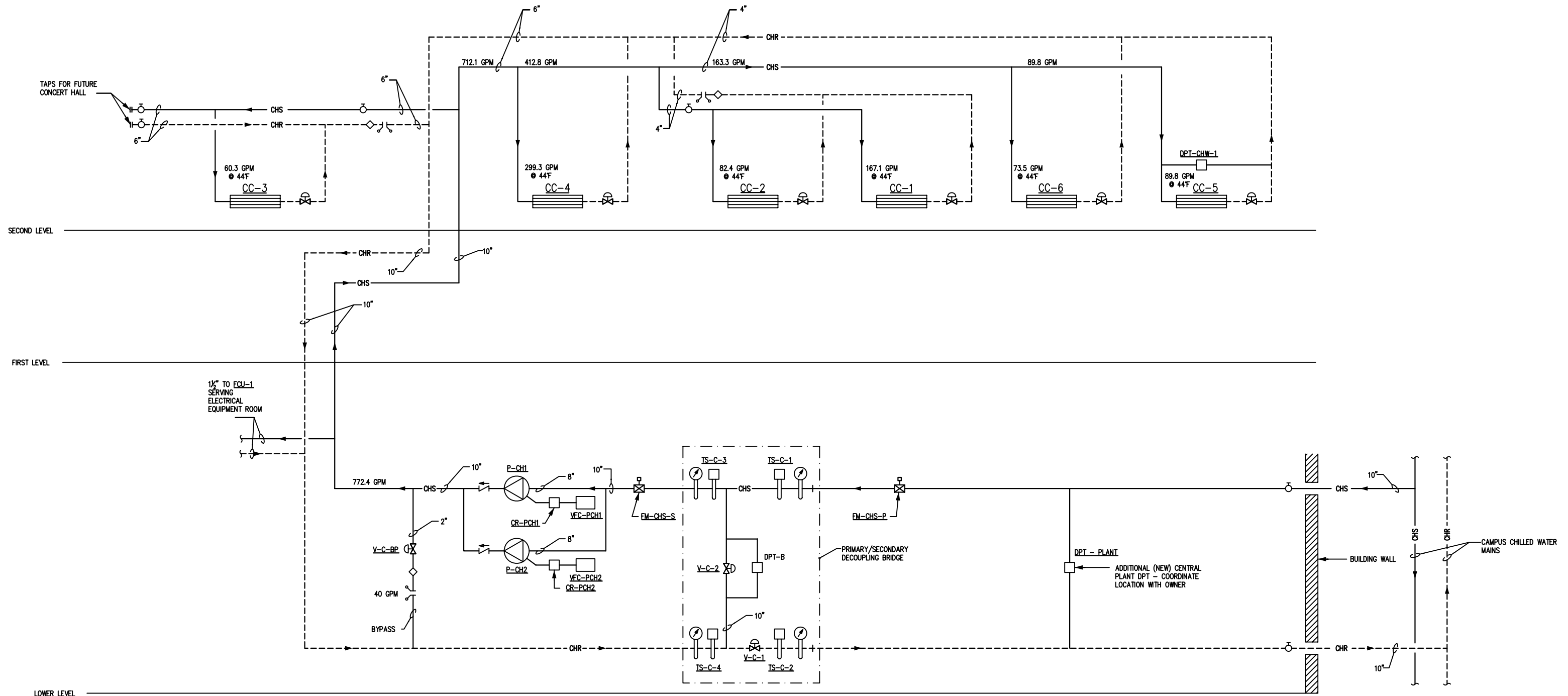
AIR HANDLING UNIT NO. 3 – PROSCENIUM STAGE

(AHU-6 – ORCHESTRA REHEARSAL, SIMILAR)

N.T.S

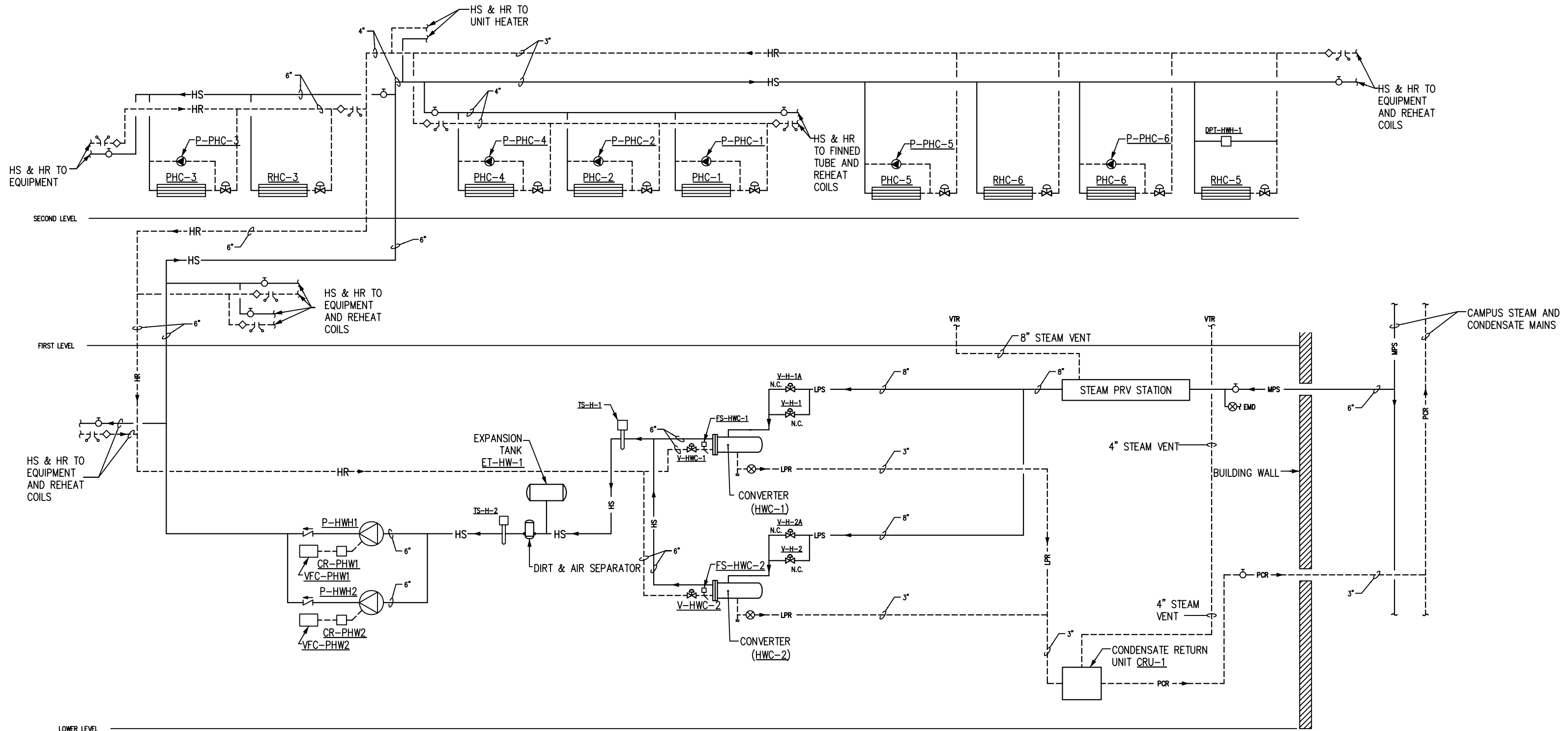


AIR HANDLING UNIT NO. 5 – RECITAL HALL  
N.T.S



CHILLED WATER SYSTEM SCHEMATIC

NO SCALE



HEATING SYSTEM SCHEMATIC  
NO SCALE

Schedules:

Table 4: Air Handling Units

Air Handling Units												
General			Cooling Coil									
Designation	Total Airflow (cfm)		Designation	Capacity (MBH)		EAT (°F)		LAT (°F)		EWT (°F)	LWT (°F)	Water Flowrate (GPM)
	Max	Min		Sensible	Total	DB	WB	DB	WB			
AHU-1	19200	9600	CC-1	663.6	1002.2	82.0	68.6	50.0	49.5	44	56	167.1
AHU-2	7900	2650	CC-2	282.4	494.1	85.1	71.1	52.0	51.5	44	56	82.4
AHU-3	9450	3150	CC-3	255.2	361.5	77.0	64.4	52.0	51.5	44	56	60.3
AHU-4	35000	17500	CC-4	1122.7	1795.5	81.7	68.2	52.0	51.5	44	56	299.3
AHU-5	10500	3500	CC-5	362.9	538.7	82.0	66.8	50.0	49.5	44	56	89.8
AHU-6	7000	2350	CC-6	254.0	441.0	83.6	70.2	50.0	49.5	44	56	73.5

Heating Coil						
Designation	Capacity (MBH)	EAT (°F)	LAT (°F)	EWT (°F)	LWT (°F)	Water Flowrate (GPM)
PHC-1	414.7	30	50	180	160	41.6
PHC-2	170.6	32	52	180	160	17.2
PHC-3	204.1	32	52	180	160	20.4
RHC-3	306.2	55	85	200	170	20.4
PHC-4	756.0	32	52	180	160	75.6
PHC-5	226.8	30	50	180	160	22.8
RHC-5	362.9	53	85	200	170	24.2
PHC-6	151.2	30	50	180	160	15.2
RHC-6	241.9	53	85	200	170	16.1



Table 5: Humidifiers

Humidifiers					
Designation	Input Capacity (MBH)	Output Capacity (LBS/HR)	Max APD (IN W.G.)	Min No. Dispersion Tubes	Voltz/Phase/ Hz
H-1	476	400	0.10	12	120/1/60
H-2	238	200	0.10	7	120/1/60
H-3	238	200	0.10	6	120/1/60
H-4	700	600	0.10	12	120/1/60
H-5	238	200	0.10	5	120/1/60
H-6	238	200	0.10	8	120/1/60

Table 6: Expansion Tanks

Expansion Tank					
Designation	Service	Type	Tank Volume (Gal)	Fill Pressure (PSIG)	Relief Valve Setting (PSIG)
ET-HW-1	Heating Water	Heavy Duty Bladder	317	25	60
ET-DHWR	Domestic Water		2.1	55	80

Table 7: Steam to Water Converter

Steam to Water Converter												
Designation	Min Diameter (IN)	Max Length (IN)	No. of Passes	Capacity (MBH)	Water Flowrate (GPM)	EWT (°F)	LWT (°F)	Max WPD (FT HD)	Steam (PSIG)		Control Valve (LBS/HR)	Steam Trap (LBS/HR)
									Control Valve	Entering Shell		
HWC-1	20	60	4	7700	530	170	200	4	15	5	8100	24300
HWC-2	20	60	4	7700	530	170	200	4	15	5	8100	24300

Table 8: Pumps

Pumps								
Designation	Type	Service	Water Flowrate (GPM)	Head (FT HD)	Min Pump Efficiency	Pump Speed (RPM)	BHP / Motor HP	Volts/Ph/Hz
P-CH1	Vert In-line	Chilled Water	750	100	78	1750	24.3 / 40	460/3/60
P-CH2	Vert In-line	Chilled Water	750	100	78	1750	24.3 / 40	460/3/60
P-HWH1	Vert In-line	Heating Water	265	90	67	1750	9.0 / 15	460/3/60
P-HWH2	Vert In-line	Heating Water	265	90	67	1750	9.0 / 15	460/3/60
P-PHC-1	In-line	AHU-1 PH Coil	20.8	12	40	1150	0.16 / 0.25	115/1/60
P-PHC-2	In-line	AHU-2 PH Coil	8.6	14	25	1150	0.12 / 0.25	115/1/60
P-PHC-3	In-line	AHU-3 PH Coil	10.2	17	29	1150	0.15 / 0.25	115/1/60
P-PHC-4	In-line	AHU-4 PH Coil	37.8	10	41	1150	0.23 / 0.33	115/1/60
P-PHC-5	In-line	AHU-5 PH Coil	11.4	9	23	1150	0.10 / 0.25	115/1/60
P-PHC-6	In-line	AHU-6 PH Coil	7.6	13	23	1150	0.11 / 0.25	115/1/60
P-DBP-1		Domestic water	115	138	-	3600	10	460/3/60
P-DBP-2		Domestic water	115	138	-	3600	10	460/3/60
P-SEJ-1		Sanitary	77	22	-	1750	2	460/3/60
P-SEJ-2		Sanitary	77	22	-	1750	2	460/3/60
P-SUP-1		Storm	50	25	-	1750	1	460/3/60
P-SUP-2		Storm	50	25	-	1750	1	460/3/60
P-DHWR-1	In-line	Domestic HW	3	15	-	3250	1/8	115/1/60
P-ELV-1		Sanitary	55	15	-	3600	1/2	460/3/60
P-ELV-2		Sanitary	55	15	-	3600	1/2	460/3/60
P-ELV-3		Sanitary	55	15	-	3600	1/2	460/3/60

Table 9: Condensate Return Units

Condensate Return Units							
Designation	Type	Capacity	Inlet Pressure (PSIG)	Lift Pressure (PSIG)	Pump Speed (RPM)	Motor HP	Volts /Ph/Hz
CRU-1	Pressure Powered	15,000 LBS/HR	40	30	---	---	---
CRU-2	Electric Pump	15 GPM	---	20	1750	2 @ 1/2	460/3/60

Table 10: Unit Heaters and Cabinet Unit Heaters

Propeller Unit Heaters and Cabinet Unit Heaters					
Designation	Location	Minimum Capacity	Airflow @ 70°F EAT (CFM)	Water Flowrate @ 200°F EWT (GPM)	Max WPD (FT HD)
UH-1	Mech Room	50 MBH	1535	3.3	1.0
UH-2	Mech Room	15 MBH	590	1.0	1.0
UH-3	Corridor 100P	15 MBH	590	1.0	1.0
CUH-1	Vestibule 100N	62.4 MBH	660	4.2	5.9
CUH-2	South Vestibule	3 kW	330	---	---
CUH-3	Vestibule 100T	19.5 MBH	280	1.3	3.2
CUH-4	Vestibule 100W	44.2 MBH	670	2.9	9.9
CUH-5	Vestibule 100Y	44.2 MBH	670	2.9	9.9
CUH-6	Vestibule 100Z	28.6 MBH	340	1.9	4.3
CUH-7	Stair 199A	16.9 MBH	210	1.1	4.1
CUH-8	Band Storage	16.9 MBH	210	1.1	4.1
CUH-9	Reception 100R	31.2 MBH	400	2.1	3.3

## System Operation:

### *Air-Handling Units:*

The air-handling units have two modes of operation occupied mode and unoccupied mode. The direct digital control (DDC) system monitors and controls the operation of the components of the air-handling unit. The AHU operates under unoccupied mode until 2 or more of the zones request operation. The outdoor air temperature and the supply air temperature largely contribute how the AHU operates.

### *Variable Air Volume Air-Handling Units 1 and 4:*

When the outdoor air temperature is at or above 65°F the preheat coil does not operate and chilled water to the cooling coil maintains the supply air temperature 55°F. During these operating conditions, the return air damper is closed and the relief air damper remains open to maintain adequate minimum outdoor air.

When the outdoor air temperature is between 52°F and 65°F the preheat coil does not operate and the cooling coil is used to maintain supply air at a temperature of 55°F. During these operating conditions, the maximum outdoor air is supplied and the relief air damper is closed.

When the outdoor air temperature is below 55°F the preheat coil warms the air so that the air does not freeze the cooling coils when the air passes through them. During these operating conditions, the minimum outdoor air damper is open.

Each of the zones has a carbon dioxide sensor, which the DDC monitors. If the amount of carbon dioxide exceeds the set limit of 700 ppm then the amount of outside air supplied to the AHU increases to combat the carbon dioxide levels.

The speed of the supply fan is modulated through a variable frequency controller to maintain static pressure in the supply ducts. The static pressure allows the supply air to be delivered to the spaces at the designed flow rate. The return air fan also is modulated through by a variable frequency controller. The return air fan maintains a differential between the supply airflow and the return airflow so that the building remains pressurized.

### *Constant Volume Single Zone Air-Handling Units 2, 3, and 6:*

When the space temperature is at or above 72°F and the outdoor air temperature is at or above 65°F, the chilled water flows through the cooling coil to maintain a supply air temperature of 72°F. The preheat and reheat coils at this time are closed. The outdoor air dampers are open to allow 20% of the design air volume.

When the space temperature is at or above 72°F and the outdoor air temperature is between 52°F and 65°F the maximum amount of outdoor air is supplied to the air-handling unit. The cooling coil and reheat coil maintain the supply air temperature and relative humidity levels.

When the space temperature is at or below 70°F the preheat coil maintains the supply air temperature at 70°F. The outdoor air dampers are open to allow 10% of the design supply air volume to be outdoor air.

*Chilled Water System:*

The chilled water for the Center for the Arts is supplied from the campus chilled water mains. There are two pumps, located in the lower level mechanical room, that each has a dedicated variable frequency controller to modulate the speed of the pump in order to maintain adequate system differential pressure. The pumps pump the chilled water to the cooling coils in the air handling units and the fan coil units that cool the electrical equipment room. The chilled water system is monitored by the DDC system.

*Heating Water System:*

The heating system for the Center for the Arts is supplied from the campus steam mains. The steam enters the Center for the Arts as medium pressure steam then encounters a pressure reducing station where the steam is converted to low pressure steam. The low pressure steam is then converted to 200°F water in one of the two steam to water converters. Before the water is pumped throughout the building, there is an expansion tank, which allows for the expansion of the water. There are two pumps, located in the lower level mechanical room, that each has a dedicated variable frequency controller to modulate the speed of the pump in order to maintain adequate system differential pressure. The heating water is then pumped throughout the building supplying heating water to the air-handling unit preheat and reheat coils, the unit heaters, duct mounted reheat coils and other equipment. The heating water system is monitored by the DDC system.

## System Critique:

The use of the spaces within the Center for the Arts building largely governed the decisions for mechanical equipment and design. The performing spaces are highly sensitive to the acoustical criteria. Each of the performance spaces have an isolated foundation to cut down on the transfer of vibration from one portion of the building to another. In the design of the mechanical systems the designers had to balance meeting the required RC ratings for each space and achieving the desired room temperature and humidity levels.

The most sensitive of the performing spaces is the Recital Hall which requires an RC rating of RC 15-19 in order to create the desired sound quality. This RC rating is difficult to achieve through the tradition over head supply of air. Kirkegaard Acoustical Consultants favor an underfloor supply system because it can be extremely effective in controlling background HVAC noise level, thus keeping the RC levels low enough to meet the required RC 15-19 levels.

The Proscenium Theater requires an RC 18-22 rating. The Proscenium Theater however, is supplied from above due to the presence of a balcony above the main seating level and an orchestra pit and storage located below the main seating level. Kirkegaard Acoustical Consultants favor constant volume systems over variable air volume system because of the noise created by the variable volume equipment. The Proscenium Theater air distribution is a constant volume system that is supplied from the gallery level 40' above seating level.

The two other large performance spaces are the orchestra rehearsal and the black box theater rehearsal. The orchestra rehearsal is supplied from over head from a dedicated constant volume air-handling unit. The theater rehearsal is supplied from the same variable air volume that supplies the practice rooms and back of house theater support rooms.

The Center for the Arts will use an estimated 2.8million kWh each year. One main advantage of using variable air volume air-handling units is their ability to reduce energy costs. The question arises though what do you sacrifice sound quality in the performance spaces or energy use. The answer falls within the hands of the owner and operator of the building, the University of Delaware. Does the university want a state of the art performance center that uses more energy but has performance spaces that create the highest quality performances? Or does the university want to sacrifice the performance quality of the spaces in order to save money on energy costs? Or can the university have both by implementing energy saving devices?

## Appendix A:

Design heating and cooling loads determined in Technical Assignment 2.

Design heating and cooling loads determined by Mueller Associates.

## Load / Airflow Summary

By ae

Description **		Floor Area ft²	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	ASHRAE 62-89 Htg OA fraction
Concessions - 120C	Rm/Zn Tot	241	2.0	7,080	7,580	297	7.39	89	-1,076	0	0.0	0.0
COATS - 131	Rm/Zn Tot	159	0.0	1,628	1,628	69	3.34	21	-255	0	0.0	0.0
INNER LOBBY - 100F	Rm/Zn Tot	550	40.0	12,130	22,130	604	5.99	181	-2,191	0	0.0	0.0
MEN - 132	Rm/Zn Tot	347	0.0	3,553	3,553	151	2.38	45	-556	0	0.0	0.0
WOMEN - 135	Rm/Zn Tot	474	0.0	4,853	4,853	207	2.38	62	-760	0	0.0	0.0
ELEVATOR ROOM - 168	Rm/Zn Tot	52	0.0	218	218	10	1.05	3	-38	0	0.0	0.0
LIGHT BOOTH - 155G	Rm/Zn Tot	179	1.0	3,305	3,555	140	4.27	42	-510	0	0.0	0.0
SOUND BOOTH -155H	Rm/Zn Tot	97	1.0	1,905	2,155	82	6.61	25	-297	0	0.0	0.0
ORCHARD STREET LOBBY-100B	Rm/Zn Tot	4,710	275.0	457,427	526,177	21,541	11.12	6,462	-158,415	0	0.0	0.0
CIRCULATION-200C	Rm/Zn Tot	855	25.0	6,250	12,500	335	1.68	100	-1,233	0	0.0	0.0
LOCK-250A	Rm/Zn Tot	143	0.0	1,707	1,707	72	2.75	22	-265	0	0.0	0.0
BOOTH- 237	Rm/Zn Tot	350	2.0	6,473	6,973	275	4.28	82	-1,000	0	0.0	0.0
SOUND ROOM - 239	Rm/Zn Tot	91	0.0	1,553	1,553	65	3.88	19	-236	0	0.0	0.0
DIMMER - 243	Rm/Zn Tot	125	0.0	437	437	20	0.89	6	-78	0	0.0	0.0
LOCK - 250D	Rm/Zn Tot	382	0.0	3,498	3,498	150	2.14	45	-552	0	0.0	0.0
VESTIBULE - 250G	Rm/Zn Tot	50	0.0	341	341	15	1.63	4	-55	0	0.0	0.0
<b>AHU-1</b>	Sys Tot/Ave	8,805	346.0	512,359	598,859	24,032			-167,517	0	0.0	0.0
<b>AHU-1</b>	Sys Block	8,805	346.0	512,359	598,859	24,032			-167,515	0	0.0	0.0
PROSCENIUM THEATRE SEATING	Rm/Zn Tot	4,387	502.0	200,364	325,864	8,423	4.43	0	-1	8,423	0.0	0.0
<b>AHU-2</b>	Sys Tot/Ave	4,387	502.0	200,364	325,864	8,423			-1	8,423	0.0	0.0
<b>AHU-2</b>	Sys Block	4,387	502.0	200,364	325,864	8,423			-1	8,423	0.0	0.0
PROSCENIUM THEATER STAGE	Rm/Zn Tot	3,094	60.0	108,667	123,667	4,707	2.20	0	-32,213	4,707	0.0	0.0
<b>AHU-3</b>	Sys Tot/Ave	3,094	60.0	108,667	123,667	4,707			-32,213	4,707	0.0	0.0
<b>AHU-3</b>	Sys Block	3,094	60.0	108,667	123,667	4,707			-32,213	4,707	0.0	0.0
RECITAL HALL SEATING	Rm/Zn Tot	2,420	200.0	99,557	149,557	4,108	3.00	0	-1,242	4,108	0.0	0.0
RECITAL HALL STAGE	Rm/Zn Tot	692	40.0	24,147	34,147	896	1.71	0	-283	896	0.0	0.0
<b>AHU-5</b>	Sys Tot/Ave	3,112	240.0	123,704	183,704	5,004			-1,526	5,004	0.0	0.0
<b>AHU-5</b>	Sys Block	3,112	240.0	123,704	183,704	5,004			-1,526	5,004	0.0	0.0
ORCHESTRA REHEARSAL	Rm/Zn Tot	5,114	410.0	268,939	371,439	7,991	2.29	0	-33,781	7,991	0.0	0.0

\*\* This report does not display heating only systems.



## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	Htg	ASHRAE 62-89 OA fraction
<b>AHU-6</b>	Sys Tot/Ave	5,114	410.0	268,939	371,439	7,991			-33,781	7,991	0.0	0.0	
<b>AHU-6</b>	Sys Block	5,114	410.0	268,939	371,439	7,991			-33,781	7,991	0.0	0.0	
WOMEN -104	Rm/Zn Tot	182	0.0	1,864	1,864	74	2.23	22	-374	0	0.0	0.0	
MEN - 105	Rm/Zn Tot	181	0.0	1,853	1,853	74	2.23	22	-371	0	0.0	0.0	
ELEVATOR ROOM-102A	Rm/Zn Tot	54	0.0	55	55	4	0.38	1	-34	0	0.0	0.0	
BAND STORAGE - 102	Rm/Zn Tot	654	0.0	3,030	3,030	127	1.06	38	-1,335	0	0.0	0.0	
INSTRUMENT STORAGE - 101D	Rm/Zn Tot	1,857	0.0	10,915	10,915	437	1.28	131	-6,043	0	0.0	0.0	
NORTH LOBBY - 100A	Rm/Zn Tot	1,600	97.0	61,611	85,861	2,606	8.88	782	-24,159	0	0.0	0.0	
CORRIDOR - 100C	Rm/Zn Tot	337	0.0	575	575	32	0.52	10	-249	0	0.0	0.0	
RECEPTION - 110	Rm/Zn Tot	123	1.0	796	1,046	36	1.58	11	-191	0	0.0	0.0	
CORRIDOR - 100D	Rm/Zn Tot	567	0.0	9,866	9,866	448	4.31	135	-13,078	0	0.0	0.0	
MANAGEMENT OFFICE - 111	Rm/Zn Tot	111	1.0	1,117	1,367	51	2.51	15	-252	0	0.0	0.0	
OPERATIONS OFFICE - 112	Rm/Zn Tot	115	1.0	1,132	1,382	52	2.46	16	-256	0	0.0	0.0	
NSO OFFICE - 106	Rm/Zn Tot	129	1.0	1,801	2,051	77	3.25	23	-366	0	0.0	0.0	
NSO LIBRARY - 106A	Rm/Zn Tot	491	6.0	8,203	9,703	332	3.68	99	-1,554	0	0.0	0.0	
CORRIDOR - 100E	Rm/Zn Tot	880	0.0	1,502	1,502	83	0.52	25	-649	0	0.0	0.0	
INSTRUMENT UNCASING - 123	Rm/Zn Tot	670	0.0	2,287	2,287	106	0.86	32	-670	0	0.0	0.0	
USHER - 114	Rm/Zn Tot	164	4.0	2,066	3,066	95	3.15	28	-452	0	0.0	0.0	
BOX OFFICE MANAGER - 115B	Rm/Zn Tot	120	2.0	1,851	2,351	85	3.86	25	-396	0	0.0	0.0	
BOX OFFICE -115	Rm/Zn Tot	121	3.0	5,404	6,154	222	10.02	67	-971	0	0.0	0.0	
BOX OFFICE WORKROOM - 115A	Rm/Zn Tot	267	3.0	3,023	3,773	131	2.67	39	-639	0	0.0	0.0	
PIANO STORAGE - 122	Rm/Zn Tot	227	0.0	620	620	30	0.72	9	-203	0	0.0	0.0	
GREEN ROOM 2 - 124	Rm/Zn Tot	282	7.0	2,032	3,782	102	1.98	31	-525	0	0.0	0.0	
CORRIDOR SOUTH - 100E	Rm/Zn Tot	444	0.0	758	758	42	0.52	13	-328	0	0.0	0.0	
BUILDING STORAGE -137	Rm/Zn Tot	89	0.0	243	243	12	0.72	4	-80	0	0.0	0.0	
PANTRY - 139	Rm/Zn Tot	168	0.0	5,367	5,367	242	7.85	73	-1,069	0	0.0	0.0	
DRESSING ROOM - 140	Rm/Zn Tot	284	4.0	4,877	5,877	207	3.97	62	-962	0	0.0	0.0	

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## Load / Airflow Summary

By ae

Description **		Floor Area ft²	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	ASHRAE 62-89 Htg OA fraction
DRESSING ROOM - 141	Rm/Zn Tot	390	4.0	7,496	8,496	305	4.26	91	-1,954	0	0.0	0.0
ELECTRICAL - 143	Rm/Zn Tot	82	0.0	420	420	18	1.20	5	-104	0	0.0	0.0
DRESSING ROOM - 142	Rm/Zn Tot	341	8.0	7,680	9,680	318	5.09	96	-1,926	0	0.0	0.0
MAKEUP - 144	Rm/Zn Tot	353	10.0	8,344	10,844	348	5.38	104	-2,055	0	0.0	0.0
DRESSING ROOM - 146	Rm/Zn Tot	341	8.0	7,680	9,680	318	5.09	96	-1,926	0	0.0	0.0
GREEN ROOM - 147	Rm/Zn Tot	694	18.0	13,563	18,063	621	4.88	186	-6,605	0	0.0	0.0
PROP KITCHEN - 148	Rm/Zn Tot	148	2.0	1,611	2,111	73	2.70	22	-357	0	0.0	0.0
ELEC STORAGE - 150	Rm/Zn Tot	128	0.0	655	655	28	1.20	8	-162	0	0.0	0.0
CORRIDOR - 100H	Rm/Zn Tot	386	0.0	659	659	37	0.52	11	-285	0	0.0	0.0
CORRIDOR -100K	Rm/Zn Tot	611	0.0	1,043	1,043	58	0.52	17	-451	0	0.0	0.0
SCENERY DOCK - 164	Rm/Zn Tot	759	8.0	17,543	19,543	712	5.12	214	-3,239	0	0.0	0.0
RECEIVING - 165	Rm/Zn Tot	284	0.0	1,484	1,484	62	1.19	19	-1,106	0	0.0	0.0
STAGE DOOR OFFICE - 166	Rm/Zn Tot	220	2.0	5,168	5,668	219	5.42	66	-3,465	0	0.0	0.0
CUST STORAGE - 167	Rm/Zn Tot	242	0.0	1,481	1,481	60	1.35	18	-1,288	0	0.0	0.0
RECEPTION	Rm/Zn Tot	138	1.0	2,648	2,898	98	3.88	29	-1,345	0	0.0	0.0
PIANO STORAGE	Rm/Zn Tot	147	0.0	401	401	19	0.72	6	-132	0	0.0	0.0
STORAGE - 162D	Rm/Zn Tot	126	0.0	430	430	20	0.86	6	-126	0	0.0	0.0
CORRIDOR - 100P	Rm/Zn Tot	853	0.0	1,456	1,456	81	0.52	24	-629	0	0.0	0.0
ELECTRICAL ROOM - 138	Rm/Zn Tot	98	0.0	167	167	9	0.52	3	-72	0	0.0	0.0
LOCK - 101C	Rm/Zn Tot	160	0.0	273	273	15	0.52	5	-118	0	0.0	0.0
DIMMER ROOM - 101E	Rm/Zn Tot	109	0.0	958	958	36	1.81	11	-462	0	0.0	0.0
CORRIDOR - 100L	Rm/Zn Tot	245	0.0	418	418	23	0.52	7	-181	0	0.0	0.0
ENSEMBLE - 201	Rm/Zn Tot	268	6.0	9,129	10,629	389	7.92	117	-3,878	0	0.0	0.0
ENSEMBLE - 202	Rm/Zn Tot	264	6.0	10,031	11,531	426	8.80	128	-4,961	0	0.0	0.0
ELECTRICAL	Rm/Zn Tot	750	5.0	9,829	11,079	406	2.95	122	-1,953	0	0.0	0.0
COMPOSTION - 211												
PRACTICE ROOM - 204	Rm/Zn Tot	99	1.0	4,348	4,598	181	9.98	54	-1,939	0	0.0	0.0
PRACTICE ROOM - 206	Rm/Zn Tot	1,683	17.0	39,256	43,506	1,656	5.37	497	-20,629	0	0.0	0.0
PRACTICE ROOM - 213	Rm/Zn Tot	104	1.0	1,760	2,010	75	3.93	22	-347	0	0.0	0.0
PRACTICE ROOM - 215	Rm/Zn Tot	104	1.0	1,760	2,010	75	3.93	22	-347	0	0.0	0.0
DOUBLE PIANO - 223	Rm/Zn Tot	273	2.0	3,745	4,245	155	3.10	47	-743	0	0.0	0.0

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## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	Htg	ASHRAE 62-89 OA fraction
DOUBLE PIANO - 225	Rm/Zn Tot	253	2.0	3,540	4,040	147	3.17	44	-702	0	0.0	0.0	
LOUNGE - 200B	Rm/Zn Tot	206	0.0	2,112	2,112	84	2.23	25	-423	0	0.0	0.0	
PRACTICE ROOM - 227	Rm/Zn Tot	532	4.0	8,247	9,247	346	3.55	104	-1,631	0	0.0	0.0	
PRACTICE ROOM -242	Rm/Zn Tot	174	1.0	3,746	3,996	149	4.67	45	-2,051	0	0.0	0.0	
PRACTICE ROOM - 241	Rm/Zn Tot	102	1.0	1,744	1,994	74	3.95	22	-344	0	0.0	0.0	
THEATER REHEARSAL - 162	Rm/Zn Tot	2,400	144.0	113,044	149,044	4,344	4.29	1,303	-22,272	0	0.0	0.0	
THEATER PLATFORM - 253	Rm/Zn Tot	660	5.0	10,958	12,208	454	3.75	136	-2,499	0	0.0	0.0	
DIMMER - 251	Rm/Zn Tot	394	0.0	3,139	3,139	132	1.83	40	-688	0	0.0	0.0	
LAUNDRY - 006	Rm/Zn Tot	203	0.0	4,079	4,079	175	4.70	53	-802	0	0.0	0.0	
CORRIDOR - 001C	Rm/Zn Tot	504	0.0	860	860	48	0.52	14	-372	0	0.0	0.0	
WARDROBE - 005	Rm/Zn Tot	347	0.0	2,369	2,369	98	1.54	29	-530	0	0.0	0.0	
STUDENT STORAGE - 016	Rm/Zn Tot	291	0.0	1,986	1,986	82	1.54	25	-444	0	0.0	0.0	
TRAP ROOM - 013	Rm/Zn Tot	720	0.0	2	2	23	0.17	7	-342	0	0.0	0.0	
CORRIDOR - 001A	Rm/Zn Tot	620	0.0	2	2	20	0.17	6	-295	0	0.0	0.0	
COMM ROOM - 010	Rm/Zn Tot	95	0.0	162	162	9	0.52	3	-70	0	0.0	0.0	
ELEVATOR ROOM - 002B	Rm/Zn Tot	67	0.0	69	69	5	0.38	1	-43	0	0.0	0.0	
SOUND STORAGE - 007	Rm/Zn Tot	295	0.0	2,014	2,014	84	1.54	25	-450	0	0.0	0.0	
CORRIDOR - 001B	Rm/Zn Tot	226	0.0	386	386	21	0.52	6	-167	0	0.0	0.0	
STAGE MANAGER - 011	Rm/Zn Tot	134	1.0	1,615	1,865	70	2.86	21	-339	0	0.0	0.0	
TECHNICAL DIRECTOR - 012	Rm/Zn Tot	228	2.0	3,285	3,785	137	3.28	41	-651	0	0.0	0.0	
<b>AHU-4</b>	Sys Tot/Ave	28,967	390.0	457,639	555,139	19,052			-153,103	0	0.0	0.0	
<b>AHU-4</b>	Sys Block	28,967	390.0	445,594	543,094	18,445			-153,096	0	0.0	0.0	

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Mueller Associates

## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil	Coil	Space	Air Changes ach/hr	VAV	Main Coil	Heating	Percent		ASHRAE
				Cooling Sensible Btu/h	Cooling Total Btu/h	Design Max SA cfm		Minimum SA cfm	Heating Sensible Btu/h	Fan Max SA cfm	OA	Htg	62-89 OA fraction
Orchestra Rehearsal 101	Rm/Zn Tot	5,114	410.0	253,654	407,080	6,462	1.75	0	-257,835	6,462	36.5	36.5	
<b>AHU-6</b>	Sys Tot/Ave	5,114	410.0	253,654	407,080	6,462			-257,835	6,462	36.5	36.5	
<b>AHU-6</b>	Sys Block	5,114	410.0	253,654	407,080	6,462			-257,835	6,462	36.5	36.5	
Proscenium Main Stage 154	Rm/Zn Tot	3,094	60.0	258,436	324,183	9,064	2.51	0	-121,928	9,064	8.7	8.7	
<b>AHU-3</b>	Sys Tot/Ave	3,094	60.0	258,436	324,183	9,064			-121,928	9,064	8.7	8.7	
<b>AHU-3</b>	Sys Block	3,094	60.0	258,436	324,183	9,064			-121,928	9,064	8.7	8.7	
Orchard Street Lobby 100B	Rm/Zn Tot	5,079	591.0	433,850	689,908	12,956	4.45	3,887	-213,532	0	32.7	100.0	
South Lobby 100J	Rm/Zn Tot	452	58.0	57,493	87,000	1,889	9.20	567	-30,074	0	21.0	69.9	
Lobby Cupolas/Light Monitors	Rm/Zn Tot	177	0.0	23,232	30,817	339	9.99	102	-18,090	0	2.6	8.7	
Concession 120C	Rm/Zn Tot	241	4.0	8,318	11,981	230	4.53	69	-2,191	0	34.7	100.0	
Elev Mech 168	Rm/Zn Tot	52	0.0	17,066	17,066	321	37.03	96	-1,701	0	0.0	0.0	
Lock 155C and 155D	Rm/Zn Tot	134	0.0	1,053	1,293	37	1.64	11	-1,157	0	18.3	61.1	
Sound Booth 155H	Rm/Zn Tot	96	1.0	13,589	14,376	371	23.22	111	-1,969	0	4.0	13.5	
Light Booth 155G	Rm/Zn Tot	179	2.0	6,252	7,826	157	5.27	47	-1,522	0	19.1	63.6	
Light Booth 155G Lower	Rm/Zn Tot	77	1.0	979	1,229	25	1.98	8	-332	0	0.0	0.0	
Lock 120A	Rm/Zn Tot	56	0.0	215	315	8	0.82	2	-159	0	36.7	100.0	
Lock 120B	Rm/Zn Tot	72	0.0	276	405	10	0.82	3	-204	0	36.7	100.0	
Lock 250D	Rm/Zn Tot	382	0.0	4,042	4,715	64	0.59	19	-1,436	0	30.0	99.9	
Vest 250G	Rm/Zn Tot	46	0.0	677	759	14	1.53	4	-272	0	16.4	54.5	
Inner Lobby 100F	Rm/Zn Tot	541	40.0	39,885	78,513	869	9.64	261	-8,542	0	92.1	100.0	
Inner Lobby Ramp	Rm/Zn Tot	131	0.0	1,133	1,367	39	1.81	12	-731	0	16.6	55.3	
Sound Room 302	Rm/Zn Tot	120	0.0	37,477	37,692	685	37.35	205	-4,143	0	0.9	2.9	
Coats 131	Rm/Zn Tot	159	0.0	1,185	1,469	39	1.48	12	-585	0	20.2	67.5	
Vestibule 100T	Rm/Zn Tot	191	0.0	12,440	23,099	303	3.64	91	-4,410	0	3.1	10.5	
Booth 237	Rm/Zn Tot	305	3.0	35,962	38,322	1,116	17.81	335	-9,187	0	4.0	0.0	
Women 135	Rm/Zn Tot	474	0.0	4,660	5,508	158	2.00	47	-2,762	0	15.0	50.0	
Men 132	Rm/Zn Tot	347	0.0	3,411	4,032	116	2.00	35	-2,022	0	15.0	50.0	
Circulation 200C	Rm/Zn Tot	710	21.0	51,157	66,629	1,231	8.67	369	-10,926	0	25.6	0.0	
Circulation 200C South	Rm/Zn Tot	145	4.0	9,388	12,335	226	7.80	68	-2,317	0	26.5	0.0	
Circulation 200C North	Rm/Zn Tot	206	0.0	3,831	4,200	83	2.03	25	-1,288	0	12.3	41.1	
Vest 100N	Rm/Zn Tot	370	0.0	31,481	32,119	1,055	6.58	317	-57,391	0	1.8	5.8	

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## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	Htg	ASHRAE 62-89 OA fraction
<b>AHU-1</b>	Sys Tot/Ave	10,742	725.0	846,089	1,220,011	22,343			-376,943	0	33.1	71.6	
<b>AHU-1</b>	Sys Block	10,742	725.0	715,132	1,107,443	18,471			-376,647	0	33.1	71.6	
Theater Rehearsal 162	Rm/Zn Tot	2,421	144.0	202,009	273,678	6,414	5.02	1,924	-79,596	0	13.5	0.0	
Practice Rooms 206-240 even	Rm/Zn Tot	1,494	18.0	57,192	81,186	1,494	5.00	448	-46,365	0	24.1	80.3	
Practice 242	Rm/Zn Tot	138	2.0	5,264	7,930	130	4.71	39	-4,186	0	30.8	100.0	
Double Piano 223	Rm/Zn Tot	273	2.0	6,205	8,871	141	2.59	42	-1,537	0	28.3	94.3	
Double Piano 225	Rm/Zn Tot	253	2.0	5,678	8,344	127	2.51	38	-1,428	0	31.5	100.0	
Reception 100R	Rm/Zn Tot	138	3.0	10,459	18,932	330	11.94	99	-25,406	0	18.2	60.7	
Stage Door Office 166	Rm/Zn Tot	220	2.0	7,088	9,183	208	4.74	63	-6,481	0	19.2	64.0	
Cust Stor 167	Rm/Zn Tot	242	0.0	4,728	5,248	156	2.15	47	-6,205	0	7.8	25.9	
Receiving 165	Rm/Zn Tot	284	0.0	5,116	5,718	168	1.97	50	-14,974	0	8.4	28.1	
Piano Storage 163	Rm/Zn Tot	165	0.0	1,236	1,590	34	1.12	10	-241	0	24.4	81.2	
Dressing 140	Rm/Zn Tot	284	4.0	14,354	18,028	411	7.23	123	-3,361	0	14.6	0.0	
Green Room 147	Rm/Zn Tot	694	18.0	33,810	49,816	908	6.54	272	-13,318	0	29.7	0.0	
Dressing Rooms 142 & 146	Rm/Zn Tot	682	16.0	57,261	71,423	1,797	13.17	539	-17,376	0	13.4	0.0	
Makeup 144	Rm/Zn Tot	353	10.0	25,224	34,409	722	10.23	217	-7,076	0	20.8	0.0	
Dressing Room 141	Rm/Zn Tot	390	4.0	16,660	20,334	466	5.98	140	-5,912	0	12.9	0.0	
Instrument Storage 101D	Rm/Zn Tot	1,857	0.0	43,347	47,330	1,398	2.51	419	-35,187	0	6.6	22.1	
Reception 110	Rm/Zn Tot	108	1.0	2,227	3,285	71	3.94	21	-670	0	28.2	93.9	
Management Office 111	Rm/Zn Tot	111	1.0	2,253	3,311	72	3.89	22	-682	0	27.8	92.6	
Operations Office 112	Rm/Zn Tot	115	1.0	2,288	3,346	73	3.83	22	-698	0	27.2	90.8	
Usher 114	Rm/Zn Tot	179	4.0	4,231	8,463	104	2.89	31	-1,181	0	77.2	0.0	
Box Office Manager 115B	Rm/Zn Tot	127	1.0	2,394	3,452	78	3.67	23	-747	0	25.8	85.9	
Box Office Workroom 115A	Rm/Zn Tot	282	3.0	6,773	9,947	215	4.57	64	-2,384	0	27.9	93.0	
Box Office 115	Rm/Zn Tot	139	3.0	5,391	8,565	160	6.90	48	-1,724	0	37.5	100.0	
Practice Room 204	Rm/Zn Tot	80	1.0	5,027	6,328	151	9.42	45	-5,244	0	13.3	44.3	
Ensemble 201	Rm/Zn Tot	268	6.0	13,202	22,347	360	6.71	108	-7,833	0	33.4	100.0	
Ensemble 202	Rm/Zn Tot	264	6.0	13,123	21,660	356	6.73	107	-8,984	0	33.7	100.0	
Electric Composition 211	Rm/Zn Tot	195	5.0	10,885	16,175	285	7.30	85	-2,387	0	35.1	100.0	
Practice Rooms 213-215	Rm/Zn Tot	168	2.0	4,540	7,206	120	3.57	36	-1,110	0	33.4	100.0	

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## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg Htg	ASHRAE 62-89 OA fraction
Practice Room 227, 229 and 231	Rm/Zn Tot	336	6.0	9,451	17,449	241	3.59	72	-2,231	0	49.7 100.0	
Practice Room 233	Rm/Zn Tot	119	2.0	4,607	7,273	115	4.83	34	-1,511	0	34.8 100.0	
Practice Room 241	Rm/Zn Tot	86	2.0	3,320	5,986	76	4.44	23	-705	0	52.4 100.0	
Alcove 200B	Rm/Zn Tot	218	0.0	4,898	5,365	120	2.75	36	-7,471	0	9.1 30.3	
Green Room 2 124	Rm/Zn Tot	282	7.0	7,959	13,863	222	4.71	66	-2,811	0	47.4 0.0	
Piano Storage 122	Rm/Zn Tot	249	0.0	3,188	3,722	109	2.63	33	-1,529	0	11.4 38.0	
Storage 162D	Rm/Zn Tot	135	0.0	1,011	1,301	28	1.12	8	-198	0	24.4 81.2	
Scenery Dock 164	Rm/Zn Tot	756	8.0	19,633	28,097	572	1.46	172	-8,089	0	28.0 93.3	
Painting Area 164A	Rm/Zn Tot	214	2.0	4,210	6,326	116	2.07	35	-1,173	0	34.6 100.0	
Lock 162A	Rm/Zn Tot	123	0.0	1,111	1,374	39	1.90	12	-648	0	15.8 52.5	
Prop Kitchen 148	Rm/Zn Tot	148	0.0	4,872	5,190	137	5.56	41	-1,508	0	5.4 18.0	
Electric Storage 150	Rm/Zn Tot	127	0.0	1,811	2,074	62	2.94	19	-1,027	0	10.2 34.1	
Lock 101C	Rm/Zn Tot	160	0.0	2,109	2,448	39	1.46	12	-670	0	20.5 68.3	
Pantry 139	Rm/Zn Tot	180	0.0	13,906	14,272	487	16.24	146	-4,488	0	1.8 6.2	
Building Storage 137	Rm/Zn Tot	89	0.0	1,478	1,662	51	3.42	15	-722	0	8.8 29.2	
NSO Office 106A	Rm/Zn Tot	129	1.0	3,069	4,126	102	4.73	31	-1,113	0	19.7 65.5	
Cust 103	Rm/Zn Tot	132	0.0	1,018	1,301	34	1.55	10	-443	0	19.4 64.6	
Men 105	Rm/Zn Tot	181	0.0	3,090	3,436	100	1.72	30	-6,492	0	9.1 30.2	
Women 104	Rm/Zn Tot	182	0.0	2,000	2,349	62	1.06	19	-2,843	0	14.7 48.9	
Laundry 006	Rm/Zn Tot	203	0.0	33,254	33,690	626	20.56	188	-3,004	0	1.6 5.4	
Wardrobe 005	Rm/Zn Tot	347	0.0	15,593	16,338	536	10.30	161	-4,429	0	3.2 10.8	
Cust 008	Rm/Zn Tot	85	0.0	1,825	1,998	59	3.33	18	-740	0	7.3 24.2	
Sound Storage 007	Rm/Zn Tot	322	0.0	2,411	3,102	66	0.99	20	-471	0	24.4 81.3	
Stage Manager 011	Rm/Zn Tot	134	1.0	2,456	3,514	80	3.98	24	-775	0	25.0 83.3	
Technical Director 012	Rm/Zn Tot	228	2.0	5,012	7,128	162	4.73	49	-2,001	0	24.7 82.4	
Band Storage 102	Rm/Zn Tot	585	0.0	12,281	13,471	393	2.24	118	-28,817	0	7.4 24.8	
NSO Library 106	Rm/Zn Tot	491	3.0	10,371	12,902	330	4.03	99	-3,830	0	13.6 45.5	
Elec 143	Rm/Zn Tot	82	0.0	8,121	8,297	139	10.19	42	-668	0	2.9 9.8	
Elec 138	Rm/Zn Tot	73	0.0	30,742	30,898	594	48.80	178	-2,849	0	0.6 2.0	
Box Office Storage 115C	Rm/Zn Tot	59	0.0	455	581	15	1.55	5	-198	0	19.4 64.6	

\*\* This report does not display heating only systems.

## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	ASHRAE 62-89 Htg OA fraction
Theater Rehearsal Platform 253	Rm/Zn Tot	547	3.0	18,629	21,004	596	3.17	179	-8,197	0	8.0	26.8
Student Storage 016	Rm/Zn Tot	291	0.0	2,179	2,803	60	0.99	18	-426	0	24.4	81.3
Instrument Uncasing 123	Rm/Zn Tot	670	0.0	7,147	8,585	244	2.19	73	-3,758	0	13.7	45.7
Trap Room 013	Rm/Zn Tot	720	0.0	10,360	11,904	336	2.25	101	-3,050	0	10.7	35.8
LL Stair Corridors 001B and 001C	Rm/Zn Tot	226	0.0	720	865	11	0.24	3	-5,366	0	100.0	100.0
Corridors 001C and 001B	Rm/Zn Tot	504	0.0	856	1,180	25	0.24	8	-7,576	0	100.0	100.0
Corridor 001A	Rm/Zn Tot	620	0.0	5,055	6,385	147	1.14	44	-3,719	0	21.1	70.5
Lock 013A	Rm/Zn Tot	65	0.0	235	374	5	0.40	2	-39	0	60.1	99.9
Men 217	Rm/Zn Tot	132	0.0	1,461	1,740	23	0.86	7	-362	0	29.1	97.1
Women 219	Rm/Zn Tot	140	0.0	1,687	1,983	29	1.03	9	-516	0	24.3	81.0
Corridor 200A	Rm/Zn Tot	1,861	0.0	21,780	25,722	372	1.00	112	-8,904	0	25.0	83.4
Lock 235A	Rm/Zn Tot	151	0.0	1,998	2,322	39	1.28	12	-662	0	19.5	64.8
Lock 250A	Rm/Zn Tot	143	0.0	2,030	2,326	71	1.57	21	-1,308	0	10.0	33.5
Corridor 100P West	Rm/Zn Tot	181	0.0	1,780	2,164	25	0.82	7	-450	0	36.8	100.0
Corridor 100P	Rm/Zn Tot	672	0.0	16,776	24,104	552	1.56	166	-32,935	0	6.1	20.3
Corridor 100L	Rm/Zn Tot	245	0.0	12,364	22,774	419	3.24	126	-42,302	0	2.9	9.7
Lock 162B and 162C	Rm/Zn Tot	76	0.0	668	831	20	1.42	6	-570	0	19.2	63.9
Director Niche xxx	Rm/Zn Tot	140	2.0	5,728	7,225	177	6.88	53	-1,259	0	17.0	0.0
Corridor 100H	Rm/Zn Tot	386	0.0	8,433	9,261	217	3.37	65	-3,463	0	8.9	29.7
Corridor 100K	Rm/Zn Tot	611	0.0	10,232	11,494	358	3.51	107	-6,005	0	8.5	28.5
Lock 154A	Rm/Zn Tot	47	0.0	461	562	16	2.06	5	-496	0	14.6	48.5
Lock 154B	Rm/Zn Tot	51	0.0	201	310	7	0.82	2	-127	0	36.8	100.0
Corridor 100C	Rm/Zn Tot	337	0.0	10,773	11,474	390	5.51	117	-11,370	0	4.3	14.4
Band Storage Vending	Rm/Zn Tot	91	0.0	4,413	4,601	149	5.89	45	-1,329	0	3.1	10.2
Lock 101A and 101B	Rm/Zn Tot	136	0.0	535	827	18	0.82	6	-338	0	36.8	100.0
North Lobby 100A	Rm/Zn Tot	1,489	205.0	130,606	199,578	3,748	13.73	1,124	-50,804	0	29.5	98.4
Elev Room 102A	Rm/Zn Tot	54	0.0	24,193	24,193	474	31.59	142	-2,758	0	0.0	0.0
Corridor 100D	Rm/Zn Tot	255	0.0	10,666	11,196	379	8.92	114	-11,876	0	3.4	11.2
Corridor 100D Ramp	Rm/Zn Tot	285	0.0	15,758	16,351	563	11.84	169	-16,022	0	2.5	8.4
Wing 121A	Rm/Zn Tot	167	0.0	12,755	13,113	444	15.95	133	-3,680	0	1.9	6.3

\*\* This report does not display heating only systems.

## Load / Airflow Summary

By ae

Description **		Floor Area ft <sup>2</sup>	People #	Coil	Coil	Space	Air Changes ach/hr	VAV	Main Coil	Heating	Percent		ASHRAE
				Cooling Sensible Btu/h	Cooling Total Btu/h	Design Max SA cfm		Minimum SA cfm	Heating Sensible Btu/h	Fan Max SA cfm	OA	Htg	62-89 OA fraction
Wing 121B	Rm/Zn Tot	237	0.0	1,167	1,676	40	1.02	12	-907	0	29.4	97.8	
Lock 155B	Rm/Zn Tot	88	0.0	515	703	14	1.05	4	-236	0	31.2	100.0	
Lock 155A and 155F	Rm/Zn Tot	100	0.0	595	809	21	1.28	6	-444	0	23.4	77.9	
Corridor 100E South	Rm/Zn Tot	444	0.0	4,370	5,287	153	2.07	46	-2,588	0	14.5	48.4	
Corridor 100E	Rm/Zn Tot	880	0.0	8,253	10,141	290	1.98	87	-4,916	0	15.2	50.6	
Lock 155E	Rm/Zn Tot	138	0.0	744	1,040	20	0.75	6	-310	0	34.7	100.0	
Lock 310	Rm/Zn Tot	50	0.0	751	858	14	1.73	4	-552	0	17.4	57.9	
Lock 311	Rm/Zn Tot	50	0.0	747	854	15	1.75	4	-553	0	17.1	57.1	
Lock 250B and 250C	Rm/Zn Tot	84	0.0	838	1,018	29	1.75	9	-906	0	14.3	47.7	
Lock 250F	Rm/Zn Tot	107	0.0	4,466	4,687	146	4.30	44	-2,514	0	3.7	12.2	
Lock 250E	Rm/Zn Tot	107	0.0	1,948	2,177	58	1.70	17	-971	0	9.3	31.0	
Elevator Room 002B	Rm/Zn Tot	67	0.0	16,639	16,639	327	20.89	98	-2,116	0	0.0	0.0	
Front of House Storage 136	Rm/Zn Tot	81	0.0	1,037	1,211	36	2.63	11	-497	0	11.4	37.9	
<b>AHU-4</b>	Sys Tot/Ave	32,105	503.0	1,170,138	1,534,350	33,733			-642,923	0	17.1	35.3	
<b>AHU-4</b>	Sys Block	32,105	503.0	1,143,436	1,510,535	32,787			-641,481	0	17.1	35.3	
Proscenium Theater Auditorium 155	Rm/Zn Tot	4,387	502.0	304,071	468,855	8,509	2.98	0	-255,457	8,509	32.6	0.0	
Spot Booth 301	Rm/Zn Tot	207	1.0	31,122	31,971	738	27.91	0	-3,934	738	2.0	0.0	
<b>AHU-2</b>	Sys Tot/Ave	4,594	503.0	335,194	500,826	9,247			-259,391	9,247	30.1	0.0	
<b>AHU-2</b>	Sys Block	4,594	503.0	335,228	500,860	9,247			-259,391	9,247	30.1	0.0	
Tel/Data 125	Rm/Zn Tot	55	0.0	1,721	1,721	155	10.13	0	0	155	0.0	0.0	
Tel/Data 244	Rm/Zn Tot	81	0.0	2,245	2,245	193	11.89	0	-41	193	0.0	0.0	
Main Comm Room 009	Rm/Zn Tot	91	0.0	1,948	1,948	168	8.92	0	-495	168	0.0	0.0	
Hub Comm Room 010	Rm/Zn Tot	97	0.0	1,291	1,291	108	5.40	0	-1,690	108	0.0	0.0	
Dimmer Room 251	Rm/Zn Tot	394	0.0	133,400	133,400	11,969	91.13	0	-1,766	11,969	0.0	0.0	
Dimmer Room 101E	Rm/Zn Tot	109	0.0	57,960	57,960	5,205	171.89	0	-1	5,205	0.0	0.0	
Dimmer Room 243	Rm/Zn Tot	125	0.0	44,245	44,245	3,913	152.32	0	-636	3,913	0.0	0.0	
Sound Room 239	Rm/Zn Tot	155	0.0	8,995	9,028	727	22.82	0	-683	727	1.1	1.1	
<b>Split Systems (Telecom)</b>	Sys Tot/Ave	1,107	0.0	251,806	251,840	22,437			-5,312	22,437	0.0	0.0	
<b>Split Systems (Telecom)</b>	Sys Block	1,107	0.0	251,769	251,802	22,437			-4,010	22,437	0.0	0.0	

\*\* This report does not display heating only systems.



## Appendix B:

Energy analysis from Trane Trace 700.

Energy Consumption Summary

Equipment Energy Consumption

Monthly Energy Consumption

Monthly Utility Costs

<h2 style="margin: 0;">ENERGY CONSUMPTION SUMMARY</h2> <p style="margin: 0;">By ae</p>
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	Elect Cons. (kWh)	P.Stm Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
<b>Primary heating</b>				
Primary heating	37.8	237.4	0.2 %	320.4
<b>Primary cooling</b>				
Cooling Compressor	969,344.2		32.5 %	99,261.1
Tower/Cond Fans	126,640.0		4.2 %	12,968.0
Condenser Pump			0.0 %	0.0
Other CLG Accessories	876.0		0.0 %	89.7
Cooling Subtotal....	1,096,860.1		36.8 %	112,318.7
<b>Auxiliary</b>				
Supply Fans			0.0 %	0.0
Circ Pumps			0.0 %	0.0
Base Utilities			0.0 %	0.0
Aux Subtotal....			0.0 %	0.0
<b>Lighting</b>				
Lighting	1,881,053.8		63.0 %	192,620.3
<b>Receptacle</b>				
Receptacles			0.0 %	0.0
<b>Heating plant load</b>				
Base Utilities			0.0 %	0.0
<b>Cogeneration</b>				
Cogeneration			0.0 %	0.0
<b>Totals</b>				
Totals**	2,977,951.5	237.4	100.0 %	305,259.5

\* Note: Resource Utilization factors are included in the Total Source Energy value.

\*\* Note: This report can display a maximum of 6 utilities. If additional utilities are used, they will be included in the total.

<h2 style="margin: 0;">EQUIPMENT ENERGY CONSUMPTION</h2> <p style="margin: 0;">By ae</p>
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Alternative: 1 UDel CFA

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<b>Lights</b>													
Electric (kWh)	159,760.6	144,300.3	159,760.6	154,607.2	159,760.6	154,607.0	159,760.7	159,760.6	154,607.4	159,760.7	154,607.1	159,760.9	1,881,053.8
Peak (kW)	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7	214.7
<b>Cpl 1: Cooling plant - 001</b>													
<b>Air-cooled chiller - 001 (Cooling Equipment)</b>													
Electric (kWh)	74,136.8	67,218.2	77,124.6	76,421.7	85,910.0	89,277.2	96,331.5	90,589.7	83,781.2	78,719.1	74,790.2	75,044.1	969,344.3
Peak (kW)	108.5	114.0	117.7	120.3	144.9	159.5	162.0	154.8	147.2	120.3	114.7	111.1	162.0
<b>Eq5221 - Condenser fan</b>													
Electric (kWh)	9,989.1	9,055.9	10,379.8	10,285.1	11,177.8	11,132.8	11,671.6	11,392.0	10,791.1	10,591.9	10,065.0	10,107.8	126,640.0
Peak (kW)	14.6	15.4	15.9	16.3	16.8	17.4	17.7	17.2	16.8	15.9	15.5	15.0	17.7
<b>Eq5302 - Cntl panel &amp; interlocks (Misc Accessory Equipment)</b>													
Electric (kWh)	74.4	67.2	74.4	72.0	74.4	72.0	74.4	74.4	72.0	74.4	72.0	74.4	876.0
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
<b>Hpl 1: Heating plant - 002</b>													
<b>Boiler - 001 (Heating Equipment)</b>													
Purchased Steam (therms)	53.3	49.3	31.6	19.0	0.0	0.0	0.0	0.0	0.0	13.8	25.5	44.9	237.4
Peak (therms/Hr)	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2
<b>Eq5061 - Condensate return pump (Misc Accessory Equipment)</b>													
Electric (kWh)	8.1	7.3	5.7	3.1	0.0	0.0	0.0	0.0	0.0	2.4	3.9	7.3	37.8
Peak (kW)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

## MONTHLY ENERGY CONSUMPTION

By ae

Alternative: 1      UDel CFA

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<b>Electric</b>													
On-Pk Cons. (kWh)	41,731	37,750	46,389	40,711	47,222	80,894	74,579	83,740	71,265	44,755	42,414	39,918	651,368
Off-Pk Cons. (kWh)	146,917	132,669	139,277	146,588	148,402	127,694	150,196	129,752	136,695	145,070	140,977	152,173	1,696,410
Mid-Pk Cons. (kWh)	55,322	50,229	61,679	54,090	61,299	46,501	43,063	48,325	41,291	59,323	56,148	52,904	630,175
On-Pk Demand (kW)	335	339	344	346	377	392	394	387	379	351	343	338	394
Off-Pk Demand (kW)	333	334	338	345	361	374	378	371	363	340	338	335	378
Mid-Pk Demand (kW)	338	344	348	351	365	375	385	373	364	349	345	341	385
<b>Purchased Steam</b>													
On-Pk Cons. (therms)	7	6	3	0	0	0	0	0	0	0	0	3	19
Off-Pk Cons. (therms)	32	30	22	16	0	0	0	0	0	11	18	29	158
Mid-Pk Cons. (therms)	14	13	7	3	0	0	0	0	0	3	7	13	61
On-Pk Demand (therms/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Pk Demand (therms/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Pk Demand (therms/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Building Energy Consumption =			190,494	Btu/(ft2-year)									
Source Energy Consumption =			570,800	Btu/(ft2-year)									
Floor Area =			53,479	ft2									

<h2 style="margin: 0;">MONTHLY UTILITY COSTS</h2> <p style="margin: 0;">By ae</p>
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Alternative: 1

Utility	Jan	Feb	Mar	Apr	----- May	----- Monthly Utility Costs ----- June	July	----- Aug	Sept	Oct	Nov	Dec	Total
<b>Electric</b>													
On-Pk Cons. (\$)	1,598	1,447	1,775	1,559	1,806	3,084	2,845	3,192	2,719	1,713	1,624	1,529	24,889
<b>Gas</b>													
On-Pk Cons. (\$)	18	18	18	18	18	18	18	18	18	18	18	18	210
<b>Monthly Total (\$):</b>	1,615	1,464	1,792	1,576	1,824	3,102	2,862	3,210	2,736	1,730	1,641	1,546	25,099

References:

Kirkegaard Associates. *Acoustic Design Guidelines*. 14 March 2003.

Previous Technical Assignments.

TRANE TRACE 700 v 4.1.1. 2001