Technical Assignment 2

Building and Plant Energy Analysis Report

Rendering Courtesy of A/S/G Architects

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Table of Contents:

Executive Summary:

This report contains the building and plant analysis for the Center for the Arts on the University of Delaware in Newark, Delaware. The building is analyzed for compliance with the LEED Green Building Certification System and Standard 90.1-2004 building envelope and lighting power density sections. This report also examines the lost rentable space due to mechanical system spaces and well as the mechanical system first costs. Load and energy estimates were performed by Trace Trane 700 to determine annual energy consumption and costs. The energy consumption data is also used to determine the emissions associated with operation of the building.

The LEED Green Building Certification System consists of 6 categories in which points are earned toward 4 levels of certification. The Center for the Arts earns 15 points, however the minimum points required for the lowest level, Certification is 26 points.

ASHRAE Standard 90.1-2004 is used to provide minimum requirements to produce energy efficient designs for buildings. The building envelope method analyzes the wall constructions, roof constructions and fenestration of the building. The Center for the Arts complies with the standard 90.1-2004 specified maximum U-Values for a building located in Climate Zone 4a but fails to comply with the solar heat gain coefficient specified in the fenestration section. Standard 90.1-2004 also recommends maximum lighting power densities based on space description in order to design energy efficient buildings. Approximately 50% of the rooms in the Center for the Arts comply with the space-by-space method of analyzing lighting power density.

The mechanical spaces of the Center for the Arts compose approximately 10% of the gross floor area.

The $3.9 million first cost for the mechanical and plumbing systems comprise 10% of the initial bid for construction.

The energy analysis from the Trace program yields a kilowatt per hour yearly rate from the spaces and systems entered into the program. The emissions analysis found that the Center for the Arts will produce 1680 lbs of particulates, 19600 lbs of SO2, 11670 lbs of NO2 and 3.5 million lbs of CO2 each year.

LEED Green Building Analysis:

The Leadership in Energy and Environmental Design (LEED) is a certification system that is set forth by the United States Green Building Council (USGBC). The USGBC is an organization that promotes buildings that are environmentally responsible, profitable, and healthy places to live and work. LEED-NC version 2.1 was used to analyze the Center for the Arts (CFA) degree of compliance. LEED-NC version 2.1 consists of a point system worth a total of 69 points between six major categories. There are 4 different levels of "green building" compliance within LEED-NC 2.1: Certification 26-32 points, Silver 33-38 points, Gold 39-51 points, and Platinum 52-69 points.

In the sustainable sites category, the CFA meets the prerequisite of erosion and sediment control. Erosion control measures are set forth in the Specifications and detailed on the civil drawings. Thus, the CFA is qualified to earn points in the Sustainable Sites Category and earns a total of 4 points.

In the Water Efficiency category, the CFA earns no points. However, in this analysis it is unknown whether credit 1.1 and 1.2, water efficient landscaping, comply, therefore it is possible for 2 points to be earned.

In the Energy and Atmosphere category, the CFA earns no points. The CFA meets only two of the three prerequisites for this category, failing to comply with the Fundamental Building Systems Commissioning prerequisite.

In the Materials and Resources category, the CFA earns 2 points. The prerequisite for storage and collection of recyclables is met allowing for points to be earned for construction waste management and local/ regional materials.

In the Indoor Environmental Quality category the CFA earns nine points. Both of the prerequisites, minimum IAQ performance and environmental tobacco smoke control, are met. There are four credits that the compliance of the CFA is unknown.

In the Innovation and Design Process category no points are awarded to the CFA. Four of the five points in this category are awarded for innovation in design; the CFA does not have any system or design components that were designed to comply in this category.

The Center for the Arts only earns 15 points out of a total possible 69, therefore not qualifying the building for the minimum LEED rating of Certification. This analysis was done assuming the point would not be earned if there was not enough documentation to determine compliance. Overall it was not the intent of the University of Delaware to design the Center for the Arts as a "green building".

See Appendix A for details of LEED compliance broken down by category.

Standard 90.1-2004 Building Envelope Compliance:

ASHRAE Standard 90.1-2004 is used to provide minimum requirements to produce energy efficient designs for buildings. The building envelope portion of Standard 90.1-2004 establishes the minimum U-values and solar heat gain coefficients (SHGC), based on climate zone, for construction of buildings.

The first step to determine the Building Envelope Compliance is to determine the climate zone in which the building resides. The Center for the Arts is located in Newark, Delaware therefore according to Table B-1 in Appendix B of Standard 90.1, the state of Delaware resides within Climate Zone 4a. According to Table D-1 in Appendix D of Standard 90.1, Wilmington, Delaware, the closest listed city to Newark, has a HDD65 of 4937 and CDD50 of 3557. In Table 5.5.3.1 the roof U-value multiplier is found to be 1.00. Since the CFA is in Climate Zone 4a, Table 5.5-4 is used to determine the building envelope compliance through the specification of minimum R-Values of insulation, maximum U-Values, and maximum SHGC.

Typical Wall or Roof Assembly	Design		Standard 90		Compliance
	R-Value	U-Value	R-Value	U-Value	
Brick Wall Assembly	12.82	0.060	5.7	0.151	Yes
Roof Assembly	21.63	0.041	15.0	0.063	Yes

Appendix B contains the detailed summary of the wall and roof assemblies.

Percent Glazing	Design		Standard 90		Compliance
	U-Value	SHGC	U-Value	SHGC	
10.1-20.0% Glazing	0.25	0.47	0.57	0.39	No

Appendix B contains a detailed summary of the percent glazing.

The Center for the Arts complies with Standard 90.1 Building Envelope for the above grade wall assembly, roof assembly and the glazing U-value. The Center for the Arts does not comply with the solar heat gain coefficient for all orientations.

Standard 90.1-2004 Lighting Power Density:

ASHRAE Standard 90.1-2004 is used to provide minimum requirements to produce energy efficient designs for buildings. The lighting power density portion of Standard 90.1-2004 establishes the maximum lighting power densities for buildings through two methods. The two methods are the building area method and the space-by-space method.

The building area method establishes a lighting power density based on the use of the building. The total watts of lighting power used by the building are divided by the total square footage of the building and that value is compared to the value give in Table 9.5.1 of Standard 90.1-2004. The Center for the Arts is a Performing Arts Theater and has a building power density of 1.6 watts per square foot. The overall building power density is 1.3 watts per square foot. Since the designed lighting power density is less then the Standard 90.1-2004 allowable lighting power density the Center for the Arts complies with the Building Area method.

The space-by space method establishes power densities for each space in the building based on the use of the space. The maximum allowable lighting power density for each type of space is listed in Table 9.6.1 of Standard 90.1-2004. For each space in the building the watts supplied to the space for lighting are divided by the area of the space. In order to comply with the space-by-space method the design lighting power density must be less then the allowable power density, as specified in the standard, for each space in the building.

The Center for the Arts failed to comply with the space-by-space method for Lighting Power Density. Only 40 spaces within the building had designed lighting power densities less then the allowable. Attached in Appendix C is the detailed summary of the space-by-space method for the Center for the Arts.

Lost Rentable Space:

The mechanical rooms and shafts that service the mechanical system are essential to the success of mechanical systems however their presence decreases the amount of rentable space. This loss in rentable space creates a loss in revenue for the building owner. In the case of the Center for the Arts, the University of Delaware is losing rentable space but rather losing usable space. The following table is a summary of the mechanical spaces throughout the CFA.

Space Description	Area (ft^2)
Lower Level Mech Room	1023
Second Level Mech Room	7300
Supply Air Shaft Spaces	31
Return Air Shaft Spaces	184
Total	8538

The 8,538 square feet of mechanical spaces make up approximately 9.6% of the entire building spaces. The major contributing factor to the mechanical spaces making almost 10% of the building is that all the air handling units are located on the second floor of the building in between the Proscenium Theater and Recital Hall.

Mechanical System First Costs:

The mechanical first cost for the Center for the Arts is $3,941,708.00 or $42.79 per square foot. This information was provided by Vermeulens Cost Consultants at the point of 50% design development. The summary of plumbing and HVAC equipment included in this mechanical first cast estimate can be found in Appendix D. The mechanical systems make up approximately 10.9% of the estimated bid package.

Yearly Energy Utilization Data:

Since the Center for the Arts is currently under construction there are not yet any meter readings or utility bills for the building.

TRANE TRACE 700 Load and Energy Analysis:

Trane's TRACE 700 simulation program was used to perform HVAC and energy analysis on the Center for the Arts. A summary of the TRACE loads can be found in Appendix E. The loads in each space were simply the people load based and lighting load based on given information in the drawings and Specifications. The few offices were assumed to a miscellaneous load to account for a computer in the space. The schedule used for time-of-day use consisted of off peak rates on the weekends and nighttime year round and peak and mid-peak hours during the daytime. The peak and mid-peak is divided into mid-peak in the morning, time varying by season, and peak in the afternoon and evening hours.

The loads computed in Trace are compared to the design values in Appendix F. It is found that two thirds of the spaces in the simulation resulted in lower supply air CFM then the CFA is actually designed for. The discrepancy could be a result of the assumptions and lack of available data to run the simulation. The equipment in rooms such as the sound and light booths was not taken into account in the simulation. The partition loads resulting from spaces being adjacent to mechanical, electrical and elevator rooms was also not taken into account in the simulation due to lack of information on these loads.

Annual Energy Consumption and Operating Costs:

Trane TRACE 700 simulation program was used to perform an energy consumption analysis for the Center for the Arts. Since the CFA does not yet have any actual utility bills, utility pricing for electricity and natural gas was obtained from online from companies that supply the Newark region of Delaware. According to the Delaware Electric Cooperative, the electric rate would consist of a $7.40 consumer charge and then flat rate per kilowatt hour in the summer and a stepped rated at 700 kilowatt hours in the winter months. The natural gas rate was obtained from the Delaware Division of the Chesapeake Utilities Corporation. The customer charge for natural gas in $17.40 and then there is a stepped rate for the first 20 Ccf, next 30 Ccf and then over 50 Ccf. The Trace energy calculations resulted in a yearly cost of $568 for electricity and natural gas use.

The following table is a summary of the emissions associated with the fuel mix of the electricity supplied to the Center for The Arts. The Trace 700 analysis found that the CFA uses 2,850,003 kWh per year. The total pollutants represent the yearly pollutants produced as a result of electricity used by CFA.

		lbm Pollutant /kWh U.S.			
Fuel	% Mix U.S.	Particulates	SO2/kWh	NOx/kWh	CO2/kWh
Coal	52.5	0.0005775	0.006709222	0.003888913	1.128779151
Oil	1.1	0.0000121	0.000169564	3.11289E-05	0.023220858
Nat. Gas	6.9	0	9.31234E-07	0.000175072	0.092497124
Nuclear	37.2	0	0	0	0
Hydro/Wind	2.3	0	0	0	0
Totals	100	0.0005896	0.006879716	0.004095114	1.244497133
Center for the Arts		Total Pollutants (lbs)			
kWh	2,850,003	1680	19607	11671	3546821

Mueller Associates is the MEP firm that designed the Center for the Arts. Mueller did not perform an energy analysis of the building for their design considerations. Energy analysis is not a requirement for all projects designed by Mueller Associates.

Appendix G includes the reports from Trace summarizing the energy use of the Center for the Arts.

Appendix A:

LEED-NC Version 2.1 Registered Project Checklist

University of Delaware Center for the Arts
Newark, DE

Yes	?	No			
4	**2**	**8**	**Sustainable Sites**		**14** Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
Y			Credit 1	**Site Selection**	1
	?		Credit 2	**Development Density**	1
		N	Credit 3	**Brownfield Redevelopment**	1
Y			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Y			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		N	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
		N	Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
		N	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		N	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
	?		Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		N	Credit 6.2	**Stormwater Management**, Treatment	1
		N	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
		N	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
Y			Credit 8	**Light Pollution Reduction**	1
Yes	?	No			
	2	**3**	**Water Efficiency**		**5** Points
	?		Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
	?		Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		N	Credit 2	**Innovative Wastewater Technologies**	1
		N	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1
Yes	?	No			
2		**6**	**Energy & Atmosphere**		**17** Points
		N	Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
		N	Credit 1	**Optimize Energy Performance**	1 to 10

		N	Credit 2.1	**Renewable Energy**, 5%	1
		N	Credit 2.2	**Renewable Energy**, 10%	1
		N	Credit 2.3	**Renewable Energy**, 20%	1
		N	Credit 3	**Additional Commissioning**	1
Y			Credit 4	**Ozone Depletion**	1
Y			Credit 5	**Measurement & Verification**	1
		N	Credit 6	**Green Power**	1

Yes	?	No			
2		11		**Materials & Resources**	**13** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		N	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
		N	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
Y			Credit 2.1	**Construction Waste Management**, Divert 50%	1
		N	Credit 2.2	**Construction Waste Management**, Divert 75%	1
		N	Credit 3.1	**Resource Reuse**, Specify 5%	1
		N	Credit 3.2	**Resource Reuse**, Specify 10%	1
		N	Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
		N	Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
Y			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
		N	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		N	Credit 6	**Rapidly Renewable Materials**	1
		N	Credit 7	**Certified Wood**	1

Yes	?	No			
9	5	1		**Indoor Environmental Quality**	**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
Y			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
	?		Credit 2	**Ventilation Effectiveness**	1
Y			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	?		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
	?		Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
	?		Credit 4.2	**Low-Emitting Materials**, Paints	1
	?		Credit 4.3	**Low-Emitting Materials**, Carpet	1
Y			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
Y			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
Y			Credit 6.1	**Controllability of Systems**, Perimeter	1
Y			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1

Y			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
Y			Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
Y			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		N	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No			
		5	**Innovation & Design Process**		**5** Points
		N	Credit 1.1	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.2	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
		N	Credit 2	**LEED™ Accredited Professional**	1
Yes	?	No			
17	9	34	**Project Totals** (pre-certification estimates)		**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Appendix B:

Wall Construction:

Layers	Thickness (in)	Density (lb/ft^3)	R-Value ($hr\text{-}ft^2\text{-}F/BTU$)
Inside surface resistance	0.00	0.0	0.68500
CMU block	6.00	38.0	1.51515
Insulation	2.00	0.5	12.82051
Air Space	1.00	0.0	0.91000
Face Brick	4.00	125.0	0.43300
Outside surface resistance	0.00	0.0	0.33300
		Total	16.69666
		U-Value	0.060

Roof Construction:

Layers	Thickness (in)	Density (lb/ft^3)	R-Value ($hr\text{-}ft^2\text{-}F/BTU$)
Inside surface resistance	0.00	0.0	0.68500
Metal Deck	0.03	489	0.00011
Concrete	4.00	38	1.51515
R-22 Batt Insulation	4.00	0.50	21.63461
Slate	0.50	270	0.05002
Outside surface resistance	0.00	0.0	0.33300
		Total	24.21789
		U-Value	0.041

Fenestration:

Gross Wall Area (ft^2)	Gross Window Area (ft^2)	% Glazing of Wall
49750	5010	10.1

Percent Glazing	Design			Standard 90		
	U-Value	SHGC, North	SHGC, All	U-Value	SHGC, North	SHGC All
10.1-20.0% Glazing	0.25	0.47	0.47	0.57	0.49	0.39

Appendix C:

Room Name	Space Description	Area (Sq. Ft)	Watts	Watts / Sq.Ft	LPD (W/Sq.Ft)	Compliance
Concession	Cafeteria	241	950	3.9	1.2	No
Coats	Storage	159	208	1.3	0.8	No
Inner Lobby	Lobby	500	676	1.4	1.3	No
Men	Restroom	347	610	1.8	0.9	No
Women	Restroom	474	698	1.5	0.9	No
Elevator Room	Storage	52	64	1.2	0.3	No
Light Booth	Control Room	179	192	1.1	0.5	No
Sound Booth	Control Room	97	64	0.7	0.5	No
Orchard Street Lobby	Lobby	4,710	1600	0.3	3.3	Yes
Lock	Lobby / Corridor	143	500	3.5	0.5	No
Booth	Control Room	350	192	0.5	0.5	Yes
Sound Room	Control Room	91	128	1.4	0.5	No
Dimmer (RH)	Control Room	125	128	1.0	0.5	No
Lock	Corridor	382	1000	2.6	0.5	No
Vestibule	Corridor/ Transition	46	100	2.2	0.5	No
South Lobby	Lobby	452	630	1.4	3.3	Yes
Vestibule	Corridor/ Transition	370	1170	3.2	0.5	No
Sound Room	Office Space	120	128	1.1	1.1	Yes
Spot Booth	Control Room	192	192	1.0	0.5	No
Proscenium Theatre Seating	Auditorium Seating	4,387	9711	2.2	2.6	Yes
Proscenium Theatre Stage	Stages, Studios	3,094	7221	2.3	2.6	Yes
Women	Restroom	182	470	2.6	0.9	No
Men	Restroom	181	364	2.0	0.9	No
Elevator Room	Storage	54	64	1.2	0.3	No
Band Storage	Active Storage	654	192	0.3	0.8	Yes
Instrument Storage	Active Storage	1,857	1280	0.7	0.8	Yes
North Lobby	Corridor / Transition	1,489	2000	1.3	0.5	No
Reception	Lobby (General)	123	54	0.4	1.3	Yes
Corridor	Corridor	600	832	1.4	0.5	No

Management Office	Office Space	111	54	0.5	1.1	Yes
Operations Office	Office Space	115	54	0.5	1.1	Yes
NSO Office	Office Space	129	128	1.0	1.1	Yes
NSO Library	Library Stacks	491	640	1.3	1.7	Yes
Corridor	Corridor	680	448	0.7	0.5	No
Instrument Uncasing	Active Storage	670	256	0.4	0.8	Yes
Usher	Office Space	164	54	0.3	1.1	Yes
Box Office Manager	Office Space	120	54	0.5	1.1	Yes
Box Office	Office Space	121	260	2.1	1.1	No
Box Office Workroom	Office Space	267	416	1.6	1.1	No
Piano Storage	Active Storage	227	256	1.1	0.8	No
Green Room 2	Conference / Meeting Room	282	300	1.1	1.3	Yes
Front of House Storage	Active Storage	81	64	0.8	0.8	Yes
Building Storage	Storage	89	128	1.4	0.3	No
Pantry	Food Preparation	168	224	1.3	1.2	No
Dressing Room	Dressing Room	284	256	0.9	0.6	No
Dressing Room	Dressing Room	390	384	1.0	0.6	No
Elec	Electrical / Mechanical	82	64	0.8	1.5	Yes
Dressing Room	Dressing Room	341	256	0.8	0.6	No
Makeup	Dressing Room	353	384	1.1	0.6	No
Dressing Room	Dressing Room	341	256	0.8	0.6	No
Green Room	Conference / Meeting Room	694	750	1.1	1.3	Yes
Prop Kitchen	Food Preparation	148	160	1.1	1.2	Yes
Electric Storage	Electrical / Mechanical	127	128	1.0	1.5	Yes
Corridor	Corridor	386	512	1.3	0.5	No
Corridor	Corridor	611	384	0.6	0.5	No
Scenery Dock	Office Space	756	1024	1.4	1.1	No
Receiving	Active Storage	284	192	0.7	0.8	Yes
Stage Door Office	Office Space	220	192	0.9	1.1	Yes
Cust Storage	Storage	242	192	0.8	0.3	No
Reception	Lobby (General)	138	64	0.5	1.3	Yes
Piano Storage	Active Storage	147	128	0.9	0.8	No
Storage	Storage	126	128	1.0	0.3	No

Corridor	Corridor	672	320	0.5	0.5	Yes
Elec	Storage	98	64	0.7	1.5	Yes
Lock	Corridor / Transition	160	300	1.9	0.5	No
Dimmer Room	Control Room	109	64	0.6	0.5	No
Corridor	Corridor	245	192	0.8	0.5	No
Ensemble	Office Space	268	216	0.8	1.1	Yes
Ensemble	Office Space	264	216	0.8	1.1	Yes
Electric Composition	Office Space	220	288	1.3	1.1	No
Practice Rooms	Office Space	95	108	1.1	1.1	Yes
Lounge	Lounge	218	312	1.4	1.2	No
Double Piano	Office Space	273	216	0.8	1.1	Yes
Double Piano	Office Space	253	216	0.9	1.1	Yes
Practice Rooms	Office Space	150	108	0.7	1.1	Yes
Practice Room	Office Space	102	54	0.5	1.1	Yes
Theater Rehearsal	Performing Arts Space	2,400	8750	3.6	2.6	No
Theater Rehearsal Platform	Performing Arts Space	547	256	0.5	2.6	Yes
Dimmer (PT)	Control Room	394	192	0.5	0.5	Yes
Laundry	Coin-operated Laundries	203	384	1.9	0.6	No
Corridor	Corridor	504	256	0.5	0.5	Yes
Wardrobe	Active Storage	347	576	1.7	0.8	No
Student Storage	Storage	291	128	0.4	0.3	No
Trap Room	Storage	720	640	0.9	0.3	No
Corridor	Corridor	620	384	0.6	0.5	No
Comm Room	Storage	95	64	0.7	0.3	No
Elevator Room	Storage	67	64	1.0	0.3	No
Sound Storage	Storage	295	256	0.9	0.3	No
Corridor	Corridor	226	192	0.8	0.5	No
Stage Manager	Office Space	134	192	1.4	1.1	No
Technical Director	Office Space	135	192	1.4	1.1	No
Recital Hall Seating Area	Auditorium Seating	2,420	2511	1.0	2.6	Yes
Recital Hall Stage	Stages, Studios	692	374	0.5	2.6	Yes
Orchestra Rehearsal	Auditorium Seating	5,114	8810	1.7	2.6	Yes

Appendix D:

The information in this chart for Mechanical System estimated first costs was provided by Vermeulens Cost Consultants.

Plumbing and HVAC Equipment	Quantity	Unit Cost	Amount
Storm Pipe	1	$117,185	$117,185.00
Sanitary Pipe	1	$175,080	$175,080.00
Domestic Water	1	$122,279	$122,279.00
Insulation (Plumbing)	1	$36,128	$36,128.00
Plumbing Equipment	1	$97,730	$97,730.00
Plumbing Fixtures and RI	1	$113,945	$113,945.00
Heating Water Pipe	1	$280,684	$280,684.00
Chilled Water Pipe	1	$116,720	$116,720.00
Steam Pipe	1	$119,500	$119,500.00
Steam Condensate Pipe	1	$31,959	$31,959.00
Gas Pipe	1	$22,232	$22,232.00
Insulation (Duct)	1	$303,380	$303,380.00
Automatic Temp Controls	1	$356,645	$356,645.00
Test and Balance	1	$39,370	$39,370.00
Duct	1	$672,530	$672,530.00
HVAC Equipment	1	$1,080,716	$1,080,716.00
Wet Sprinkler System	1	$255,625	$255,625.00

Mechanical Systems Subtotal	$3,941,708.00

Appendix E:

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-1
Type - Bypass VAV with Reheat (30% Min Flow Default)

Coil Location - System

Coil Peak Calculation Time: July, hour 9
Ambient DB/WB/HR: 78 / 70 / 98

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	211,592		211,592	35.3 %
Glass Transmission	3,444		3,444	0.6 %
Wall Transmission	11,746		11,746	2.0 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	158,347		158,347	26.4 %
People	86,500	86,500	173,000	28.9 %
Misc. Equipment Loads	0	0	0	0.0 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	471,628	86,500	558,128	93.2 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	1,144		1,144	0.2 %
Roof Load to Plenum	0		0	0.0 %
Lighting Load to Plenum	39,587		39,587	6.6 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	0		0	0.0 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	512,359	86,500	598,859	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	76.4 / 63.1	°F
Coil Entering Humidity Ratio	65.24	gr/lb
Coil Leaving Air (DB / WB)	57.2 / 54.7	°F
Coil Leaving Humidity Ratio	60.11	gr/lb
Coil Sensible Load	512.36	MBh
Coil Total Load	598.86	MBh
Cooling Supply Air Temperature	57.21	°F
Total Cooling Airflow	24,031.57	cfm
Resulting Room Relative Humidity	50.10	%

General Engineering Checks

Total Cooling Load	49.9	ton
Area / Load	176.44	ft²/ton
Total Floor Area	8,805	ft²
Cooling Airflow	2.73	cfm/ft²
Airflow / Load	481.55	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

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Alternative - 1 Design Cooling Load report page 1

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-2
Type - Terminal Air Blender

Coil Location - System

Coil Peak Calculation Time: June, hour 12
Ambient DB/WB/HR: 83 / 67 / 76

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	0		0	0.0 %
Glass Transmission	0		0	0.0 %
Wall Transmission	0		0	0.0 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	59,891		59,891	18.4 %
People	125,500	125,500	251,000	77.0 %
Misc. Equipment Loads	0	0	0	0.0 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	185,391	125,500	310,891	95.4 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	0		0	0.0 %
Roof Load to Plenum	0		0	0.0 %
Lighting Load to Plenum	14,973		14,973	4.6 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	0		0	0.0 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	200,364	125,500	325,864	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	76.4 / 66.4	°F
Coil Entering Humidity Ratio	81.41	gr/lb
Coil Leaving Air (DB / WB)	55.0 / 53.9	°F
Coil Leaving Humidity Ratio	60.39	gr/lb
Coil Sensible Load	200.36	MBh
Coil Total Load	325.86	MBh
Cooling Supply Air Temperature	55.00	°F
Total Cooling Airflow	8,422.75	cfm
Resulting Room Relative Humidity	62.30	%

General Engineering Checks

Total Cooling Load	27.2	ton
Area / Load	161.55	ft²/ton
Total Floor Area	4,387	ft²
Cooling Airflow	1.92	cfm/ft²
Airflow / Load	310.17	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Design Cooling Load report page 2

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-3
Type - Bypass Multizone

Coil Location - System

Coil Peak Calculation Time: July, hour 17
Ambient DB/WB/HR: 87 / 73 / 100

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	0		0	0.0 %
Glass Transmission	0		0	0.0 %
Wall Transmission	19,150		19,150	15.5 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	10,863		10,863	8.8 %
Net Ceiling Load	0		0	0.0 %
Lighting	42,239		42,239	34.2 %
People	15,000	15,000	30,000	24.3 %
Misc. Equipment Loads	0	0	0	0.0 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	87,252	15,000	102,252	82.7 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	853		853	0.7 %
Roof Load to Plenum	10,002		10,002	8.1 %
Lighting Load to Plenum	10,560		10,560	8.5 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	0		0	0.0 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	108,667	15,000	123,667	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	78.5 / 63.8	°F
Coil Entering Humidity Ratio	65.25	gr/lb
Coil Leaving Air (DB / WB)	57.7 / 55.1	°F
Coil Leaving Humidity Ratio	60.70	gr/lb
Coil Sensible Load	108.67	MBh
Coil Total Load	123.67	MBh
Cooling Supply Air Temperature	57.69	°F
Total Cooling Airflow	4,707.50	cfm
Resulting Room Relative Humidity	50.11	%

General Engineering Checks

Total Cooling Load	10.3	ton
Area / Load	300.23	ft²/ton
Total Floor Area	3,094	ft²
Cooling Airflow	1.52	cfm/ft²
Airflow / Load	456.79	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Design Cooling Load report page 3

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-4
Type - Bypass VAV with Reheat (30% Min Flow Default)

Coil Location - System

Coil Peak Calculation Time: July, hour 16
Ambient DB/WB/HR: 89 / 73 / 99

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	21,373		21,373	3.9 %
Glass Transmission	8,988		8,988	1.7 %
Wall Transmission	20,733		20,733	3.8 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	192,955		192,955	35.5 %
People	97,500	97,500	195,000	35.9 %
Misc. Equipment Loads	38,826	0	38,826	7.1 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	380,375	97,500	477,875	88.0 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	9,032		9,032	1.7 %
Roof Load to Plenum	8,187		8,187	1.5 %
Lighting Load to Plenum	48,239		48,239	8.9 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	0		0	0.0 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	445,832	97,500	543,332	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	76.4 / 63.0	°F
Coil Entering Humidity Ratio	64.98	gr/lb
Coil Leaving Air (DB / WB)	55.5 / 53.3	°F
Coil Leaving Humidity Ratio	57.23	gr/lb
Coil Sensible Load	445.83	MBh
Coil Total Load	543.33	MBh
Cooling Supply Air Temperature	55.46	°F
Total Cooling Airflow	18,885.76	cfm
Resulting Room Relative Humidity	49.91	%

General Engineering Checks

Total Cooling Load	45.3	ton
Area / Load	639.77	ft²/ton
Total Floor Area	28,967	ft²
Cooling Airflow	0.65	cfm/ft²
Airflow / Load	417.11	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

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Alternative - 1 Design Cooling Load report page 4

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-5
Type - Bypass Multizone

Coil Location - System

Coil Peak Calculation Time: July, hour 16
Ambient DB/WB/HR: 89 / 73 / 99

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	0		0	0.0 %
Glass Transmission	0		0	0.0 %
Wall Transmission	0		0	0.0 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	49,093		49,093	26.7 %
People	60,000	60,000	120,000	65.3 %
Misc. Equipment Loads	0	0	0	0.0 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	109,093	60,000	169,093	92.0 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	0		0	0.0 %
Roof Load to Plenum	2,338		2,338	1.3 %
Lighting Load to Plenum	12,273		12,273	6.7 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	0		0	0.0 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	123,704	60,000	183,704	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	77.2 / 65.7	°F
Coil Entering Humidity Ratio	76.72	gr/lb
Coil Leaving Air (DB / WB)	55.0 / 53.7	°F
Coil Leaving Humidity Ratio	59.78	gr/lb
Coil Sensible Load	123.70	MBh
Coil Total Load	183.70	MBh
Cooling Supply Air Temperature	55.00	°F
Total Cooling Airflow	5,004.02	cfm
Resulting Room Relative Humidity	58.77	%

General Engineering Checks

Total Cooling Load	15.3	ton
Area / Load	203.28	ft²/ton
Total Floor Area	3,112	ft²
Cooling Airflow	1.61	cfm/ft²
Airflow / Load	326.88	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Design Cooling Load report page 5

Design Cooling Load Summary

By ae

Center for the Arts
Newark, Delaware

System - AHU-6
Type - Bypass Multizone

Coil Location - System

Coil Peak Calculation Time: July, hour 17
Ambient DB/WB/HR: 87 / 73 / 100

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	24,258		24,258	6.5 %
Glass Transmission	1,696		1,696	0.5 %
Wall Transmission	17,964		17,964	4.8 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	83,780		83,780	22.5 %
People	102,500	102,500	205,000	55.0 %
Misc. Equipment Loads	0	0	0	0.0 %
Cooling Infiltration	0	0	0	0.0 %
Sub-Total ==>	230,198	102,500	332,698	89.3 %
Ventilation Load	0	0	0	0.0 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	1,314		1,314	0.4 %
Roof Load to Plenum	16,479		16,479	4.4 %
Lighting Load to Plenum	20,945		20,945	5.6 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenur	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	988		988	0.3 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	269,923	102,500	372,423	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	78.7 / 63.8	°F
Coil Entering Humidity Ratio	65.18	gr/lb
Coil Leaving Air (DB / WB)	48.3 / 47.3	°F
Coil Leaving Humidity Ratio	46.90	gr/lb
Coil Sensible Load	269.92	MBh
Coil Total Load	372.42	MBh
Cooling Supply Air Temperature	48.57	°F
Total Cooling Airflow	7,988.70	cfm
Resulting Room Relative Humidity	50.06	%

General Engineering Checks

Total Cooling Load	31.0	ton
Area / Load	164.78	ft²/ton
Total Floor Area	5,114	ft²
Cooling Airflow	1.56	cfm/ft²
Airflow / Load	257.41	cfm/ton
Percent Outdoor Air	0.0	%
Cooling Load Methodology	TETD-TA1	

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Design Cooling Load report page 6

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	Percent OA Htg	ASHRAE 62-89 OA fraction
Concessions - 120C	Rm/Zn Tot	241	2.0	7,080	7,580	297	7.39	89	-1,593	208	0.0	0.0	
COATS - 131	Rm/Zn Tot	159	0.0	1,628	1,628	69	3.34	21	-596	49	0.0	0.0	
INNER LOBBY - 100F	Rm/Zn Tot	550	40.0	12,130	22,130	604	5.99	181	-3,371	423	0.0	0.0	
MEN - 132	Rm/Zn Tot	347	0.0	3,553	3,553	151	2.38	45	-1,301	106	0.0	0.0	
WOMEN - 135	Rm/Zn Tot	474	0.0	4,853	4,853	207	2.38	62	-1,777	145	0.0	0.0	
ELEVATOR ROOM - 168	Rm/Zn Tot	52	0.0	218	218	10	1.05	3	-149	7	0.0	0.0	
LIGHT BOOTH - 155G	Rm/Zn Tot	179	1.0	3,305	3,555	140	4.27	42	-894	98	0.0	0.0	
SOUND BOOTH -155H	Rm/Zn Tot	97	1.0	1,905	2,155	82	6.61	25	-506	57	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	-168,520	15,078	0.0	0.0	
CIRCULATION-200C	Rm/Zn Tot	855	25.0	6,250	12,500	335	1.68	100	-3,067	234	0.0	0.0	
LOCK-250A	Rm/Zn Tot	143	0.0	1,707	1,707	72	2.75	22	-571	51	0.0	0.0	
BOOTH- 237	Rm/Zn Tot	350	2.0	6,473	6,973	275	4.28	82	-1,751	192	0.0	0.0	
SOUND ROOM - 239	Rm/Zn Tot	91	0.0	1,553	1,553	65	3.88	19	-432	45	0.0	0.0	
DIMMER - 243	Rm/Zn Tot	125	0.0	437	437	20	0.89	6	-346	14	0.0	0.0	
LOCK - 250D	Rm/Zn Tot	382	0.0	3,498	3,498	150	2.14	45	-1,372	105	0.0	0.0	
VESTIBULE - 250G	Rm/Zn Tot	50	0.0	341	341	15	1.63	4	-163	10	0.0	0.0	
AHU-1	Sys Tot/Ave	8,805	346.0	512,359	598,859	24,032			-186,408	16,822	0.0	0.0	
AHU-1	Sys Block	8,805	346.0	512,359	598,859	24,032			-186,406	16,822	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	
AHU-2	Sys Tot/Ave	4,387	502.0	200,364	325,864	8,423			-1	8,423	0.0	0.0	
AHU-2	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	
AHU-3	Sys Tot/Ave	3,094	60.0	108,667	123,667	4,707			-32,213	4,707	0.0	0.0	
AHU-3	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	
AHU-5	Sys Tot/Ave	3,112	240.0	123,704	183,704	5,004			-1,526	5,004	0.0	0.0	
AHU-5	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	269,923	372,423	7,989	2.29	0	-33,781	7,989	0.0	0.0	

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

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Load/Airflow Summary report page 1

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	Percent OA Htg	ASHRAE 62-89 OA fraction
AHU-6	Sys Tot/Ave	5,114	410.0	269,923	372,423	7,989			-33,781	7,989	0.0	0.0	
AHU-6	Sys Block	5,114	410.0	269,923	372,423	7,989			-33,781	7,989	0.0	0.0	
WOMEN -104	Rm/Zn Tot	182	0.0	1,864	1,864	73	2.20	22	-688	51	0.0	0.0	
MEN - 105	Rm/Zn Tot	181	0.0	1,853	1,853	73	2.20	22	-685	51	0.0	0.0	
ELEVATOR ROOM-102A	Rm/Zn Tot	54	0.0	55	55	3	0.35	1	-128	2	0.0	0.0	
BAND STORAGE - 102	Rm/Zn Tot	654	0.0	3,034	3,034	123	1.03	37	-2,466	86	0.0	0.0	
INSTRUMENT STORAGE - 101D	Rm/Zn Tot	1,857	0.0	10,936	10,936	426	1.25	128	-9,254	298	0.0	0.0	
NORTH LOBBY - 100A	Rm/Zn Tot	1,600	97.0	61,631	85,881	2,596	8.85	779	-26,928	1,817	0.0	0.0	
CORRIDOR - 100C	Rm/Zn Tot	337	0.0	575	575	30	0.49	9	-831	21	0.0	0.0	
RECEPTION - 110	Rm/Zn Tot	123	1.0	796	1,046	35	1.54	10	-403	24	0.0	0.0	
CORRIDOR - 100D	Rm/Zn Tot	567	0.0	9,877	9,877	445	4.28	134	-14,058	312	0.0	0.0	
MANAGEMENT OFFICE - 111	Rm/Zn Tot	111	1.0	1,117	1,367	50	2.48	15	-444	35	0.0	0.0	
OPERATIONS OFFICE - 112	Rm/Zn Tot	115	1.0	1,132	1,382	51	2.43	15	-455	36	0.0	0.0	
NSO OFFICE - 106	Rm/Zn Tot	129	1.0	1,801	2,051	76	3.22	23	-589	53	0.0	0.0	
NSO LIBRARY - 106A	Rm/Zn Tot	491	6.0	8,203	9,703	329	3.65	99	-2,404	230	0.0	0.0	
CORRIDOR - 100E	Rm/Zn Tot	880	0.0	1,502	1,502	78	0.49	24	-2,171	55	0.0	0.0	
INSTRUMENT UNCASING - 123	Rm/Zn Tot	670	0.0	2,287	2,287	102	0.83	31	-1,829	71	0.0	0.0	
USHER - 114	Rm/Zn Tot	164	4.0	2,066	3,066	94	3.12	28	-736	66	0.0	0.0	
BOX OFFICE MANAGER - 115B	Rm/Zn Tot	120	2.0	1,851	2,351	84	3.83	25	-604	59	0.0	0.0	
BOX OFFICE -115	Rm/Zn Tot	121	3.0	5,404	6,154	221	9.98	66	-1,180	155	0.0	0.0	
BOX OFFICE WORKROOM - 115A	Rm/Zn Tot	267	3.0	3,023	3,773	129	2.64	39	-1,100	91	0.0	0.0	
PIANO STORAGE - 122	Rm/Zn Tot	227	0.0	620	620	29	0.69	9	-596	20	0.0	0.0	
GREEN ROOM 2 - 124	Rm/Zn Tot	282	7.0	2,032	3,782	101	1.95	30	-1,013	71	0.0	0.0	
CORRIDOR SOUTH - 100E	Rm/Zn Tot	444	0.0	758	758	40	0.49	12	-1,095	28	0.0	0.0	
BUILDING STORAGE -137	Rm/Zn Tot	89	0.0	243	243	11	0.69	3	-234	8	0.0	0.0	
PANTRY - 139	Rm/Zn Tot	168	0.0	5,367	5,367	241	7.82	72	-1,360	169	0.0	0.0	
DRESSING ROOM - 140	Rm/Zn Tot	284	4.0	4,877	5,877	205	3.94	62	-1,453	144	0.0	0.0	

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

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Load/Airflow Summary report page 2

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	Percent OA Htg	ASHRAE 62-89 OA fraction
DRESSING ROOM - 141	Rm/Zn Tot	390	4.0	7,499	8,499	303	4.23	91	-2,629	212	0.0	0.0	
ELECTRICAL - 143	Rm/Zn Tot	82	0.0	420	420	18	1.17	5	-246	12	0.0	0.0	
DRESSING ROOM - 142	Rm/Zn Tot	341	8.0	7,683	9,683	316	5.06	95	-2,516	222	0.0	0.0	
MAKEUP - 144	Rm/Zn Tot	353	10.0	8,347	10,847	346	5.35	104	-2,665	242	0.0	0.0	
DRESSING ROOM - 146	Rm/Zn Tot	341	8.0	7,683	9,683	316	5.06	95	-2,516	222	0.0	0.0	
GREEN ROOM - 147	Rm/Zn Tot	694	18.0	13,574	18,074	617	4.85	185	-7,806	432	0.0	0.0	
PROP KITCHEN - 148	Rm/Zn Tot	148	2.0	1,611	2,111	72	2.67	22	-613	51	0.0	0.0	
ELEC STORAGE - 150	Rm/Zn Tot	128	0.0	655	655	27	1.17	8	-383	19	0.0	0.0	
CORRIDOR - 100H	Rm/Zn Tot	386	0.0	659	659	34	0.49	10	-952	24	0.0	0.0	
CORRIDOR -100K	Rm/Zn Tot	611	0.0	1,043	1,043	54	0.49	16	-1,507	38	0.0	0.0	
SCENERY DOCK - 164	Rm/Zn Tot	759	8.0	17,543	19,543	708	5.09	212	-4,552	496	0.0	0.0	
RECEIVING - 165	Rm/Zn Tot	284	0.0	1,488	1,488	60	1.16	18	-1,597	42	0.0	0.0	
STAGE DOOR OFFICE - 166	Rm/Zn Tot	220	2.0	5,171	5,671	217	5.39	65	-3,845	152	0.0	0.0	
CUST STORAGE - 167	Rm/Zn Tot	242	0.0	1,487	1,487	58	1.32	18	-1,707	41	0.0	0.0	
RECEPTION	Rm/Zn Tot	138	1.0	2,654	2,904	97	3.85	29	-1,583	68	0.0	0.0	
PIANO STORAGE	Rm/Zn Tot	147	0.0	401	401	19	0.69	6	-386	13	0.0	0.0	
STORAGE - 162D	Rm/Zn Tot	126	0.0	430	430	19	0.83	6	-344	13	0.0	0.0	
CORRIDOR - 100P	Rm/Zn Tot	853	0.0	1,456	1,456	76	0.49	23	-2,104	53	0.0	0.0	
ELECTRICAL ROOM - 138	Rm/Zn Tot	98	0.0	167	167	9	0.49	3	-242	6	0.0	0.0	
LOCK - 101C	Rm/Zn Tot	160	0.0	273	273	14	0.49	4	-395	10	0.0	0.0	
DIMMER ROOM - 101E	Rm/Zn Tot	109	0.0	959	959	36	1.78	11	-650	25	0.0	0.0	
CORRIDOR - 100L	Rm/Zn Tot	245	0.0	418	418	22	0.49	7	-604	15	0.0	0.0	
ENSEMBLE - 201	Rm/Zn Tot	268	6.0	9,136	10,636	388	7.89	116	-4,342	271	0.0	0.0	
ENSEMBLE - 202	Rm/Zn Tot	264	6.0	10,039	11,539	424	8.77	127	-5,417	297	0.0	0.0	
ELECTRICAL COMPOSTION - 211	Rm/Zn Tot	750	5.0	9,829	11,079	401	2.92	120	-3,250	281	0.0	0.0	
PRACTICE ROOM - 204	Rm/Zn Tot	99	1.0	4,352	4,602	181	9.95	54	-2,111	126	0.0	0.0	
PRACTICE ROOM - 206	Rm/Zn Tot	1,683	17.0	39,287	43,537	1,646	5.34	494	-23,540	1,152	0.0	0.0	
PRACTICE ROOM - 213	Rm/Zn Tot	104	1.0	1,760	2,010	74	3.90	22	-526	52	0.0	0.0	
PRACTICE ROOM - 215	Rm/Zn Tot	104	1.0	1,760	2,010	74	3.90	22	-526	52	0.0	0.0	
DOUBLE PIANO - 223	Rm/Zn Tot	273	2.0	3,745	4,245	154	3.07	46	-1,215	108	0.0	0.0	

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

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Load/Airflow Summary report page 3

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	Percent OA Htg	ASHRAE 62-89 OA fraction
DOUBLE PIANO - 225	Rm/Zn Tot	253	2.0	3,540	4,040	146	3.14	44	-1,140	102	0.0	0.0	
LOUNGE - 200B	Rm/Zn Tot	206	0.0	2,112	2,112	83	2.20	25	-780	58	0.0	0.0	
PRACTICE ROOM - 227	Rm/Zn Tot	532	4.0	8,247	9,247	343	3.52	103	-2,551	240	0.0	0.0	
PRACTICE ROOM -242	Rm/Zn Tot	174	1.0	3,752	4,002	148	4.64	44	-2,352	104	0.0	0.0	
PRACTICE ROOM - 241	Rm/Zn Tot	102	1.0	1,744	1,994	73	3.92	22	-521	51	0.0	0.0	
THEATER REHEARSAL - 162	Rm/Zn Tot	2,400	144.0	113,127	149,127	4,331	4.27	1,299	-26,431	3,031	0.0	0.0	
THEATER PLATFORM - 253	Rm/Zn Tot	660	5.0	10,960	12,210	450	3.72	135	-3,641	315	0.0	0.0	
DIMMER - 251	Rm/Zn Tot	394	0.0	3,139	3,139	130	1.80	39	-1,369	91	0.0	0.0	
LAUNDRY - 006	Rm/Zn Tot	203	0.0	4,079	4,079	174	4.67	52	-1,153	122	0.0	0.0	
CORRIDOR - 001C	Rm/Zn Tot	504	0.0	860	860	45	0.49	13	-1,243	31	0.0	0.0	
WARDROBE - 005	Rm/Zn Tot	347	0.0	2,369	2,369	96	1.51	29	-1,130	67	0.0	0.0	
STUDENT STORAGE - 016	Rm/Zn Tot	291	0.0	1,986	1,986	81	1.51	24	-947	57	0.0	0.0	
TRAP ROOM - 013	Rm/Zn Tot	720	0.0	2	2	19	0.14	6	-1,587	13	0.0	0.0	
CORRIDOR - 001A	Rm/Zn Tot	620	0.0	2	2	16	0.14	5	-1,367	11	0.0	0.0	
COMM ROOM - 010	Rm/Zn Tot	95	0.0	162	162	8	0.49	3	-234	6	0.0	0.0	
ELEVATOR ROOM - 002B	Rm/Zn Tot	67	0.0	69	69	4	0.35	1	-158	3	0.0	0.0	
SOUND STORAGE - 007	Rm/Zn Tot	295	0.0	2,014	2,014	82	1.51	25	-960	57	0.0	0.0	
CORRIDOR - 001B	Rm/Zn Tot	226	0.0	386	386	20	0.49	6	-558	14	0.0	0.0	
STAGE MANAGER - 011	Rm/Zn Tot	134	1.0	1,615	1,865	69	2.83	21	-571	49	0.0	0.0	
TECHNICAL DIRECTOR - 012	Rm/Zn Tot	228	2.0	3,285	3,785	136	3.25	41	-1,045	95	0.0	0.0	
AHU-4	Sys Tot/Ave	28,967	390.0	457,877	555,377	18,886			-203,213	13,220	0.0	0.0	
AHU-4	Sys Block	28,967	390.0	445,832	543,332	18,886			-203,206	13,220	0.0	0.0	

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Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Load/Airflow Summary report page 4

Appendix F:

Room Number	Room Name	Design CFM	Simulation CFM	Is simulation value above or below design value?
120C	Concession	230	297	Above
131	Coats	80	69	Below
100F	Inner Lobby	870	604	Below
132	Men	120	151	Above
135	Women	160	207	Above
168	Elevator Room	320	10	Below
155G	Light Booth	158	140	Below
155H	Sound Booth	372	82	Below
100B	Orchard Street Lobby	15,152	21,541	Above
250A	Lock	72	72	
237	Booth	1,117	275	Below
239	Sound Room	150	65	Below
243	Dimmer (RH)	225	437	Above
250D	Lock	65	150	Above
250G	Vestibule	14	15	
155	Proscenium Theatre Seating	2,773	8,423	Above
154	Proscenium Theatre Stage	786	4,707	Above
104	Women	110	73	Below
105	Men	270	73	Below
102A	Elevator Room	480	3	Below
102	Band Storage	456	125	Below
101D	Instrument Storage	1,398	426	Below
100A	North Lobby	3,750	2,596	Below
110	Reception	71	35	Below
100D	Corridor	380	445	Above
111	Management Office	75	50	Below
112	Operations Office	77	51	Below
106	NSO Office	110	76	Below
106A	NSO Library	331	329	
100E	Corridor	292	78	Below
123	Instrument Uncasing	250	102	Below
114	Usher	108	94	Below
115B	Box Office Manager	81	84	
115	Box Office	167	221	Above

115A	Box Office Workroom	224	129	Below
122	Piano Storage	110	29	Below
124	Green Room 2	222	101	Below
136	Front of House Storage	154	40	Below
137	Building Storage	50	11	Below
139	Pantry	500	241	Below
140	Dressing Room	410	205	Below
141	Dressing Room	470	303	Below
143	Elec	300	18	Below
142	Dressing Room	900	316	Below
144	Makeup	720	346	Below
146	Dressing Room	900	316	Below
147	Green Room	900	617	Below
148	Prop Kitchen	140	72	Below
150	Electric Storage	62	27	Below
100H	Corridor	218	34	Below
100K	Corridor	359	54	Below
164	Scenery Dock	665	708	Above
165	Receiving	168	60	Below
166	Stage Door Office	208	217	
167	Cust Storage	156	58	Below
100R	Reception	330	97	Below
163	Piano Storage	34	19	Below
162D	Storage	28	19	Below
100P	Corridor	552	76	Below
138	Elec	600	167	Below
101C	Lock	50	14	Below
101E	Dimmer Room	550	36	Below
100L	Corridor	440	22	Below
201	Ensemble	400	388	
202	Ensemble	360	424	Above
211	Electric Composition	380	401	Above
Typical	Practice Rooms	380	375	
200B	Lounge	315	83	Below
223	Double Piano	142	154	
225	Double Piano	127	146	Above
242	Practice Rooms	240	245	
241	Practice Room	85	73	Below
162	Theater Rehearsal	6,440	4,331	Below

252	Theater Rehearsal Platform	596	450	Below
251	Dimmer (PT)	1,500	130	Below
006	Laundry	640	174	Below
001C	Corridor	126	45	Below
005	Wardrobe	560	96	Below
016	Student Storage	79	81	
013	Trap Room	340	19	Below
001A	Corridor	260	16	Below
010	Comm Room	85	162	Above
002B	Elevator Room	330	69	Below
007	Sound Storage	170	82	Below
001B	Corridor	57	20	Below
011	Stage Manager	84	69	Below
012	Technical Director	170	136	Below
120	Recital Hall Seating Area	7,914	4,108	Below
121	Recital Hall Stage	3,111	896	Below
101	Orchestra Rehearsal	7,000	7,989	Above

Appendix G:

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
Electric													
On-Pk Cons. (kWh)	39,841	36,078	44,301	38,890	45,162	77,391	71,357	80,120	68,196	42,766	40,521	38,156	622,778
Off-Pk Cons. (kWh)	140,705	127,119	133,383	140,400	142,101	122,240	143,794	124,226	130,904	138,992	135,048	145,767	1,624,680
Mid-Pk Cons. (kWh)	52,814	47,979	58,976	51,731	58,584	44,464	41,184	46,227	39,488	56,756	53,734	50,608	602,546
On-Pk Demand (kW)	320	323	327	329	360	374	377	369	362	335	327	323	377
Off-Pk Demand (kW)	319	320	323	329	346	358	363	355	347	325	323	320	363
Mid-Pk Demand (kW)	323	328	331	334	349	359	367	357	347	332	329	326	367
Purchased Steam													
On-Pk Cons. (therms)	18	16	19	11	0	0	0	0	0	18	18	17	118
Off-Pk Cons. (therms)	63	57	59	59	2	0	0	0	3	52	60	65	421
Mid-Pk Cons. (therms)	24	21	26	17	1	0	0	0	1	18	24	22	155
On-Pk Demand (therms/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0
Off-Pk Demand (therms/hr)	1	0	0	0	0	0	0	0	0	0	0	0	1
Mid-Pk Demand (therms/hr)	0	0	0	0	0	0	0	0	0	0	0	0	0

Building Energy Consumption = 183,181 Btu/(ft2-year)
Source Energy Consumption = 547,438 Btu/(ft2-year)
Floor Area = 53,479 ft2

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

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Alternative - 1 Monthly Energy Consumption report page 1

MONTHLY UTILITY COSTS

By ae

Alternative: 1

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
					------- Monthly Utility Costs -------								
Electric													
On-Pk Demand ($)	27	27	27	29	32	33	33	33	32	30	27	27	358
Gas													
On-Pk Cons. ($)	18	18	18	18	18	18	18	18	18	18	18	18	210
Monthly Total ($):	44	44	45	47	49	51	51	50	50	47	45	45	568

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Monthly Utility Costs report Page 1 of 1

ENERGY CONSUMPTION SUMMARY

By ae

	Elect Cons. (kWh)	P.Stm Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
Primary heating				
Primary heating	13.7	693.4	0.7 %	925.9
Primary cooling				
Cooling Compressor	968,059.6		33.7 %	99,129.5
Tower/Cond Fans			0.0 %	0.0
Condenser Pump			0.0 %	0.0
Other CLG Accessories	876.0		0.0 %	89.7
Cooling Subtotal....	968,935.6		33.8 %	99,219.2
Auxiliary				
Supply Fans			0.0 %	0.0
Circ Pumps			0.0 %	0.0
Base Utilities			0.0 %	0.0
Aux Subtotal....			0.0 %	0.0
Lighting				
Lighting	1,881,053.8		65.5 %	192,620.3
Receptacle				
Receptacles			0.0 %	0.0
Heating plant load				
Base Utilities			0.0 %	0.0
Cogeneration				
Cogeneration			0.0 %	0.0
Totals				
Totals**	2,850,003.0	693.4	100.0 %	292,765.5

* 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.

Project Name: Center for the Arts
Dataset Name: P:\Udel CFA.trc

TRACE® 700 v4.1 calculated at 11:40 AM on 10/31/2005
Alternative - 1 Energy Consumption Summary report page 1

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