Heiges Field House Arena Cooling Feasibility Study

PREPARED FOR:
Shippensburg University
1871 Old Main Dr.
Shippensburg, PA 17257

SHIPPENSBURG PROJECT:
SU-2017/27

RPA PROJECT:
17116.001

DATE:
December 12, 2017

TABLE OF CONTENTS

LIST OF ATTACHMENTS

1. EXECUTIVE SUMMARY

RPA Engineering was retained to evaluate the feasibility of adding cooling coils to the four existing air handlers at Heiges Field House Arena (HFHA). The addition of cooling coils will improve temperature and humidity control which will improve occupant comfort and will prevent issues with moisture and cracking relative the interior wooden structure. The existing chiller plant has adequate capacity to serve addition of HFHA without any additional equipment. New chilled water piping infrastructure will need to be extended from Vault A to HFHA and should be straight-forward considering existing piping connections with isolation valves are already in place. Space constraints will complicate the installation of the coils in air handlers 9 and 10, however these challenges can be overcome with thorough design and planning. The coils on air handlers 11 and 12 can be installed without complication. The estimated cost to complete the project is $900,691.

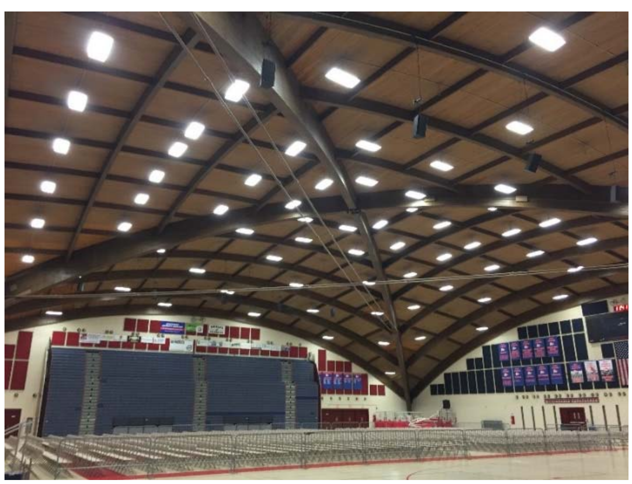
2. INTRODUCTION

Shippensburg University installed four new air handling units at Heiges Field House Arena (HFHA) in 2008 with the intent of installing chilled water coils in all of the units at a future date. Provisions were made to include a cooling coil section when the units were manufactured, thus allowing for future installation. The purpose of this study is to evaluate the feasibility and costs associated with installing the cooling coils.

3. EXISTING CONDITIONS

Chilled water to the Shippensburg Campus is provided by three 1,000 ton VFD centrifugal chillers and one 500 ton air-cooled chiller for a total combined capacity of 3,500 tons of cooling. Heat rejection is via three 1,000 ton cooling towers. Water is circulated by four chilled water pumps. Provisions for the addition of a fourth 1,000 ton chiller and cooling tower (complete with pumps) have been made to account for the addition of future buildings not yet connected to the chilled water system.

Air Handling Units 9, 10, 11 and 12 are all Trane 57M-Series Climate Changer Air Handlers capable of providing 35,000 CFM of supply air with the ability to modulate airflow via variable frequency drives. Each of the units are equally sized and are located in mechanical rooms at the north, south, east and west extremities of the Gymnasium area. Air Handlers 10, 11 and 12 are located on first floor and air handler 9 is located on the second floor. The units employ hot water heating coils which are the sole source of heat for the Gymnasium area during the heating season. Currently the Gymnasium is heated and ventilated through these air handling units. When the outdoor air conditions are conducive to provide cooling, the air handling units provide cooling only under these conditions.



Interior of Heiges Field Hall Arena

The athletic wing of the building, which is separate from the Gymnasium, is currently partially conditioned during the cooling season and is connected to the central chilled water system via 2 ½" chilled water supply and return piping on the west side of the building. However, the Gymnasium is not connected to the chilled water system and the closest point of connection is at Vault A, near the intersection of Stadium Access Road and Lancaster Dr. There are 6" existing connections at Vault A which were left for future connection to HFH.

View of Vault "A" Facing Northeast and Southwest

4. METHODOLOGY

A Central Plant Utility Basis of Design Study was conducted by Gannett Fleming in 2012 which details the current connected chilled water load as well as the expected connected load, per building for future consideration. This report was used as the basis of determining the overall effect of adding HFHA to the central chilled water system. While the calculations and capacities in the Gannet Fleming report were referenced, RPA Engineering performed addition calculations for preliminary chilled water coil sizing.

Field investigations were conducted to determine the best overall routing for chilled water piping from Vault A to the four air handling units at HFHA. Additionally, the pipe routing inside HFHA was evaluated to determine the overall amount of space available to add chilled piping infrastructure to the building.

5. DISCUSSION

Chilled Water Loads and Chiller Plant Evaluation

Per the study by Gannett Fleming, the peak load and total diversified load for the HFHA Gymnasium are 233 tons and163 tons, respectively. The current connected peak load is 3,188 tons and with the addition of the Gymnasium, this will rise to 3,421 tons. Similarly, the current connected diversified load to the chillers is 2,232 tons and with the addition of the Gymnasium, this will rise to 2,395 tons.

	Building Name	Building Type	Conditioned Area (sq.ft.)	Cooling Load (tons)	Cooling Load Factor (sq.ft./ton)
Existing Buildings with Cooling	Reisner Dining Hall	Dining	71,296	350	204
	Heiges Field House	Athletic	8,400	24	350
	Franklin / Shippen & Luhrs / Dauphin	Lab / Class / Class	201,308	700	288
	Performing Arts Center (PAC)	Theater / Class	92,380	340	272
	Shearer / Rowland Halls	Class	42,863	185	232
	Kriner Dining Hall	Dining	32,611	70	466
	Student Rec Center (ShipREC)	Gym	64,196	192	334
	Huber Arts Center	Class	44,000	90	489
	Memorial Auditorium	Auditorium	26,375	80	330
	Lehman Library	Library	74,108	185	401
	MCT Center	IT Center / Class	39,194	100	392
	Grove Hall	Class	69,278	300	231
	Old Main (partially cooled)	Admin	75,000	140	536
New Buildings (Connected within 5 yrs)	Stewart	Admin	11,936	32	373
	Ceddia Union Building (CUB)		140,000	400	350
	Residence Halls (Phase 3)	Residence	297,700	0	-
	Near-Term Total		**1,290,645**	**3,188**	
	Near-Term Total w/ 70% Diversity			**2,232**	

Connected Cooling Load, Source Gannett Flemming 2012 Report

Therefore, the existing chillers in the chiller plant have adequate capacity to handle both the peak and diversified loads with the addition of HFHA. Currently, the possibility of adding both Horton Hall and Gilbert Hall is being considered under separate studies. The total combined diversified load for these two buildings is 145 tons and would bring the total connected peak load to 2,540 tons if HFHA was also added. The existing chilled water system would be adequate to support the addition all three buildings.

With the air handling units being equally sized, each of the respective cooling coils will also need to be equally sized. Each coil should be sized for a total peak capacity of 76 tons of cooling with the ability to provide good heat transfer and turbulent water flow conditions down to a diversified load of 61 tons. Therefore the air handling units will be able to provide adequate cooling to the space on a design-day and provide reliable performance during typical loading conditions. Airflow from the air handling units can be modulated to increase turn-down and further decrease cooling capacity.

Chilled Water Piping

When the central chilled water system was installed in 2013, 6” piping connections were left for future service to HFH including 6” butterfly valves for isolation. The total required flow for all four Gymnasium air handling unit coils is 485 gpm (gallons per minute). This flow will require 6” piping, therefore the current piping connections are adequate to serve HFH. The 6” lines are capable of a recommended maximum flow of 780 gallons per minute, therefore some spare capacity will be available on these mains for future expansion.

6” Future Chilled Water Connections at North Wall of Vault A

After considering the possible options for routing the piping from Vault A, it was determined the most efficient route would be to exit the vault and travel north to a point near the northwest corner of HFH. Please refer to **Attachment 2** for a depiction of the route. 4” branch lines would then be extended east to each of the mechanical rooms. The entire piping system outside of HFHA would consist of direct-buried, pre-insulated piping in a conduit and would remain as such until entering the mechanical spaces where it would transition to black steel piping with fiberglass insulation. Leak detection could be added in the void space of the conduit.

Chilled Water Coil Installation in Air Handling Units

Each air handling unit will have (2) chilled water coils installed with an intermediate drain pan due to the height of the air tunnel. The intermediate drain pan will drain away moisture from the top coil to prevent the water-falling effect and moisture carryover from the bottom coil. We recommend selecting coils with a high temperature differential on the chilled water system to minimize the flow required. Newer generation chillers gain efficiency and a small amount of capacity with higher entering water temperatures. Since the supply water temperature is 45°F, we would limit the temperature differential to 15˚F. This will increase the number of rows within the cooling coil; however, will ultimately provide better cooling capacity.

The supply fans will need to be balanced to overcome the additional resistance of the chilled water coil. If excess fan speed and motor horsepower capacity is not available, the supply air flow may have to be decreased slightly in order to overcome the additional static pressure of the cooling coil.

Mechanical rooms 131 and 136 which house AHU-12 and AHU-11, respectively, have adequate space to install the cooling coils and accommodate the new chilled water piping without physical modification to the room.

Mechanical Room 139, which houses AHU-10, may require a portion of the north wall to be removed to allow for installation of the new cooling coil.

Room 139 with AHU-10 and North CMU Partition at Right

The configuration of this room is not ideal for removal or installation of AHU-10 cooling and heating coils; however, the coils may be able to be removed and installed through the existing door. Therefore, it should be expected that the north wall may need partially removed and re-established prior to completion of the work.

Mechanical room 214, which houses AHU-9 has adequate space to install the new cooling coil. Installing the new chilled water piping in this area is possible, however, the proposed route has some spatial challenges. This is mainly due to the configuration and orientation of the underside of the pre-cast roof slab which has concrete reinforced webbing extending beyond the underside of slab on the 2nd Floor. This may require that the piping enter the mechanical room from the 1st floor ceiling space up through the 2nd floor in proximity to the cooling coil connections.

AHU-9, Mechanical Room 214

Routing of Existing Hot Water Piping Above AHU-9 Left, Mechanical Room 214 Concrete Deck Structure Right

The building entrances and the doors to the mechanical spaces have double-doors with 3 foot leaves which provide adequate space to transport the coils to the respective air handling unit. Since AHU-9 is on the 2nd Floor, it may be beneficial to remove the window or louver at the north wall to deliver the coil rather than to move the coil from an entry point in the building to the 2nd Floor.

Air Handling Unit Control Modifications

The control for the air handling unit should be changed to a single zone variable air volume (VAV) control in order to provide consistent dehumidification and humidity control during the cooling season. The four current temperature sensors will remain and shall have humidity added to each. Automated logic would average temperature and humidity to control the units as one zone. The existing unit has a demand controlled ventilation sequence with a carbon dioxide sensor, which shall be maintained.

Controls for the cooling mode shall be added to control the chilled water coil control valve, an economizer sequence, and dehumidification and to limit the set-back ranges during unoccupied mode.

Effect of Air Conditioning & Humidification on the Wood Floor and Ceiling

During initial meetings with Shippensburg University, concerns were raised regarding how the addition of cooling may affect the wooden interior structure of HFHA. The primary concern was regarding cracking of the wooden structure or issues with moisture. Currently without mechanical cooling, the range of temperatures and humidity the interior structure is subjected to is greater than those experienced with mechanical cooling. Adding mechanical cooling will provide improved control of the upper humidity and temperature limits. With the current configuration, there is no ability to dehumidify or cool the incoming outdoor air. Considering ventilation and temperature control in the summer, when unconditioned outdoor air enters and mixes with return air from a space that is not air conditioned, the space temperature will ultimately increase to match or exceed the outdoor air temperature depending on how much internal heat gain in the space.

Adding mechanical cooling will condition incoming outdoor air and therefore limit the range of temperatures and humidity that the wooden structure is subjected to year-over year. In turn, the amount of moisture absorbed by the structure from interior conditions will be less and the amount of expansion and contraction of the wood due to temperature and moisture content changes will be less. Furthermore, the possibility of surface condensation on the structure or floor will be reduced since the upper humidity levels will be lower in the space as well as the overall dew point where condensation would occur. Therefore, the addition of mechanical cooling should improve against moisture and cracking of the wooden interior structure. One potential concern would be if the system is shut down during unoccupied mode where the temperature and humidity of the space would rise and create temperature and humidity cycles between occupied and unoccupied modes. Additionally, if the system was down and the surface temperatures of the walls, floors or ceilings fall below dew point, condensation could occur. To limit this possibility, scheduled shut downs should be planned for periods when outdoor humidity is expected to be low or when activity in the Arena will not generate internal latent loads.

At the time of this study, Shippensburg is considering installing a new wood floor in the Arena. Per the flooring manufacturer's recommendations, ideal humidity conditions are between 35% and 55% relative humidity. If these conditions must be maintained year-round and not only during installation, a re-heat strategy should be employed to prevent overcooling of the space when the air handling units are at minimum outdoor airflow. If the space temperature is allowed to drift lower in the space, relative humidity will increase as a result. Currently the Trane units are configured with the hot water heating coil upstream of the cooling coil, therefore reheat is not possible. However the heating coil modules may be relocated ahead of the new cooling coil modules, which would negate further equipment costs and would only require field labor. If desired, separate hydronic or electric reheat coils may be installed in the supply ductwork downstream of the air handlers, but this would require investment in additional equipment as well as costs to providing piping or electrical infrastructure. To maintain minimum humidity levels of 35% in the winter, four 250 lbs/hr natural gas-fired steam generators will be required. The humidifiers are sized based on an indoor humidity of 45% relative humidity, and indoor temperature of 70°F, a total supply airflow of 140,000 CFM and an outdoor airflow of 28,000 CFM. Electric steam generators could be employed, however current draws on larger steam generators have a significant impact on operating costs of the units. Natural gas generators will require extending the existing natural gas piping which enters the facility from the south. In addition, a new connection to the main may be required to support the new generators.

Construction Schedule and Facility Impacts

Since proper isolation for existing chilled water to HFHA is already in place and an outage is not required, this project can be considered for implementation during the spring and summer months when space use is at a minimum. Since the project involves site work and excavation, which is optimally performed in warmer temperatures, this would further support this time-frame for execution. The project should be scheduled such that adequate time for restoration of green areas can occur.

While the site work can be performed without interruption, installation of the cooling coils may require interruptions in service in terms of airflow, however these should be short outages with no more than one day of interruption. These interruptions will only be incurred to physically install the coil in the air handler. Once the coil is installed into the unit casing, the unit can be energized. If desired, coil installation could occur off-hours to minimize impact to normal operation or to take advantage of cooler ambient conditions.

6. CONCLUSIONS

The existing chiller plant and piping loop has adequate capacity to support air conditioning for the Gymnasium at Heiges Field House Arena; therefore, RPA Engineering recommends that the cooling coils be installed at HFH and the building be connected to the central chilled water system. Doing so will increase occupant comfort in the Gymnasium while maintaining steady-state conditions within the space during the cooling season. Since a new flooring system is planned to be installed, providing reasonable indoor conditions will prolong the life of the flooring system. Further investigation of the exact requirements in terms of temperature and humidity should be investigated during the detailed design stage; maintaining 35% - 55% relative humidity year round will ultimately increase capital project costs as well as operating costs. While these conditions are ideal, they may not be absolutely necessary for a trouble-free flooring system.

ATTACHMENT 1

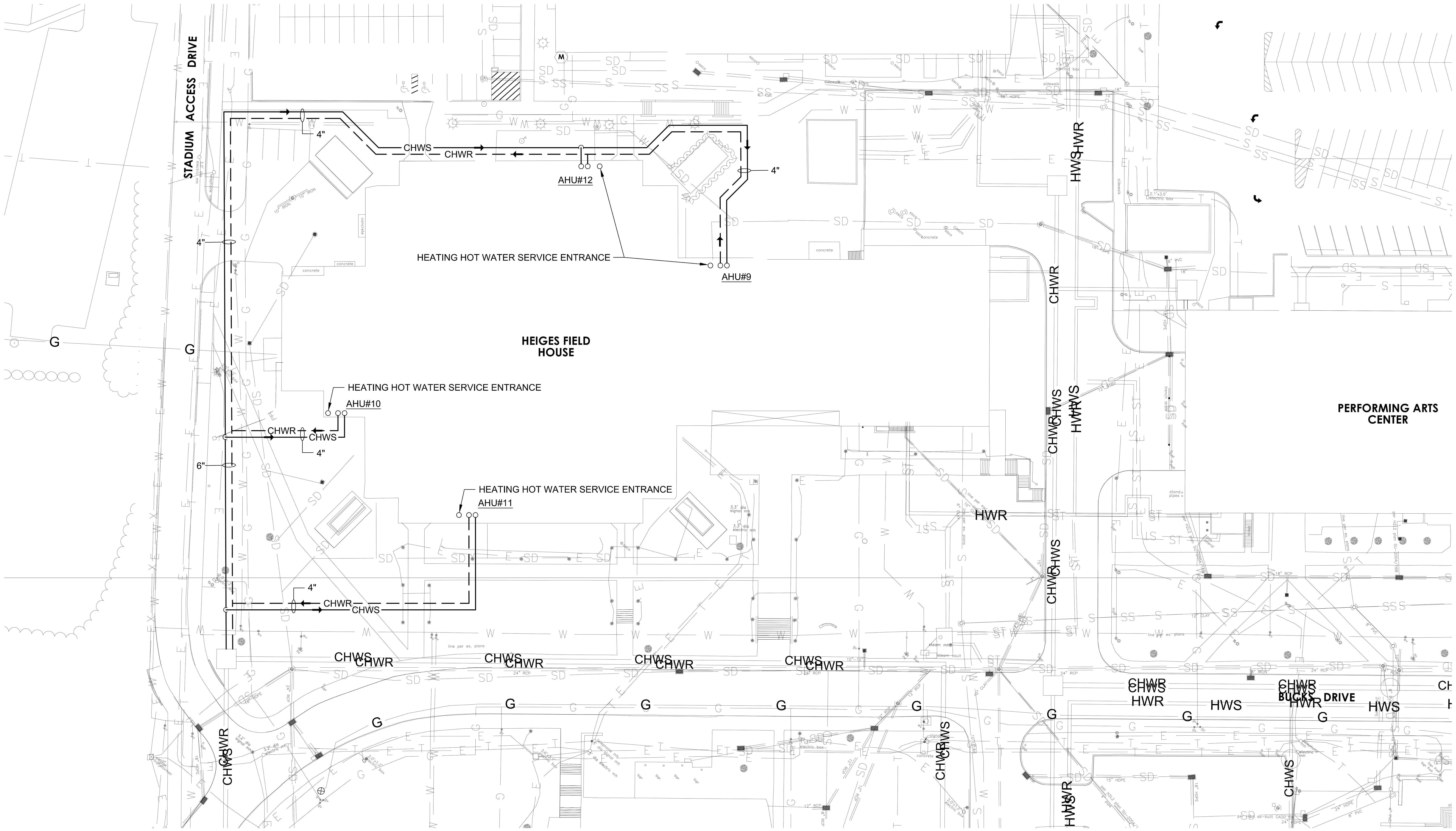
PROJECT ESTIMATE SUMMARY

Client	SHippensburg University	Job #	17116
Project:	Heiges Field House Cooling Feasibilty Study	Date	12/12/2017

Sub-Total		$750,576
Contingency	20%	$150,115
Total Price		**$900,691**

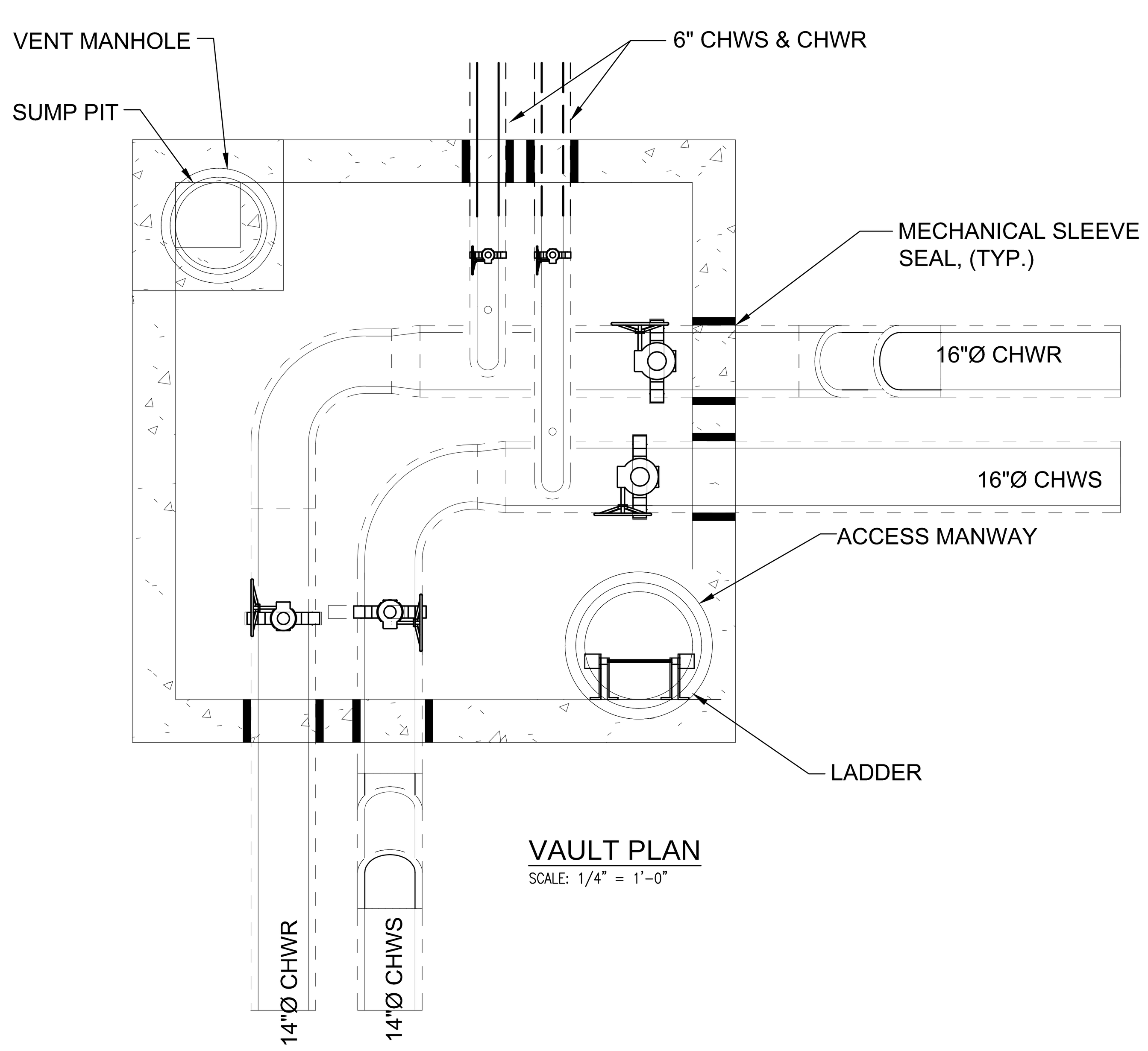
Heiges Field House Cooling Feasibility Study		Labor				Cost				
Description	**Qty**	**Hours**	**Multiplier**	**Ext Lab Hrs**	**Unit**	**Material**	**Ext Material**	**Lab Rate**	**Ext Lab**	**Total**
Mechanical										
Excavation & Backfill	270	0.5	1	135.0	cy	$10.00	$2,700.00	$70	$9,450	$12,150
Sand Backfill	90	0.5	1	45.0	cy	$25.00	$2,250.00	$70	$3,150	$5,400
Vault Penetrations & Link Seals	1	0.0	1	0.0	ls.	$2,400.00	$2,400.00	$70	$0	$2,400
Asphalt Restoration	90	0.2	1	18.0	sf.	$15.00	$1,350.00	$70	$1,260	$2,610
Sidewalk Restoration	1	0.0	1	0.0	ls.	$5,000.00	$5,000.00	$70	$0	$5,000
Greenspace Restoration	270	0.2	1	54.0	sy.	$0.50	$135.00	$70	$3,780	$3,915
6" Direct-Buried Pre-Insulated Piping	220	1.1	1	242.0	ea	$200.00	$44,000.00	$70	$16,940	$60,940
4" Direct Buried Pre-Insulated Piping	1390	0.8	1	1112.0	ea	$130.00	$180,700.00	$70	$77,840	$258,540
Cooling Coils	4	20.0	1	80.0	ea	$9,550.00	$38,200.00	$70	$5,600	$43,800
4" Chilled Water Piping (Interior Piping)	550	0.5	1	248.0	ea	$45.00	$24,750.00	$70	$17,325	$42,075
Humidifiers	4	10.0	1	40.0	ea	$19,000.00	$76,000.00	$70	$2,800	$78,800
2 1/2"Natural Gas Piping	300	0.5	1	135.0	ea	$35.00	$10,500.00	$70	$9,450	$19,950
Relocate Existing Reheat Coils	4	12.0	1	48.0	ea	$0.00	$0.00	$70	$3,360	$3,360
Demolition & Restoration of Interior Partitions	1	0.0	1	0.0	ls.	$15,000.00	$15,000.00	$70	$0	$15,000
Balancing	1	0.0	1	0.0	ls.	$7,500.00	$7,500.00	$70	$0	$7,500
Insulation	550	0.1	1	61.0	ls.	$3.30	$1,815.00	$70	$4,235	$6,050
Automatic Temperature Controls	1	0.0	1	0.0	ls.	$50,000.00	$50,000.00	$70	$0	$50,000
Total				**2218.0**			**$462,300**	**$155,190**	**$155,190**	**$617,490**
Rentals (Scaffolding, Manlifts, Safety, Etc)										$5,000.00
Small Tools/Consumables 1%										$11,174.90
Sales Tax 0%										$0.00
Overhead and Profit 15%										$95,049.74
Bond/Special Insurance 3%										$21,861.44
Permits										$0.00
Grand Total										$750,576.07

ATTACHMENT 2



SITE PLAN

SCALE: 1" = 30'-0"



VAULT PLAN

SCALE: 1/4" = 1'-0"

GRAPHIC SCALE

1"=30'-0" 0 15' 30' 45' 60' 75'

REV	DATE	DESCRIPTION	CH	APP

ENGINEER'S SEAL

KEY PLAN

RPA ENGINEERING, INC.
333 Rouser Road
Pittsburgh, PA 15108
Phone: 1.888.RPA.6053

Regional Offices
Wyomissing, PA
Philadelphia, PA
Knoxville, TN
Venice, FL
Durham, NC

Engineering For Life.
www.RPAengr.com

SHIPPENSBURG UNIVERSITY

HEIGES FIELD HOUSE COOLING FEASIBILITY STUDY

SHIPPENSBURG, PA 17257

W.O. NO. W.O.-NO.	FILE 17116M100.DWG
DRAWN MDT	DATE 8/16/17
CHECKED PJP	DATE 8/30/17
SCALE AS NOTED	REV REV

DWG TITLE: SITE PLAN

DWG NO: M-100

ATTACHMENT 3

Cooling coil

Job Information

Shippensburg University Heiges Field House
Pittsburgh Main Office
(B05)Evan Ek

Tag	Peak Load	System type	Chilled Water
Model Number	DUWB37		
Quantity	1		

Coil Information

Coil type	UW	Actual airflow	15000 cfm
Rows	4	Entering dry bulb	80.00 F
Nominal coil height	37" (940 mm)	Entering wet bulb	67.00 F
Finned length	110" (2794 mm)	Total capacity	452.36 MBh
Fin type	Delta flo H	Sensible Capacity	353.41 MBh
Fin material	Aluminum	Leaving dry bulb	58.63 F
Nominal fin spacing	120 fins per foot	Leaving wet bulb	57.52 F
Tube matl/wall thickness	.016 (0.406 mm) copper	Actual coil face area	28.52 sq ft
Corrosion resistant coating	No	APD	0.513 in H2O
Turbulators	Yes	Volume	11.75 gal
		Elevation	0.00 ft
Rigging weight	299.9 lb	Face velocity	526 ft/min
Installed weight	398.2 lb	AHRI 410 classification	AHRI ACHC certified

Chilled Water Information

Standard fluid flow rate	60.13 gpm	Fluid PD	19.71 ft H2O
Entering fluid temp	45.00 F	Fluid velocity	3.56 ft/sec
Leaving water temperature	60.00 F	Fouling factor	0.00000 hr-sq ft-deg F/Btu
Fluid temp rise	15.00 F	Reynolds number	10819.66 Each
Fluid type	Water		

Stacked Information

Coil bank airflow	30000 cfm	Coil bank fluid PD	19.71 ft H2O
Coil bank total cap	904.73 MBh	Coil bank volume	23.51 gal
Coil bank sensible cap	706.82 MBh	Coil bank rigging weight	599.8 lb
Coil bank standard flow rate	120.26 gpm	Coil bank installed weight	796.3 lb
Qty of stacked coil #1		Nominal ht stacked coil #1	

Note: Certified in accordance with the AHRI Forced-Circulation Air-Cooling and Air-Heating Coils Certification Program which is based on AHRI Standard 410 within the Range of Standard Rating Conditions listed in Table 1 of the Standard. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Cooling coil

Job Information

Shippensburg University Heiges Field House
Pittsburgh Main Office
(B05)Evan Ek

Tag	Peak Load	System type	Chilled Water
Model Number	DUWB37		
Quantity	1		

Coil Information

Coil type	UW	Actual airflow	15000 cfm
Rows	4	Entering dry bulb	80.00 F
Nominal coil height	37" (940 mm)	Entering wet bulb	67.00 F
Finned length	110" (2794 mm)	Total capacity	452.36 MBh
Fin type	Delta flo H	Sensible Capacity	353.41 MBh
Fin material	Aluminum	Leaving dry bulb	58.63 F
Nominal fin spacing	120 fins per foot	Leaving wet bulb	57.52 F
Tube matl/wall thickness	.016 (0.406 mm) copper	Actual coil face area	28.52 sq ft
Corrosion resistant coating	No	APD	0.513 in H2O
Turbulators	Yes	Volume	11.75 gal
		Elevation	0.00 ft
Rigging weight	299.9 lb	Face velocity	526 ft/min
Installed weight	398.2 lb	AHRI 410 classification	AHRI ACHC certified

Chilled Water Information

Standard fluid flow rate	60.13 gpm	Fluid PD	19.71 ft H2O
Entering fluid temp	45.00 F	Fluid velocity	3.56 ft/sec
Leaving water temperature	60.00 F	Fouling factor	0.00000 hr-sq ft-deg F/Btu
Fluid temp rise	15.00 F	Reynolds number	10819.66 Each
Fluid type	Water		

Stacked Information

Coil bank airflow	30000 cfm	Coil bank fluid PD	19.71 ft H2O
Coil bank total cap	904.73 MBh	Coil bank volume	23.51 gal
Coil bank sensible cap	706.82 MBh	Coil bank rigging weight	599.8 lb
Coil bank standard flow rate	120.26 gpm	Coil bank installed weight	796.3 lb
Qty of stacked coil #1		Nominal ht stacked coil #1	

Note: Certified in accordance with the AHRI Forced-Circulation Air-Cooling and Air-Heating Coils Certification Program which is based on AHRI Standard 410 within the Range of Standard Rating Conditions listed in Table 1 of the Standard. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Cooling coil

Job Information

		Shippensburg University Heiges Field House Pittsburgh Main Office (B05)Evan Ek	
Tag	70% Div	System type	Chilled Water
Model Number	DUWB37		
Quantity	1		

Coil Information

Coil type	UW	Actual airflow	10500 cfm
Rows	4	Entering dry bulb	80.00 F
Nominal coil height	37" (940 mm)	Entering wet bulb	67.00 F
Finned length	110" (2794 mm)	Total capacity	361.15 MBh
Fin type	Delta flo H	Sensible Capacity	268.55 MBh
Fin material	Aluminum	Leaving dry bulb	56.80 F
Nominal fin spacing	120 fins per foot	Leaving wet bulb	56.03 F
Tube matl/wall thickness	.016 (0.406 mm) copper	Actual coil face area	28.52 sq ft
Corrosion resistant coating	No	APD	0.301 in H2O
Turbulators	Yes	Volume	11.75 gal
		Elevation	0.00 ft
Rigging weight	299.9 lb	Face velocity	368 ft/min
Installed weight	398.2 lb	AHRI 410 classification	AHRI ACHC certified

Chilled Water Information

Standard fluid flow rate	48.01 gpm	Fluid PD	13.27 ft H2O
Entering fluid temp	45.00 F	Fluid velocity	2.84 ft/sec
Leaving water temperature	60.00 F	Fouling factor	0.00000 hr-sq ft-deg F/Btu
Fluid temp rise	15.00 F	Reynolds number	8637.98 Each
Fluid type	Water		

Stacked Information

Coil bank airflow	21000 cfm	Coil bank fluid PD	13.27 ft H2O
Coil bank total cap	722.30 MBh	Coil bank volume	23.51 gal
Coil bank sensible cap	537.10 MBh	Coil bank rigging weight	599.8 lb
Coil bank standard flow rate	96.01 gpm	Coil bank installed weight	796.3 lb
Qty of stacked coil #1		Nominal ht stacked coil #1	

Note: Certified in accordance with the AHRI Forced-Circulation Air-Cooling and Air-Heating Coils Certification Program which is based on AHRI Standard 410 within the Range of Standard Rating Conditions listed in Table 1 of the Standard. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

Cooling coil

Job Information

Shippensburg University Heiges Field House
Pittsburgh Main Office
(B05)Evan Ek

Tag	70% Div	System type	Chilled Water
Model Number	DUWB37		
Quantity	1		

Coil Information

Coil type	UW	Actual airflow	10500 cfm
Rows	4	Entering dry bulb	80.00 F
Nominal coil height	37" (940 mm)	Entering wet bulb	67.00 F
Finned length	110" (2794 mm)	Total capacity	361.15 MBh
Fin type	Delta flo H	Sensible Capacity	268.55 MBh
Fin material	Aluminum	Leaving dry bulb	56.80 F
Nominal fin spacing	120 fins per foot	Leaving wet bulb	56.03 F
Tube matl/wall thickness	.016 (0.406 mm) copper	Actual coil face area	28.52 sq ft
Corrosion resistant coating	No	APD	0.301 in H2O
Turbulators	Yes	Volume	11.75 gal
		Elevation	0.00 ft
Rigging weight	299.9 lb	Face velocity	368 ft/min
Installed weight	398.2 lb	AHRI 410 classification	AHRI ACHC certified

Chilled Water Information

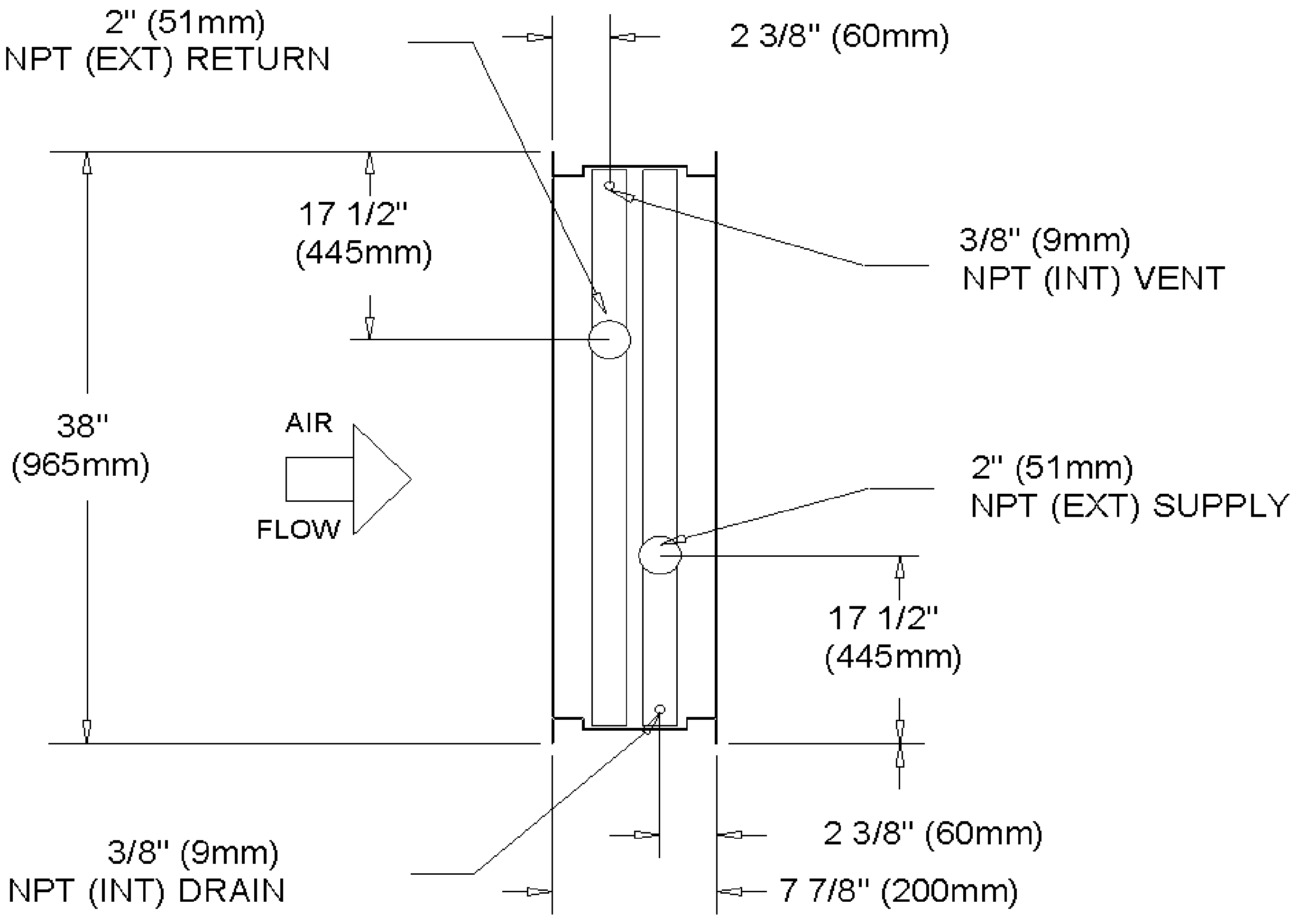
Standard fluid flow rate	48.01 gpm	Fluid PD	13.27 ft H2O
Entering fluid temp	45.00 F	Fluid velocity	2.84 ft/sec
Leaving water temperature	60.00 F	Fouling factor	0.00000 hr-sq ft-deg F/Btu
Fluid temp rise	15.00 F	Reynolds number	8637.98 Each
Fluid type	Water		

Stacked Information

Coil bank airflow	21000 cfm	Coil bank fluid PD	13.27 ft H2O
Coil bank total cap	722.30 MBh	Coil bank volume	23.51 gal
Coil bank sensible cap	537.10 MBh	Coil bank rigging weight	599.8 lb
Coil bank standard flow rate	96.01 gpm	Coil bank installed weight	796.3 lb
Qty of stacked coil #1		Nominal ht stacked coil #1	

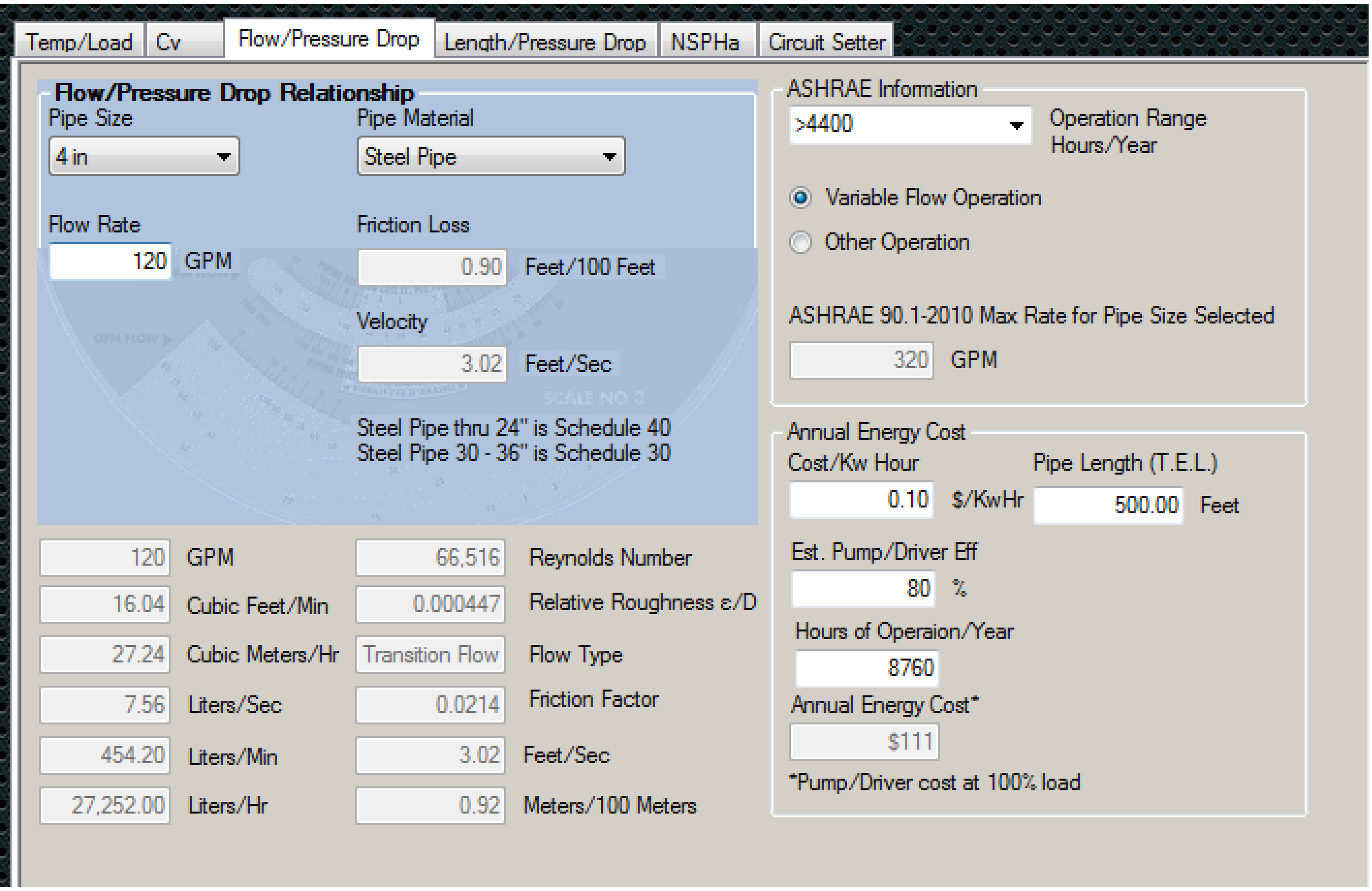
Note: Certified in accordance with the AHRI Forced-Circulation Air-Cooling and Air-Heating Coils Certification Program which is based on AHRI Standard 410 within the Range of Standard Rating Conditions listed in Table 1 of the Standard. Certified units may be found in the AHRI Directory at www.ahridirectory.org.

37" UW 4 ROW

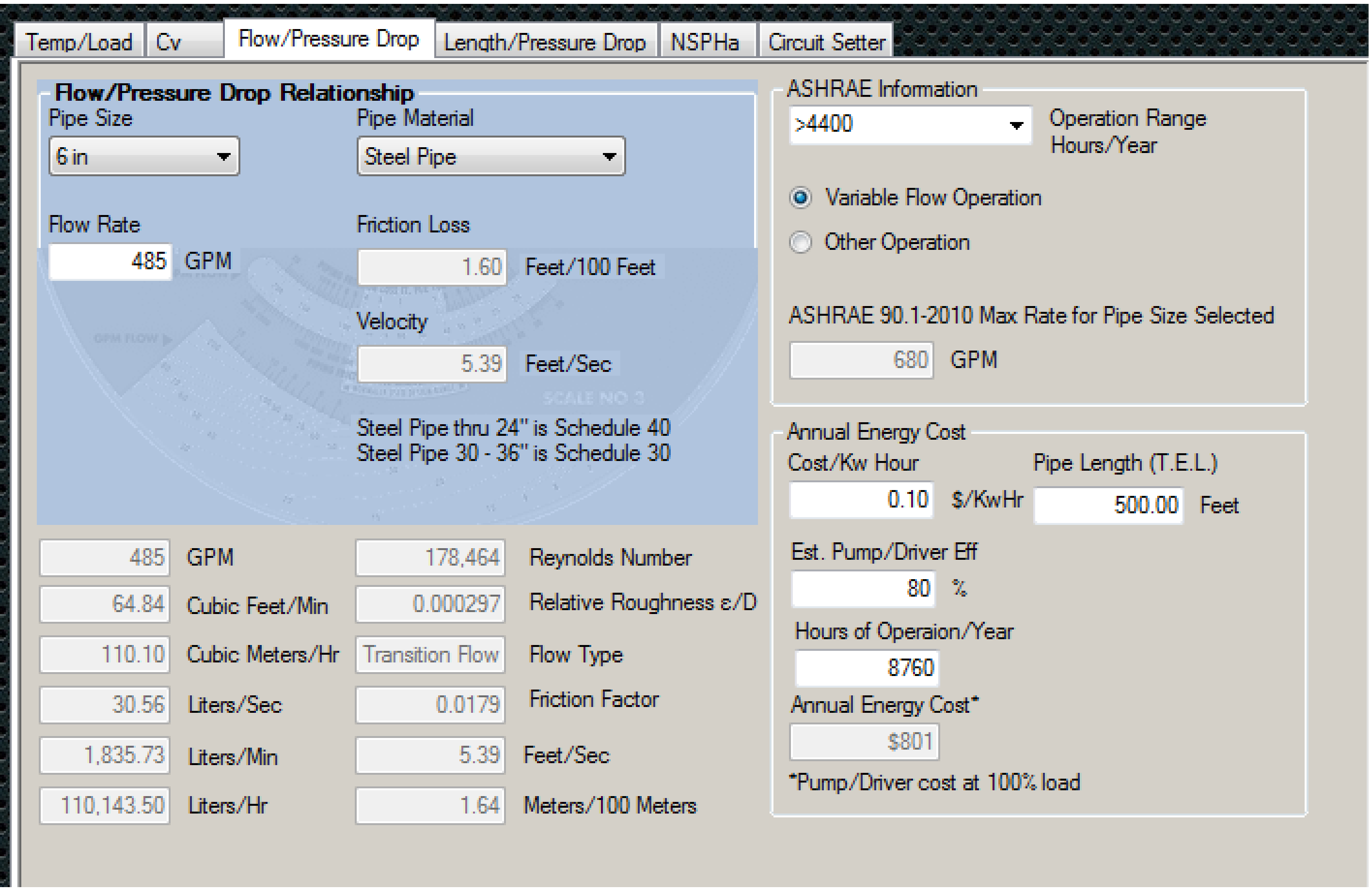

2" (51mm)
NPT (EXT) RETURN
2 3/8" (60mm)
17 1/2"
(445mm)
3/8" (9mm)
NPT (INT) VENT
38"
(965mm)
AIR
FLOW
2" (51mm)
NPT (EXT) SUPPLY
17 1/2"
(445mm)
3/8" (9mm)
NPT (INT) DRAIN
2 3/8" (60mm)
7 7/8" (200mm)

ATTACHMENT 4

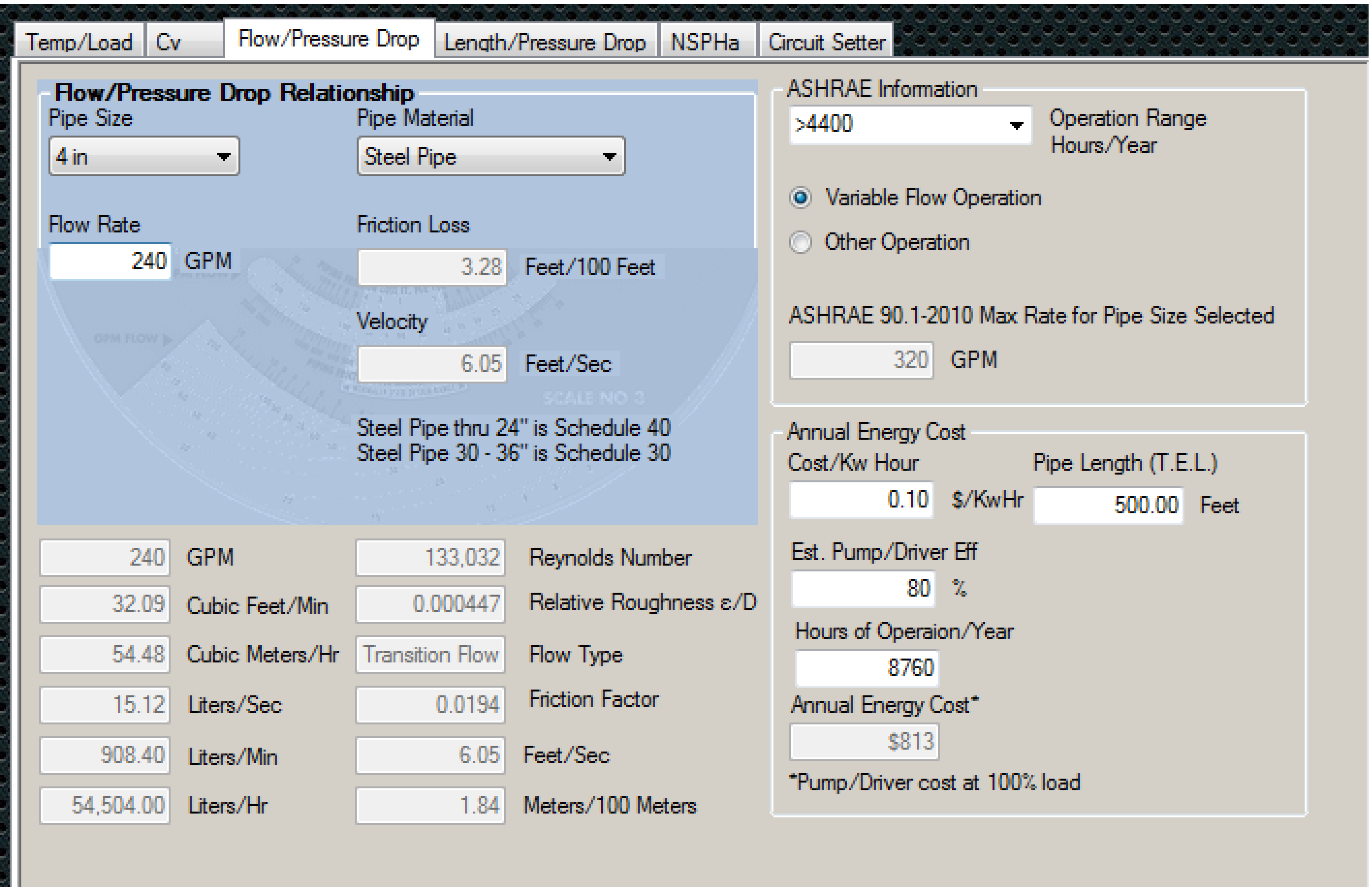
FLOW/PRESSURE DROP RELATIONSHIP



FLOW/PRESSURE DROP RELATIONSHIP



FLOW/PRESSURE DROP RELATIONSHIP



ATTACHMENT 5

Detail Report

Report information	
Report generated date	10-03-17
Systems/tags included in this report:	h1

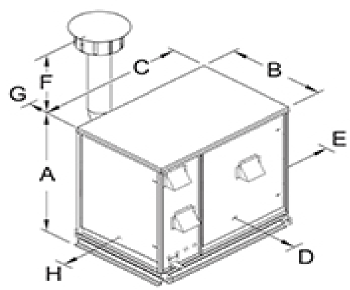
Project Information	
Project name	shippinsburg
Project description	
Project status	Open
Project phase	Design
Unit of measure	Inch-pound

Project name: shippinsburg

System/tag h1

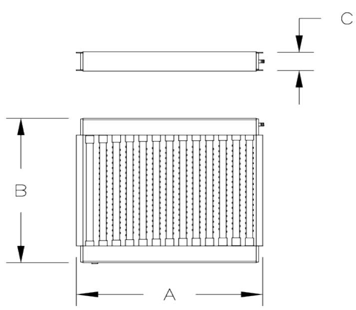
System images

Steam generator dimensions and clearances



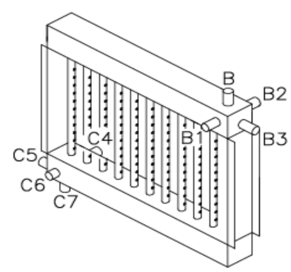
Dimensions (in.)			Clearances (in.)				
A	B	C	D	E	F	G	H
54.63	32.0	57.25	36	24	12	30	30

Dispersion dimensions



Dimensions (in.)		
A	B	C
63.0	57.0	5.0

Ultra-sorb connections

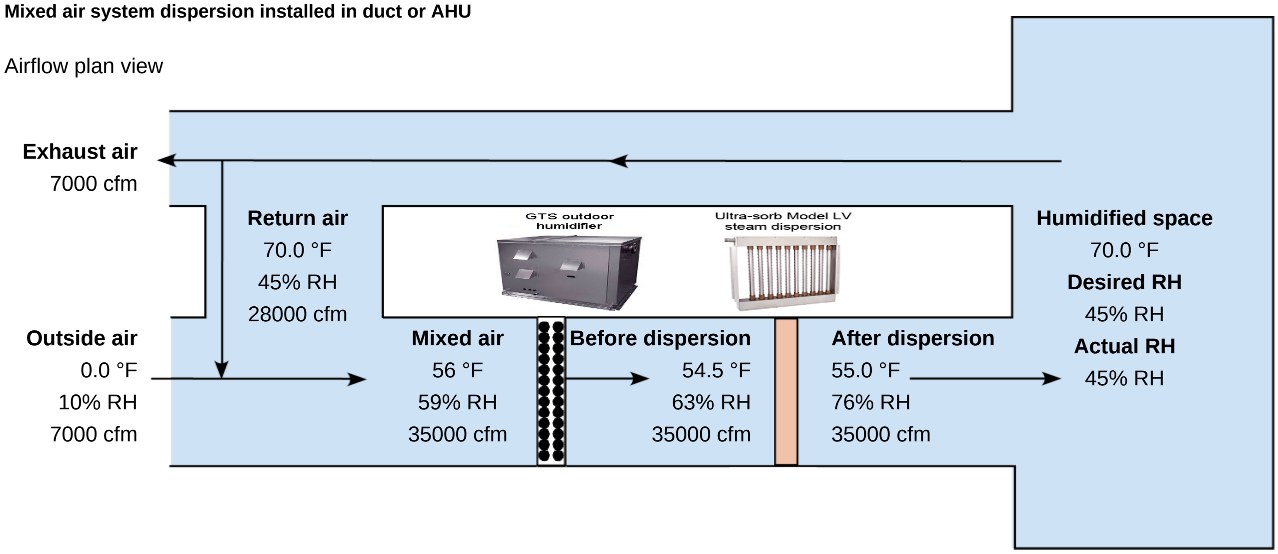


Detail Report

Project name: shippinsburg
System/tag h1

System view

Mixed air system dispersion installed in duct or AHU



Project name: shippinsburg	
System/tag h1, continued	
Application	
System Quantity	1
System Location	United States
Elevation at project site (ft)	0.0
Ventilation system type	Mixed Air System, Dispersion Installed In Duct Or AHU
Outside air dry bulb temperature (°F)	0
Outside air moisture content (%RH)	10
Outside air intake rate	Constant
Outside air intake (%)	20.0
Total air volume (cfm)	35000.0
Desired air dry bulb temperature (°F) in humidified space	70
Desired air moisture content (% RH) in humidified space	45.0
Actual moisture content (% RH) in humidified space	45.0
Non-wetting distance (inches)	7
Calculated load	Calculated
Load (lbs/hr)	215.23
Load plus loss (lbs/hr)	221.15
Dispersion installation location	Duct
Airflow direction	Horizontal
Airflow pressure drop (inches w.c.)	0.0
Duct dry bulb temp before dispersion (°F)	54.5
Duct RH before dispersion (%)	63
Duct dry bulb temp after dispersion (°F)	55.0
Duct RH after dispersion (%)	76

Application, continued	
Heat gain from steam (°F)	0.37
Heat gain from assembly (°F)	0.15
Steam dispersion	
Dispersion product	Ultra-sorb
Dispersion model	LV
Unit quantity	1
Header location	Outside Duct
Trap location	Outside Duct
Air movement	Through Dispersion Assmbly
Available inside duct/AHU width (inches)	60
Available inside duct/AHU height (inches)	48
Duct/AHU wall thickness (inches)	0
Face width (inches)	60.0
Face height (inches)	48.0
Header diameter(inches)	3.0
Overall dimensions W x H x L (inches)	63.0 X 57.0 X 5.0
Air velocity (ft/min)	1750.0
Tube diameter (inches)	1.5
Tube spacing on-center (inches)	12
Tube quantity	5
Enclosure material	Galvanized Steel
Header and tube material	304 Stainless Steel
High-Efficiency Insulated Tubes	Yes
Ship unassembled	No

Detail Report

Project name: shippinsburg	
System/tag h1, continued	
Steam dispersion, continued	
Seismic-certified	No
Operating weight (lbs)	115
Shipping weight (lbs)	149
Steam generation	
Generation product	Gas-to-Steam
Generation model	300
Unit quantity	1
Unit capacity (lbs/hr)	225.0
Water type	Potable
Energy source	Gas
Voltage (Vac)	120
Supply gas type	Natural
Gas Input Value (MBH)	300
Phase	1
Overall dimensions W x H x L (inches)	54.63 X 32.0 X 57.25
Operating weight (lbs)	1000
Shipping weight (lbs)	600
Tank material	304 Stainless Steel
Enclosure	Outdoor Enclosure
Heater package	Yes
Support	None
End-of-season drain	Yes
Notes	
Minimum water conductivity of 30 uS/cm	
Damage caused by chloride corrosion is not covered by your DriSteem warranty.	
Connections	
Steam generator outlet connection type	Flange
Steam generator outlet diameter (inches)	3
Outdoor enclosure steam outlet connection location	Inside Enclosure
Steam supply inlet location	B3
Dispersion steam inlet connection type	Hose
Dispersion steam inlet diameter (inches)	3
Condensate outlet location on condensate header	C7
Dispersion same side piping	No
Control	
Humidifier controller	Vapor-logic
Multiple-tank control	No
Operating mode	Modulating
Interoperability	BACnet
Keypad/display	Jackplate Mounted

Control, continued	
Keypad/display cable (ft)	5
Keypad/display language	English
Keypad/display unit of measure	Inch-pound
Input signal type	Humidity Transmitter
Remote temperature sensor	No
Door interlock safety switch	Yes
Accessories	
Generation Condensate Pump	None
Generation Drane-kooler	Yes
NEMA-1 safety switch	No
High-limit humidistat	Electric, Modulating
Airflow proving switch	Electric Pressure
Humidity transmitter	Room