Fall | 09

Existing Mechanical Systems Analysis

Technical Report Three

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The Walt Disney Family Museum in the Presidio of San Francisco

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Executive Summary

This report summarizes the existing conditions of the mechanical systems found within the Walt Disney Family Museum. The Walt Disney Family Foundation, the non-profit owner's of the Museum, decided upon initial design objectives that were carried throughout the building's architectural design phases. Many factors influenced the design of the buildings as well as the MEP systems such as site history, historical preservation guideline set forth by the Presidio, the interior and exterior loads as well as budget constraints. This final technical report within the Architectural Engineering Senior Thesis program reviews these ideas.

Therefore, a final critique of the WDFM and the campus buildings will lead to a final proposal. As a result of analyzing the buildings, one cannot help but notice that the systems are proficient and met necessary requirements set forth by California Code of Energy, Title 24 as well as ASHRAE Standards; however, the building lacks any type of sustainable green energy sources. A renewable energy system could help meet large loads resulting from the Museum's day to day activities and environment demands, such as the various media displays, exhibits, and lighting loads found throughout the buildings. During the initial design meetings, the owner's had considered "going green" however, due to budget restraints, this idea was removed from the scope of work. While green technologies can cost more in the upfront costs of a building, the long-term payback period for these systems can greatly reduce the building's life term costs. These options will be explored in the final proposal as well as in the Thesis design phase next semester.

The Museum Design Objectives

The Walt Disney Family Museum was created in order to display the life and achievements of Walt Disney, the man behind the world of Disney. The idea behind the Museum stems from daughter, Diane Disney Miller, in order to properly showcase the creativity and hard work of the actual man instead of just displaying a corporation the produces films and creates amusement parks.

Therefore, the Walt Disney Family Foundation, a non-profit organization was the driving force behind the development of the Museum's campus. The construction of the Museum project began in September 2007 and lasted until September 2009, with the Museum opening to the public on October 1, 2009.

The WDFM campus required that spaces be provided for a Museum showcasing galleries and displays surrounding the personal and professional life of Walt Disney, a space for archiving and preserving artifacts as well as a space for the MEP system that serves these areas. As a result of these objectives, a campus with three different buildings was created. Building 104, the Museum building, houses the galleries, displays, lecture halls, learning areas and some offices for the Museum Staff. Building 122, houses the art archives and preservation spaces as well as more offices while Building 108 houses the MEP system.

An exterior view of the Walt Disney Family Museum, Building 104. (Above)

Site History

The campus houses three buildings within the Presidio of the San Francisco, formerly known as El Presidio Real de San Francisco or Royal Presidio of San Francisco, located near the Disney family's home in Northern California. The Museum, which is identified as Building 104, occupies former army barracks, which were originally built in 1897, which housed various troops and army purposes until 1994. This building was the ideal home for the Museum, which showcases impressive views of the Golden Gate Bridge as well as the San Francisco Bay and also shares the neighborhood with other famous tenants, such as George Lucas Films.

Also located within the project, a former gymnasium built in 1904, now known as Building 122, houses art archives as well as more offices for employees. The last building within the rehabilitation project, Building 108, a former 1940s munitions shed, houses the central chiller plant, central heating plant and emergency generator.

Throughout the rehabilitation, the Presidio Trust, the protector and preserver of the park, overviewed the construction methods and restoration of the three buildings in order to maintain as much of the original craftsmanship as possible. The final cost of this impressive redevelopment project totaled $125,000,000.

The Museum consists of media exhibits, art galleries, learning spaces as well as a 115 person lecture hall as well as offices for the Museum staff and employees of the Walt Disney Family Museum. The project was created in order to educate the general public about the original "Imagineer", Walter Disney himself.

The WDFM Campus within the Presidio of San Francisco. (Right)

Ventilation Requirements within the Museum

The Presidio, is located within San Francisco, California, at 37 degrees latitude and 122 degrees longitude, within in a very landscape friendly part of the city. The following chart displays the indoor and outdoor temperatures for building's location from the ASHRAE Handbook of Fundamentals.

Table 1.0 – ASHRAE Outdoor and Indoor Design Conditions for San Francisco

Design Conditions as per ASHRAE and Building Requirements		
Seasonal Loads	Dry Bulb Temperature	Wet Bulb Temperature
Cooling Loads (Summer)	75°F (0.4%)	63°F (0.4%)
Heating Loads (Winter)	40°F (99.6%)	-
Indoor Design Conditions	68-70°F (±2°F)	-

The Museum was designed to the 2005 California Energy Code within the California Code of Regulations, Title 24. Title 24 requires that the ventilation system provides an acceptable minimum ventilation rate of 15 cfm per person times the expected number occupants or 0.15 cfm per square foot of conditioned floor space, whichever number is greater. All areas designed must have at least this minimum ventilation rate, if not higher.

The designer estimated the Museum holds 536 people within the building multiplied by the minimum rate of 15 cfm/person, totaling a minimum ventilation rate of 8,040 cfm. Using the square footage analysis, 32,351 ft^2 of conditioned floor space multiplied by 0.15 cfm totals 4,853 cfm. Therefore, the minimum ventilation air must be at least 8,040 cfm. The designed ventilation rate for the Museum totals 15,800 cfm. The breakdown within each air handling unit is shown in the table below.

Table 1.1 – Air Handling Units Capacity located in Building 104

Air Handling Units within Building 104		
Air Handling Unit	Total Airflow CFM (Supply Air)	Outside Air CFM (Ventilation Air)
AHU-104-1	28,000	5,200
AHU-104-2	34,000	5,100
AHU-104-3	22,000	3,000
AHU-104-4	4,000	2,500
Totals	**88,000**	**15,800**

Title 24 also requires CO_2 sensors to be located within each room between 1 feet and 6 feet above the floor. The CO_2 concentrations also must be less than or equal to 600

ppm plus the outdoor air CO_2 concentration in all rooms with sensors. Therefore, this helps to explain the additional ventilation within the Museum as per the designed system.

The system also utilizes air-side economizers which improves indoor air quality by conditioning the outside air instead of conditioning re-circulated air, which reduces the demands on the HVAC system while providing more ventilation air to the space.

From technical report two, the Museum's Building and Plant Energy Analysis Report, the outside air rate per person is shown in the following chart. Each area met the minimum ventilation requirement of 15 cfm/person. The chart below shows each space's outside air requirement.

Table 1.3 Minimum Ventilation Rates within the Museum per Person

Minimum Ventilation Rates per Person	
Spaces	Outside Air (cfm/person)
Exhibit Spaces, Media Explosions	20
Gallery Spaces	20
Lecture Hall	20
Learning Areas	20
General Offices	Operable windows
Corridor	0.05 cfm/ft^2
Bookstore	15
Conference Rooms	20
Lobby	15
Reception	15
Restaurant/Dining	20
Telephone/Data	20

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Heating and Cooling Loads

The overall heating and cooling loads for the building are listed in the table below. The table is a result of the Trace Trace 700 analysis as well as the design document results.

Table 2.0 – Heating and Cooling Loads within the Museum

Load	Trane Trace Calculations	Design Document Calculations
Cooling Load	159.99 ft^2/ton	138.25 ft^2/ton
Heating Load	18.02 Btuh/ft^2	19.65Btuh/ft^2

The largest loads in the building are due to lighting, people as well as miscellaneous equipment and solar gain through the building's envelope. These areas demand the most from the cooling loads while the heating loads are a result of the winter conditions. One of the interactive exhibits is shown in the picture below.

The discrepancies in the Trane Trace calculations versus the design documents are the result of overestimating the loads within the building while the design documents may have been calculated more accurately. An overestimation of the loads further ensures that the necessary cooling is provided to reduce the heat produced by the loads within the space.

The heating loads are very close to the design document calculations. However, the U-values inputted into the Trane Trace were higher than the designer U-values as a result of more rigid wall system estimation.

One of the many galleries located within the Museum (Above)

Annual Energy Use

The annual energy use from the Museum's Trane Trace analysis is show in Table 3.0. The greatest loads on the system are a result of the lighting and receptacle loads due to the lack of natural day lighting within the Museum. The Museum, a historical preservation building, has windows that are 1'-6" by 3'-6" for a total area of 5.25 ft^2, thus letting very little natural light into the building.

Table 3.0 Total Energy Consumption by HVAC Equipment in Museum per Year

Total Energy Consumption within Building per Year				
Energy Load Type	Electrical Consumption (kWh)	Gas Consumption (kBtu)	Water Consumption (1000 gals)	Percentage of Total Energy
Primary Heating	-	247,947	-	4.8%
Heating Accessories	13,140	-	-	0.9%
Cooling Compressor	83,281	-	-	5.4%
Tower/Condenser Fans	10,093	-	764	0.7%
Condenser Pump	8,035	-	-	0.5%
Cooling Accessories	4,816	-	-	0.3%
Supply Fans	119,160	-	-	7.8%
Pumps	19,455	-	-	1.3%
Base Utilities	256,666	-	-	16.8%
Lighting	628,448	-	-	41.1%
Receptacles	313,984	-	-	20.5%
Totals	1,457,078	247,947	764	100%

Table 3.1 displays the utility rates from the Presidio Trust Utility Billing as well as Pacific Gas and Electric Utility Company, which provides natural gas to the Museum. Within the San Francisco area, Pacific Gas and Electric Utility Company typically provides utilities to most commercial and residential buildings, however, because the Museum is located in the Presidio, the Presidio Trust Utility Billing supplies the buildings with electricity.

Table 3.1 Utility Rates from the Presidio and PG&E

Utility Rates from the Presidio Trust Utility Billing	
Water Consumption Rate	$2.77 kgal
Electricity Rate	$0.141 kW/h
Gas Rates from Pacific Gas and Energy (G-NR1 Schedule Type)	
Customer Charge (per day)	$2.14936
Procurement Charge (per therm)	$0.51274
Transportation Charge (per therm)	$0.10405
Total Cost per Year	$2313.54

Using the energy demands of the building per year multiplied by the cost of the utilities per kWh and per therm, a total cost of the energy consumption per year can be calculated. Therefore, the total cost of energy used by the Museum each year totals $209,877.80 which costs $6.05/ft^2.

Table 3.2 Total Energy Consumption Costs within the Museum per Year

Total Energy Consumption within Building per Year				
Energy Load Type	Electrical Consumption Cost	Gas Consumption Cost	Water Consumption Cost	Percentage of Total Energy
Primary Heating	-	$2313.54	-	4.8%
Heating Accessories	$1852.74	-	-	0.9%
Cooling Compressor	$11,742.62	-	-	5.4%
Tower/Condenser Fans	$1,423.11	-	$2,116.28	0.7%
Condenser Pump	$1,132.93	-	-	0.5%

Cooling Accessories	$679.05	-	-	0.3%
Supply Fans	$16,801.56	-	-	7.8%
Pumps	$2743.15	-	-	1.3%
Base Utilities	$36,189.91	-	-	16.8%
Lighting	$88,611.17	-	-	41.1%
Receptacles	$44,271.74	-	-	20.5%
Totals	$205, 447.98	$2,313.54	$2116.28	100%

Table 3.3 Total Yearly Energy Cost and Yearly Energy Cost per Square Foot

Yearly Cost per Square Foot		
Yearly Energy Cost	$209,877.80	$6.05/ft^2

Although, water and sewage rates are not energy concerns, the Presidio Trust Utility Billing also provides these services as well. As an urban redevelopment project, the amount of water and sewage used within this building should be taken into account from an environmental concern, especially in the state of California, which often deals with water rationing in the summer months. Therefore, the table below shows the cost of sewage and water for the Museum.

Table 3.4 Utility Costs for Sewage and Water

Utility Costs for Sewage and Water	
Sewage	$9.37/kgal
Water	$2.77/kgal

Refuse collection is also included in services provided, however, it also varies according to size. A 2 cubic yard container costs $8.36 per pick-up while a 30 cubic yard container costs $380.68 per pick-up. Within the City of San Francisco, recycling is required under the San Francisco Department of Energy's Mandatory Recycling and Compost Ordinance. Therefore, the Museum must recycle all metal, paper, plastic and glass as well as compost in order to comply with this Ordinance. However, according to the Commercial Recycling Rebate Program in San Francisco, the City reimburses all costs of recycling to the Museum.

Mechanical Equipment Tables

Within the following table, the equipment located within Building 108, the central thermal plant for heating and cooling is contained. This concept of a central plant was ideal because it allows the major HVAC components to be consolidated into one centralized location for maintenance and repairs without disturbing the visitors or employees within the Museum. Also within the Museum, sound and vibration was also a sensitive issue, therefore, the central plant eliminates these disturbances as well.

From an energy standpoint, the usage should be lower due to the three larger, high efficiency chillers versus smaller, distributed compressor chillers throughout the buildings. The electrical distribution within the buildings is also minimized, as all the major HVAC loads are located within this centralized plant.

Table 4.0 Central Plant Heating and Cooling Equipment in Building 108

Central Heating and Central Cooling Equipment				
Equipment Title	**System**	**Designation**	**Type**	**Manufacturer**
Chillers (3)	Chilled & Condenser Water	CH-1 (1) CH-1 (2) CH-1 (3)	Screw	Multitask MS90
Cooling Tower	Heat Removal	CT-1	VFD	Evapco LPT-829
Boilers	Space Heating	B-1 B-2	Condensing	AERCO KC-1000
Chilled Water Pumps	Primary Chilled Water (Return)	CHWP-1 CHWP-2	Inline	Bell&Gossett 80-5x5x7
Chilled Water Pumps	Secondary Chilled Water (Supply)	CHWP-3 CHWP-4	End Suction VFD	Bell&Gossett 1510-3BC
Condensing Water Pumps	Condensing Water	CWP-1 CWP-2	End Suction	Bell&Gossett 1510-4BC
Hot Water Pumps	Primary Water	HWP-1 HWP-2	Inline VFD	Goulds G&L 33SVB
Exhaust Fans	Exhaust/Ventilation	EF-108-1 EF-108-2	Inline	Greenheck CSP-A390

				Greenheck BDF-100
Expansion Tanks	Chilled & Hot Water System	ET-1 ET-2	-	Taco
Air Separator	Hot Water	AS-1	-	Taco

Within the Sub-basement of Building 104, the AHUs are located from which all supply ductwork begins. The idea of a floor dedicated solely to HVAC equipment allows for maintenance and repairs to take place without disturbing occupants of the Museum. It also decreases the noise and vibration throughout the building because the basement level, occupied by the Learning Area and the Lecture Halls, is located directly above this level. While these areas are occupied, they allow for more disturbance than the galleries and exhibit areas.

Table 4.1 Heating and Cooling Air Handling Equipment in Building 104

Heating and Cooling Air Handling Equipment				
Equipment	**Service**	**Designation**	**Type**	**Manufacturer**
Air Handling Units	Cooling/Heating	AHU-104-1 AHU-104-2 AHU-104-3 AHU-104-4	VFD	Temtrol Temtrol Temtrol Huntair
Exhaust Fans	Exhaust/Ventilation	EF-104-B2-1 EF-104-B2-2: EF-104-B2-21 EF-104-2-1 EF-104-2-2 EF-104-3-1 EF-104-3-2	Inline Prop Ceiling Ceiling Ceiling Ceiling Ceiling	Greenheck CSP-AQ1410 Greenheck SE1-18-429-A7 Greenheck SP-B110
Fan Coils	Heating/Cooling	FCU-104-B2-1 FCU-104-B2-2 FCU-104-3-1 FCU-104-3-2 FCU-104-3-3	Emerg. Pwr.	Williams AV-060 Williams LH-008 Williams AV-040 Williams AH-020
Fire Smoke Dampers	Fire Safety	FSD-B2-1:11 FSD-B-1:6 FSD-1-1:13 FSD-2-1:8 FSD-3-1:8	-	Ruskin Model FSD60
VAV Boxes	Cooling/Heating	VAV-104-B2-1: VAV-104-3-22	-	Titus

Mechanical System Operation Description

Within Building 104, the air handling units conditions and circulates air for use throughout the Museum. The four AHUs within the Museum provide supply heating and cooling air to the spaces as well as ventilation air on a variable frequency drive which provides air based on the needs of the spaces. These units are located in the sub-basement of the building and supply air throughout the building upwards throughout the ductwork. The air handling units contain coils, which hot water and chilled water flow through in order to cool or heat the air based on the loads within the building.

The return air moves throughout the pressure differences within the building, with the negative pressure in the sub-basement pulling the air back through the building. This air is then conditioned with new outside air in order to provide further ventilation through the spaces. An economizer is also located within each of the air handling units so that energy can be conserved based on the outside air conditions versus the re-circulated conditions.

Within Building 108, the central heating and central cooling plant are located which supplies hot water, chilled water and condenser water for Building 104 and Building 122. The boiler heats hot water for use by the buildings and air handling units and two pumps supply the water. The chiller provides chilled water and condenser water by processing water through the condenser and evaporator, accordingly.

From the schematic drawings, the chiller evaporatively cools the chilled glycol and water mixture, which is then pumped to the buildings for use by the coils. After the coils chill the air by using the chilled water, that air is supplied to the appropriate spaces. Then, the water is then pumped back into the chiller system to reduce the temperature once again for reuse. This set-up is also applicable for the hot water system except the central piece of equipment is a boiler instead of a chiller.

As shown on the schematic drawing for the cooling tower, the condenser water serves the cooling tower and the condenser portion of the chiller. The screw compressor increases the pressure of the refrigerant and after passing through the condenser, transfers

heat to the condenser water. The condenser water then goes through a heat rejection process via the cooling towers and then is pumped back to the condenser portion of the chiller. The chemical feed pumps are used to clean the condenser water in order to prevent mold and other particle build-up. This process is continued while the chillers are in operation to meet the building's demands.

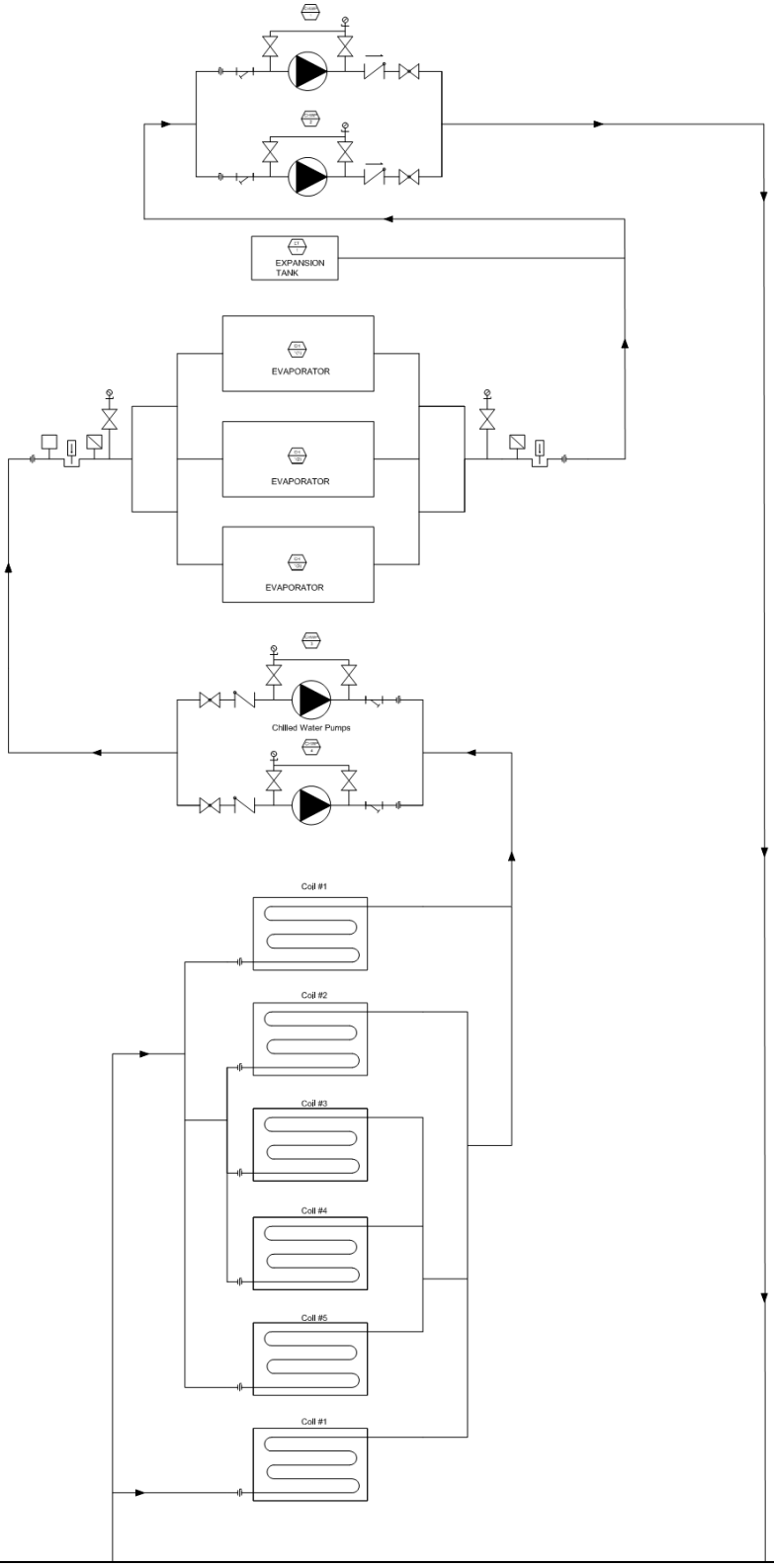

Chart 5. 0 Schematic Drawing of the Chilled Water System within the Museum's Central Thermal Plant

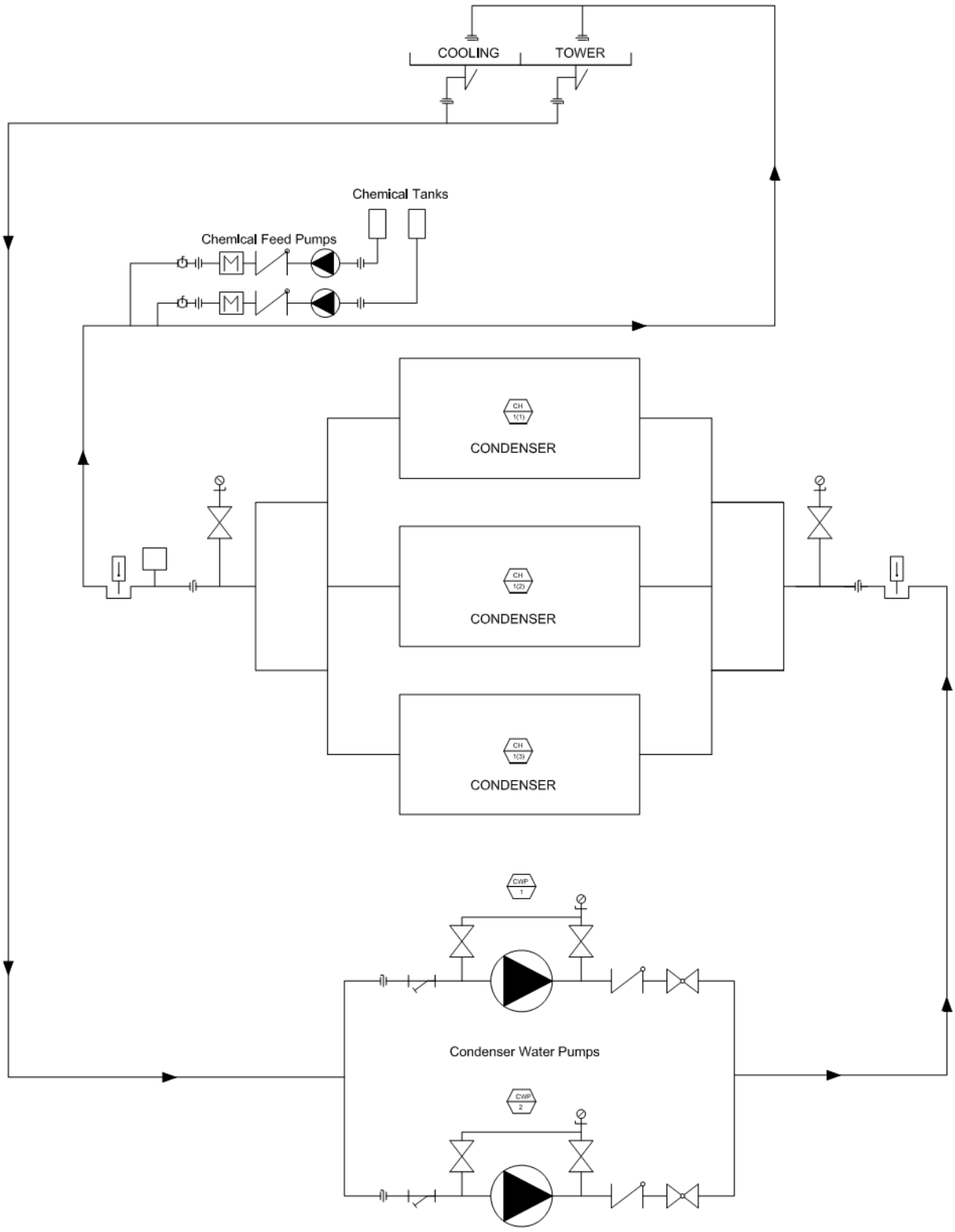

Chart 5.1 Schematic Drawing of the Condenser Water System within the Museum's Central Thermal Plant

Unusable Space due to Mechanical System

Within the Walt Disney Family Museum, space has been lost in both Building 104 and Building 108. However, the entire floor space for Building 108 is not taken into account in this analysis of lost floor space because its sole purpose is to house the central heating and central cooling plant.

The following table analyzes floor space lost in the Museum housed in Building 104 due to ductwork, piping, as well as HVAC equipment. The entire Sub-basement within Building 104 is dedicated to the Air Handling Units as well as mechanical room storage. The space lost within Basement floor level to the Attic floor level is due to the vertical mechanical duct shafts.

Table 6.1 Unusable Floor Areas due to Mechanical Systems

Unusable Floor Area due to Mechanical Systems	
Sub-Basement	7,078 ft^2
Basement	81 ft^2
First Floor	54 ft^2
Second Floor	51 ft^2
Attic Floor	41 ft^2
Total Floor Space	**7,305 ft^2**

Total Cost of Mechanical Systems

The total costs of the mechanical system have been calculated from the original bid documents in which Plant Construction won. Within the following chart, the total cost has been separated into the costs of the different buildings as well as the interconnection within the campus. However, this estimate was created during the initial design phases of the project, meaning that the original idea for the Museum's campus was to use Building 103 instead of Building 108 as the central thermal plant for Buildings 122 as well as Building 104. Therefore, these costs calculations are to be taken with this idea in mind.

Total Energy Consumption within Building per Year				
Building	Description	Quantity	Rate	Total Cost
Building 103	Mechanical Equipment	54,073 SF	15.00/SF	$811,095
Building 103	Additional Environmental Control	25,422.50 SF	5.00/SF	$127,133
Building 103	Distribution at non-program areas	10,949.00 SF	8.00/SF	$87,592
Building 103	Interconnection with 104	50,000.00 BUD	1.00/BUD	$50,000
Building 104	Mechanical Equipment	65,669.00 SF	15.00/SF	$985,035
Building 104	Additional Environmental Control	12,347.00 SF	5.00/SF	$61,735
Building 104	Distribution at non-program areas	12,793.00 SF	8.00/SF	$102,344
Building 104	Interconnection with 104	50,000 BUD	1.00/BUD	$50,000
Building 122	Mechanical Equipment	17,387.00 SF	15.00/SF	$260,805
Building 122	Distribution at non-program areas	3,470.00 SF	8.00/SF	$27,760
Utility Tunnels	-	679.00 SF	15.00/SF	$10,185
Initial Total Costs			$94.00/SF	$2,573,664.00

LEED for New Construction Analysis

During the design phase of the Museum, the Owner decided against attempting to achieve any type of LEED Certification. However, this section analyzes the credits obtained by the Museum.

Sustainable Sites – SS Prerequisite 1 – During construction, methods were taken by the contractors, Plant Construction, to prevent construction dust and debris from entering any type of storm sewer or streams surrounding the Museum. (Required)

SS 1.0 – Site Selection – The Museum is a renovation to a historical existing building and therefore, the land has been previously developed and the site is acceptable for this credit. (1 point)

SS 4.1 – Alternative Transportation – The project has public transportation provided by the San Francisco Municipal Transportation Authority also known as MUNI which is a bus system. (6 points)

SS 4.2 – Bicycle Storage and Changing Rooms – The Museum provides bicycle racks for at least 5% of the users and employee showers are also provided within the building. (1 point)

SS 4.4 – Parking Capacity – This area of the Presidio already had adequate existing parking for the Museum visitors and therefore, no additional parking was required. (2 points)

SS 8.0 – Light Pollution – The Museum's lighting controls monitor all indoor lighting and only emergency lighting is powered from 11PM – 5AM. The Presidio also has a dark sky lighting requirement as well. (1 point)

WE 2.0 – Innovative Wastewater Technologies – Water-conserving fixtures are found throughout the Museum's restrooms and kitchens. (2 points)

EA Prerequisite 1 – Fundamental Commissioning of the Building Energy Systems – A commissioning authority from Flack & Kurtz was originally assigned to this project.

EA Prerequisite 2 – The Museum, as per Technical Report One, was found to be compliant with the mentioned sections in ASHRAE Standard 90.1. However, the building did not have a full energy load simulation created in order to meet this requirement.

EA Prerequisite 3 – No CFC-based refrigerants were used within the Museum.

EA 1.0 – Optimize Energy Performance – Assuming the project was 20% more energy efficient than the original structure, this building would achieve 7 points from this credit because it is an existing building. (7 points)

MR Prerequisite – Storage and Collection of Recyclables – Under the San Francisco Recycling and Compost Ordinance, the Museum is required to meet this requirement by the city.

MR 1.1 – Maintain 75% of Existing Walls, Floors and Roofs – The building, as a historical reservation project, was required to keep as much of the original structure and materials in tact. (2 points)

MR 2.0 – Construction Waste Management – Divert 75% from Disposal – At least 65% of the non-hazardous construction and demolition debris was recycled as part of the San Francisco Construction and Demolition Debris Ordinance No. 27-06. Therefore, the Museum's construction team most likely met this credit. (2 points)

IEQ Prerequisite 1 – Minimum Indoor Air Quality Performance – Minimum requirements of Sections 4 through 7 of ASHRAE Standard 62.1-2007 were generally met as per Technical Report One.

IEQ Prerequisite 2 – Environmental Tobacco Smoke (ETS) Control – The State of California passed a state-wide ban on cigarette smoking in public places and within 20 feet of the entry way. The Museum complies with this credit.

EQ 1.0 – Outdoor Air Delivery Monitoring – As per California Code of Energy, Title 24, CO_2 monitors are required to be placed within 3 to 6 feet above the floor. (1 credit)

EQ 3.1 – Construction IAQ Management Plan – During construction, this credit was met as the SMACNA IAQ Guideline for Occupied Buildings under Construction was abided by. The contractors were also required to protect on-site and installed materials from moisture damage. Finally, all MERV filters were replaced before occupants entered the Museum. (1 point)

EQ 3.2 – Construction IAQ Management Plan - Before the Museum staff occupied the building, the HVAC system passed an air test that required contaminants were at a minimum. (1 point)

EQ 4.1 – 4.4 – All installed materials, adhesives, sealants, paints, coatings, carpet, composite wood and agrifiber products were found to be compliant with these sections. (4 points)

EQ 5.0 – Indoor Chemical and Pollutant Source Control -Within entryways, roll out mats are used by the Museum and maintained on a weekly basis. The areas in which art preservation and restoration spaces are located are adequately ventilated. Finally, MERV of 13 filtration are used in HVAC areas where required for ventilation filtration. (1 point)

EQ 6.1 – Controllability of Systems – The Museum lighting system does allow for control by the Museum staff. However, the Museum is also set on a timed schedule based on hours of occupation while occupancy sensors are also located within the galleries and rooms. (1 point)

ID Credit 2.0 – LEED Accredited Professional – One Principal of the project was LEED AP Certified. (1 point)

A total of 34 points are known for this project. Other credits may have been achieved, however, sufficient information could not be found or was not completed to achieve more points towards certification. LEED Certified requires that between 40-49 points be obtained through the project construction to completion phases. If the Museum had tried for any type of LEED certification, the building could have most likely have obtained at least LEED Certified.

Conclusion of the Mechanical Systems Analysis

Within the Walt Disney Family Museum campus, the mechanical system provides the appropriate amount of heating and cooling to meet the calculated loads, however, the system lacks environmental efficiency and sustainable design. However, the historical nature of the building as well as the constraints of the Museum's budget have left the system meeting the HVAC needs but lacking green quality. Therefore, with a closer look at the budget costs as well as long-term benefits of a greener mechanical system, the WDFM could have been pursued to agree to a more environmentally friendly design.

The overall construction cost of the system average about $94.00 per square foot while the total cost to install the mechanical system totaled over $2.5 million dollars. The total energy cost each year total $209,877.80 that equals $6.05 per square foot, which seems somewhat high but due to the large loads within the building needed to properly display the exhibits and galleries, this number is appropriate. However, if green systems were implemented concerning day lighting as well as renewable energy systems, this operating cost could be reduced.

The occupants receive a substantial amount of ventilation air as well as supply air within the Museum. The system has appropriate controls within the variable air volume system (VAV), which senses the need for more air at desired temperatures. Other controls within the building include monitoring of occupants and CO_2 levels that contribute to the HVAC system. The lighting system is also controlled although by occupancy sensor, however, a scheduled lighting system usually overrides the occupant controls.

Therefore, while the system meets basic HVAC needs of the space and the occupants, further consideration should be given to environmental concerns. Green should not be quantified by how much recycling the Museum processes every month, however, energy reduction as well as renewable energy resources that could be implemented in the Museum should define "going green". Further thought and ideas into this concept will be discussed in the upcoming mechanical project proposal.