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Technical Report One

ASHRAE Standard 62.1 and Standard 90.1

Evaluations

THE WALT DISNEY FAMILY MUSEUM

The Presidio of San Francisco, California

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Executive Summary

Within Building 104, the building within the Walt Disney Family Museum campus, houses the actually museums, exhibits and displays. An analysis of the Museum's mechanical equipment and systems within this building is contained within this report.

Following this executive summary, a comparison of the built HVAC system, designed by MEP engineers, WSP Flack + Kurtz, to ASHRAE Standard 62.1 Section 5, Systems and Equipment to check for general compliance. Section 5 outlines characteristics of the mechanical equipment such as minimum ventilation, indoor air quality, exhaust locations, operable windows amongst other concerns. A point of interest to keep in mind while evaluating this report is the fact that the Museum project was a rehabilitation project within the Presidio of San Francisco, which has stringent guidelines when dealing with compliance of Historical Preservation. This then reflects upon all systems within the building, for instance, all original windows and doors were repaired and kept in original condition, thus the restraint of non-operable windows. However, the building is 100% mechanically ventilated by 4 AHU's with a total airflow rate through the building of 88,000 CFM total, with 15,800 CFM of outside air through the system. After an in depth analysis following this summary, the project was concluded to meet general compliance with ASHRAE Standard 62.1.

Furthermore, within Section 6 of Standard 62.1, calculations were created in order to confirm that the building complied with necessary

ventilation requirements by using the Ventilation Rate Procedure. Through reference to mechanical schedules, drawings and riser diagrams, as well as abiding by proper calculations following, confirm that this building meets the necessary outdoor air as well as air quality requirements of Section 6.

The following report, supporting calculations and reference to Standard 62.1 support this summary. Current calculations and future analysis will be used to confirm that the building was designed to appropriate conditions for occupants.

In addition to determining compliance with Standard 62.1, Standard 90.1, Energy Stand for Buildings Except Low-Rise Residential Buildings was also evaluated. This standard measures energy efficiency in the building with regard to the building's envelope, HVAC systems and Lighting and Electrical systems. Therefore, the calculations for this standard also follow this Executive Summary.

Mechanical System Summary of Building 104

The Walt Disney Family Museum, located in the Presidio of San Francisco, California, displays the life long work of Walt Disney, the original founder of The Walt Disney Company. His thoughts, drawings, sketches, art works and ideas are displayed within this building for people of all ages to explore and enjoy. Within the Museum, different exhibits and galleries are contained within this building as well as offices, lecture halls and learning spaces. The building is supplied by 4-AHU, located in the sub-basement, which houses the mechanical supply and return. Total air supply to the Museum is approximately 88,000 CFM with 15, 800 CFM of outside air. The

A central chilled water and heating water plant is located within Building 108 which houses three evaporatively cooled chillers with a 254 ton total capacity and two condensing boilers with 860 MBH capacity each, to supply Buildings 104 and 122 with service water. Service water is pumped to Buildings 104 and 122 by two primary chilled water pumps with 435 GPM outflow, while condensing water is pumped by one pump at 740 GPM flow rate and finally, a primary hot water pump services both buildings with a flow rate of 60 GPM. Two chilled water pumps are on standby, while one condensing water pump and one hot water pump are also on standby in case of an equipment malfunction.

The air handling systems consist of variable supply air volume which provide heating, ventilation and cooling based on heating and cooling loads. The design supply air temperature is approximately 55°F.

Areas that are defined as exhibit areas, which are mostly found in Building 104, do not require humidity control. However, gallery areas, mostly found in Building 122 where the archives and art restoration areas are located, require precise humidity control. Building 122 is not analyzed within this technical report.

Summary of Compliance with ASHRAE Standard 62.1

Section 5 - Systems and Equipment

Within the Museum project, a mechanically ventilated system must comply with Section 5, specifically subsections 2-16. The system generally complies with a majority of these sections.

Section 5.1 Natural Ventilation – The system is not naturally ventilated and therefore, requires full mechanical ventilation supply air in order to achieve a quality air standard. Windows are not operable in any areas of the building. The return air is based on a forced pressure differential throughout the building.

Section 5.2.1 Designing for Air Balancing – The system is a variable supply air volume and the supply air can be adjusted based on space requirements.

Section 5.2.2 Plenum Systems – This section cites concerns for mixing spaces with a ceiling/floor plenum. A double high atrium space is located within the center of Building 104, called the "Blue Sky, Scene 9" where a 2 story ramp and exhibit walls is housed, giving views into the entire building. To address ventilation within this space, 17 round ceiling diffusers supply 390 CFM each into this area.

Section 5.2.3 Documentation – Air balancing and testing throughout the building was required to be documented by the specifications for the

buildings. Appropriate testing and documentation was performed on the mechanical system and found to pass appropriate design conditions.

5.3 Exhaust Duct Location – In areas where potentially harmful contaminants exist, such as water closets and kitchen areas, these spaces comply with this requirement by being exhausted through the building towards the roof.

5.4 Ventilation System Controls – This system consists of a Direct Digital Control (DDC) controls and field panels. The HVAC system controls consist of automatic control valves and dampers, thermo wells, airflow measuring stations, liquid flow sensors and switches, VAV and fan coil type terminal unit DDC controllers, packed air handling equipment DDC controllers and in some areas, humidifier controllers.

5.5.1 Resistance to Mold Growth – All airstream surfaces in equipment and duct work are exempt from this section. Equipment and ductwork are made of sheet metal and metal fasteners; Cold rolled steel sheets, lock forming quality meeting ASTM A-653 and A-653M, black or galvanized as specified and galvanizing consisting of 1 ¼ ounces per square foot, both sides.

5.5.2 Resistance to Erosion – All airstream surface materials are exempt from this section because the ductwork and equipment are made out of sheet metal.

5.6.1 Outdoor Air Intakes Location – Exempt

5.6.2 Rain Entrainment – Outdoor air intakes have rain hoods, which are found to be compliant with AMCA Standard 500-L-99. Therefore, the HVAC system is consistent with this requirement.

5.6.3 Rain Intrusion – Air handling and distribution equipment is not mounted out doors and therefore, this requirement is complying with preventing rain intrusion.

5.6.4 Snow Entrainment – Exempt

5.6.5 Bird Screens –Air intakes have screens on inlets and louvers located on the exterior at an angle prevent birds from nesting.

5.7 Local Capture of Contaminants – Non-combustible equipment, such as equipment found in the kitchen such as ovens, stove fans and refrigerators, as well as bathroom fumes are exhausted to the top of the building.

5.8 Combustion Air – The fuel-burning appliances within the building, such as the gas oven is vented and also exhausted, removing combustion products and fumes.

5.9 Particulate Matter Removal – All filter efficiencies are compliant with ASHRAE Standard 52.2-1999 as well as UL 585, UL 181, UL 900

Class 1 or 2 depending upon the filter type. The filters within the building also comply with NFPA and UL stands for fuel contributed, flame spread and smoke development.

5.11.1 Drain Pan Slope- Drain pans are found to be pitched for positive drainage and sloped appropriately to comply with this section.

5.11.2 Drain Outlet – The drain pan outlets are found to be in the center and have an integral auxiliary drain connection, which drains to a primary drain source.

5.11.3 Drain Seal – The drain pan is insulated with closed cell polyurethane that is sprayed on and into the crevices of the drain device to prevent leakage and ingestion of ambient air.

5.11.4 Pan Size – Drain pans for the fan coil units are found to fit the equipment appropriately and are made of one single sheet without joints in order to prevent leakage.

5.12.1 Finned-Tube Coils and Heat Exchangers Drain Pans – No finned-tube coils or heat exchangers located in the building.

5.12.2 Finned-Tube Coil Selection for Cleaning – Exempt

5.13 Humidifiers and Water-Spray Systems – Exempt

5.14.1 Equipment Clearance – Equipment such as fan coil units and air handling units are located with enough clearance for proper cleaning.

5.14.2 Ventilation Equipment Access – Access doors and panels are sized and provided within the equipment and duct work to have enough clear for inspection, maintenance and calibration.

5.14.3 Air Distribution System – Located in the sub-basement, the outdoor air intake areaway, the mixed air plenum as well as other equipment have access panels and clearance in order to allow access for inspection, cleaning and maintenance.

5.15.1 Building Envelope and Interior Surfaces – The roof and walls are found to have weather barriers, vapor barriers and joints, seams and penetrations are sealed appropriately to prevent air leakage and water intake. Walls were resealed in areas due to the historical nature and age of the building

5.15.2 Condensation on Interior Surfaces – Piping is insulated with glass fiber or calcium silicate when found to be necessary.

5.16 Buildings with Attached Parking Garages – Exempt

5.17 Air Classification and Recirculation – Air within the Museum is classified as Air Class 1 in all spaces except for the kitchen space and

water closets which is Air Class 4, however, this air is exhausted to the roof, therefore, no re-circulation occurs within the building.

Summary of Compliance with ASHRAE Standard 62.1

Section 6 – Ventilation Rate Procedure

Within the Museum, four Air Handling Units supply the building with 88,000 CFM with 15, 800 CFM of outside air. By following the supply duct work to the appropriate diffusers in the spaces, the building was found to be compliant in terms of outdoor air supply by using the ventilation rate procedure.

Air Handling Units and Total Airflow Rates (CFM)	
AHU-104-1	28,000
AHU-104-2	34,000
AHU-104-3	22,000
AHU-104-4	4,000

6.2.2.1 Breathing Zone Outdoor Airflow - Most of the spaces within the building consist of Museum/Gallery, Telephone/Data Entry and Office Space Occupant Categories with the Basement Level Lecture Hall and Scene Nine, a double level Museum/Gallery space being areas of interest in terms of ventilation requirements.

Equation 6-1 Breathing Zone Outdoor Airflow	$V_{bz} = R_p P_z + R_a A_z$

Breathing Zone Outdoor Airflow: V_{bz} (CFM)

Outdoor Airflow Rate Required per Person: R_p (CFM/Person)

Zone Population: P_z (Number of People)

Outdoor Airflow Rate Required per Unit Area: A_z (CFM/ft^2)

Zone Floor Area: A_z (ft^2)

This equation applies to occupiable breathing zones and therefore, storage spaces, closets, trash areas, etc. are listed but not taken into account. See attached tables in Appendix 1 for listing of rooms and airflow rates.

6.2.2.2 Zone Air Distribution Effectiveness – The zone air distribution effectiveness is determined using Table 6-2 in the Standard. In order to use this table, Air Distribution Configurations must be selected based on ceiling and floor supply throughout the building. Therefore, the zone air distribution effectiveness (E_z), was found to be 1.0 for both cool and warm air supply. Ceiling supply of warm air and floor return was selected with a factor of 1.0 for heating purposes while ceiling supply of cool air with a factor of 10 was selected for cooling purposes.

6.2.2.3 Zone Outdoor Airflow – Based on the Breathing Zone Outdoor Airflow section and the Zone Air Distribution Effectiveness, the Zone Outdoor Airflow (V_{oz}), can be calculated based on the following equation:

Equation 6-2 Zone Outdoor Airflow	$V_{oz}=V_{bz}/E_z$

6.2.5 Single-Zone System – Within this HVAC system, each air handling unit supplies a mixture of outdoor air and recirculated air to each coordinating zone. The outdoor air intake flow (V_{ot}), is determined with the following equation as well as in conjunction with Section 6.2.5 Multiple-Zone Recirculating Systems:

Equation 6-3 Outdoor Air Intake Flow	$V_{ot}=V_{oz}$

6.2.5.1 Primary Outdoor Air Fraction – Table 6.3 is used to determine system ventilation efficiency and the primary outdoor air fraction (Z_p), can be found through Equation 6-5:

Equation 6-5 Zone Primary Outdoor Air Fraction	$Z_p=V_{oz}/V_{pz}$

6.2.5.2 System Ventilation Efficiency – Using Table 6.3, once the primary outdoor air fraction (Z_p), the system ventilation efficiency (E_v) can also be found.

6.2.5.3 Uncorrected Outdoor Air Intake – First, finding the occupant diversity, D, which accounts for the variations in the number of occupants in the zones. This value is defined as $D=P_s/\sum_{\text{all zones}}P_z$ in which P_s is the system population which can vary depending on zone use and occupant location.

After finding the occupant diversity, the uncorrected outdoor air intake (Vou) can be found by using the following formula:

Equation 6-6 Uncorrected Outdoor Air Intake	$V_{ou}=D\sum_{\text{all zones}}R_pP_z+\sum_{\text{all zones}}R_aA_z$

Finally, after finding V_{ou}, the design outdoor air intake flow (V_{ot}) can be found.

6.2.5.4 Outdoor Air Intake – The design outdoor air intake can be found using Equation 6-8:

Equation 6-8 Outdoor Air Intake	$V_{ot}=V_{ou}/E_v$

This value is the minimum outdoor air that the system needs to take in order to provide enough outdoor air for occupants within the space.

ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality Conclusion:

The AHUs within the Walt Disney Family Museum are found to be compliant with Section 5 and 6 of Standard 62.1 Ventilation for Acceptable Indoor Air Quality.

Summary of Compliance - ASHRAE Standard 90.1 - Energy Standard Analysis

Within Standard 90.1 Energy Standard for Buildings, this standard analyzes certain aspects of the building such as Building Envelope, HVAC and Lighting and Electrical loads. The Museum complies with a majority of the standard however, the building is also a historical redevelopment, and thus, certain parts of the building could not be altered to meet energy requirements. This is a constant challenge for redevelopment projects and a problem that will be provided with a better solution in future years to come.

Section 5: Building Envelope

Section 5.1 General – Envelope alterations had to be taken into account because this building was a redevelopment and a glass atrium was built into the roof. Therefore, the Section 5 was carefully analyzed in order to comply with requirements concerning insulation, air leakage and fenestration.

The climate zone of the Museum is located within the 3C region, which is the Marine region, meaning the mean temperature of the coldest month is between 27°F and 65°F with the warmest month mean temperature less than 72°F. At least four months out of the year have mean temperatures over 50°F while the driest season is during the summer.

Section 5.2 Compliance – The Museum must comply with sections 5.1, General; 5.4 Mandatory Provisions; 5.7, Submittals; as well as 5.8, Product Information and Installation Requirements as well as 5.5, Prescriptive Building Envelope Option or 5.6, Building Envelope Trade-Off Option. Section 5.5 was found to be the easiest method for finding compliance and was chosen to analyze.

Section 5.4 Mandatory Provisions – Insulation compliance and Fenestration and Doors compliance are found within Section 5.8

Throughout the exterior and interior of the building, depending on the exposure, Elastomeric Sealants and Non-Elastomeric Sealants are used. Due to the building's historical standing, the joints had to be cleaned, primed, sealed and a protective coating was also applied once the sealant was cured. The envelope was sealed in areas such as around

the windows, doors, walls, foundations as well as utility penetration areas throughout floors.

Air leakage throughout the building was not tested.

There are no loading docks within the Museum. Vestibules are found to be except from this standard because the building is less than four stories about grade.

Section 5.5 Prescriptive Building Envelope Option – The Museum's building envelope is near compliance for almost all elements of the building, however, a few areas do not meet compliance exactly. Because the building is a wooden framed structure as well as a historical renovation, the building is not sealed as well as a new structure with better methods of construction and new building technologies. Both the roof and the walls above grade are very close to meeting the criteria for standard while the walls below grade, the flooring as well as the slab-on-grade meets the standards insulation criteria.

When analyzing the materials for fenestration, non-metal framing and metal framing do not meet compliance for the windows because the non-metal framing areas use non-operable, wooden framed windows while the metal framing windows are aluminum double panel windows with a U-Value slightly below criteria specifications.

Building Resistance Values Based on Appropriate Materials						
Building Area	Element	Assembly Maximum	Insulation Minimum	Design Maximum	Design Minimum	Compliance Met?
Roof	Insulation above Deck	U-0.048	R-20	U-0.052	R-19.0	No
Walls, Above Grade	Wood-Framed	U-0.089	R-13.0	U-0083	R-12.0	No

Wall, Below Grade	Below-Grade Wall	C-1.140	NR	C-1.140	NR	Yes
Floors	Wood-Framed	U-0.051	R-19.0	U-0.051	R-19.0	Yes
Slab-On-Grade Floors	Unheated	F-0.730	NR	F-1.5	NR	Yes
Fenestration	Non-Metal Framing	U-0.65	SHGC-0.25	U-1.04	-	No
	Metal Framing	U-0.60	SHGC-0.25	U-0.71	-	No
	Entrance Door	U-0.90	SHGC-0.25	U-0.330	-	Yes

The Museum's North, South and West facades are compliant with this section of Standard 90.1 concerning fenestration area. However, the East façade is not compliant because it 52.5%, 12.5% higher than the Standard's requirement of 40%. Due to 640 ft^2 of the East façade being glass in order to properly display the views of the Golden Gate Bridge, this façade is not compliant with the Standard.

Glazed Area on Building Exterior Façade				
	Glass Area	Wall Area	Percent Glass	Compliance?
East Wall	713.5	1360	52.5%	No
West Wall	168	1520	11.1%	Yes
South Wall	115.5	1120	10.3%	Yes
North Wall	115.5	1120	10.3%	Yes

Section 5.7 Submittals – All submittals required for the project were submitted and found to be compliant with the Architects Requirements.

Section 5.8 Product Information and Installation Requirements – The building envelope insulation was labeled with the appropriate U-value, installed according to the Manufacturer's Requirements, as well as protected with a moisture barrier when necessary.

Section 6: Heating, Ventilation and Air Conditioning

6.1 General – Alterations to Heating, Ventilating and Air Conditions in Existing Buildings require that the new systems installed within the Museum comply with Section 6.2 Compliance Path.
6.2 Compliance Path – The Museum must be determined for compliance with Section 6 which must meet all requirements for 6.1, General; 6.7, Submittals, 6.8, Minimum Equipment Efficiency; as well as 6.4, Mandatory Provisions; and 6.5, Prescriptive Path.

Section 6.4 Mandatory Provisions - Equipment efficiencies are as listed as per operation standards under various testing required by the specifications set forth by the architect. Mechanical equipment throughout the Museum is labeled and sized as per the heating and cooling loads throughout the building.

Each zone is controlled by automatic control valves and dampers as well as thermo wells, and Direct Digital Controls concerning VAV boxes, fan coil type and packed air handling equipment, thus, controlling the temperature and airflow within each zone. Each spaces temperature is controlled with ±1°F accuracy. The Direct Digital Control (DDC) system monitors all environmental data and controls the equipment functions within the building as well as deactivating certain areas of the building whenever the Museum is unoccupied.

The Museum also has fire and smoke dampers throughout the ducts in order to prevent the spread of flames and smokes in case of a fire. These dampers work in conjunction with the buildings fire protection system. However, the Museum also does not have dampers

where acoustical concerns are present which causes this area of the Standard to be non-compliant.

Throughout the building, all duct insulation as well as piping insulation is protected from weather elements as well as vapors found within the building due to condensation. All ducts have been sealed appropriately and pipes have been thermally insulated as well. Ducts have also been tested for leakage as per the specifications and found to be compliant with SMACNA "HVAC Air Duct Leakage Test Manual".

Within the HVAC system, all fans were found to be compliant with power limitation. Within the following chart, the power used for the fans compared to the allowable nameplate motor power can be analyzed:

Fan Power Limitation				
Equipment Analyzed	CFM	Motor HP	Variable Volume (1.7hp/1000CFM) for <20,000 or (1.5hp/1000CFM) for >20,0000	Compliance?
AHU-104-1	28,000	30	42	Yes
AHU-104-2	34,000	40	51	Yes
AHU-104-3	22,000	30	33	Yes
AHU-104-4	4,000	5	6.8	Yes
FCU-104-B2-1	6,300	3	10.71	Yes
FCU-104-B2-2	6,300	3	10.71	Yes
FCU-104-B-1	600	0.25	1.02	Yes
FCU-104-3-1	3,000	1.50	5.1	Yes
FCU-104-3-2	600	0.25	1.02	Yes
FCU-104-3-3	2100	1.50	3.57	Yes
EF-104-B2-1	950	1.10	1.615	Yes
EF-104-B2-2 to 21	3950	0.75	5.925	Yes
EF-104-2-1	94	0.11	0.1598	Yes
EF-104-2-2	94	0.11	0.1598	Yes
EF-104-3-1	94	0.11	0.1598	Yes
EF-104-3-2	94	0.11	0.1598	Yes

VAV Fan Control boxes throughout the building are driven by mechanical variable speed drives. The VAV boxes also are controlled by the Direct Digital Control system, which can reset the system based on the zone with the most pressure required.

In Building 108, where the majority of the MEP systems are housed dealing with service water, the chillers, boilers and pumps are controlled on the same DDC system in order to appropriately monitor the water needs of the campus buildings.

Section 6.7 Submittals – After the Museum was built, As-Built drawings were created and Operations and Maintenance Manuals were given to the Owner in order to comply with this section of the Standard.

Section 6.8 Minimum Equipment Efficiency Tables – As per the Manufacturer's data of the Museum's HVAC equipment, all pieces of equipment used have met a minimum efficiency.

Section 7: Service Water Heating

Section 7.1 General – The Museum's service water heating systems and equipment were installed within Building 108 as a direct replacement for the former system.

Section 7.2 Compliance Path – Compliance was determined by analyzing sections 7.1 General 7.4 Mandatory Provisions; 7.5 Prescriptive Path; 7.7, Submittals and 7.8, Product Information.

Section 7.4 Mandatory Provisions – The service water heating systems and equipment were sized according to the building loads, found to be efficient, hot water pipes insulated and temperature controls are present throughout the system.

Section 7.5 Prescriptive Path – The building has two condensing type hot water boilers which are each 1,200,000 Btu/h capacity total.

Section 7.7 Submittals – As per the project specifications, submittals were requested when needed and found to be compliant with the project.

Section 7.8 Performance requirements – AERCO KC-1000 Boilers with a thermal efficiency of 87%, an input of 1,000,000 Btu/hr

Performance Requirements for Water Heating Equipment		
Equipment Type	Size Category	Performance Required
Hot Water Supply Boilers, Gas and Oil	≥300,000 Btu/h and <12,500,000 Btu/h	80%E_t
AERCO KC-1000	1,000,000 Btu/h	80%(87%)(1,000,000Btu/hr) =696,000Btu/hr

Output for each boiler as per the project was found to be 860,000 Btu/hr, well over the performance requirements of 696,000Btu/hr.

Section 9: Lighting

Section 9.1 General – Within this section, indoor and outdoor lighting will be analyzed as well as exterior building grounds lighting. Life safety and critical lighting are not included within this scope.

When completing a compliancy analysis within this section, the installed interior lighting power includes the entire luminaire and its components and the maximum wattage of the luminaire as well.

Section 9.2 Compliance Path – The Museum's lighting systems and equipment must be analyzed in order to find compliance with sections 9.1 General, 9.4 Mandatory Provisions, and 9.5 Building Area Method.

9.4 Mandatory Provisions – Lighting control systems for the campus's interior lighting consists of relay panels, time clock, photocell occupancy sensors and low-voltage switches. This control system uses these sensors and timers to turn the lighting within the building "on/of" when the building is occupied or not occupied. Occupancy sensors are found within the learning spaces, offices, conferences, employee lunch/break rooms as well as IT and electrical closets. The gallery spaces are on a time clock automatically programmed control system that allows for the lighting within the spaces to be turned on at a particular time before the Museum opens and turned off when the Museum closes. This system can also account for holidays and weekends if the Museum is closed so energy is not used when the Museum is unoccupied.

Throughout the Presidio, the exterior lighting is controlled by the Presidio Trust for the entire campus of buildings. Parking lots, walk ways and architectural lighting are controlled by this system which is

programmed to turn "on" at a particular light level, measured by photocells, and turn "off" and then turned off at a specific time.

Section 9.5 Building Area Method Compliance Path – As per Table 9.5.1 Lighting Power Densities Using the Building Area Method, the allowable Lighting Power Density for a Museum Building is 1.1 W/ft^2. The Museum does not meet compliance by achieving 3.3 W/ft^2, which is 3 times to allowable Lighting Power Density. Reasons behind this large number is due to the fact that the Lecture Hall in the Basement contributes to a large amount of the lighting load but the lights in this space are rarely used in comparison to the Learning Spaces and Galleries. The Museum also has a large number of visual displays and does not have the advantage of using natural daylight because of the older style windows which are smaller than present day windows.

Building Area Method Compliance Path							
Fixture Type	Basement	First Floor	Second Floor	Attic	Total Luminaries	Watts/Fixture	Total Watts
M300A	16ft	130			146	2400W/36ft	9733.33
M301	6				6	75	450
M302A	103				103	2400W/36ft	6866.67
M303		35ft			35ft	2400W/36ft	2400
M304A		30	120		150	300	45000
M305	47			1	48	58	2784
M307	6				6	75	450
M307A		56	6		62	75	4650
M308	47				47	75	3525
M309		10	9		19	71	1349
M310	10ft				10ft	36	360
M311A	12				12	29	348
M312	14				14	71	994
M313	10	4			14	31	434
M315	15.5				15.5	16W/LF	248
M319		215			215	16W/LF	3440
M320	19.5ft	56			75.5	3(750)	28125
M321	14	12			26	75	1950
M322A	25				25	100	2500
M324				12	12	88	1056

M325A				60	60	60	3600
M326				19	19	60	1140
M327					0	50	0
M330		1	25		26	120	3120
M332		4			4	6W/LF	24
M333	316				316	4W/LF	1264
M334	123				123	3	369
M336	58.5				58.5	3W/LF	175.5
M339	28	17			45	3.5	157.5
M341		8			8	50	400
M345	26		50		76	10W/LF	760
M346			32		32	50	1600
M347	3				3	20	60
M350	179				179	9W/LF	1611
						Total Watts	130944

Total Watts	130944
Total Area	39711
Watts/SF	3.297423888
Museum LPD	1.1
Compliance?	No

Section 9.7 Submittals – Not Used

Section 9.8 Product Information – Not Used

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings Conclusion

The Museum was found to be near compliance with the section based on the building materials and the installation of the materials. However, some materials were not compliant which can be attributed to the fact that the Museum is a historical building with strict requirements to keep as much of the original building in tact as possible while using construction methods of the time period in which the Museum was originally constructed.

The Museum was found to mostly compliant with the HVAC section of the Standard which can be attributed to the fact that the systems designed for the Museum are completely new systems. The equipment was found to be efficient, fire and smoke dampers placed throughout the ducts as well as insulation and the fan power analysis was also found to be compliant with this section.

The Service Water section was found to be compliant as well. Each of the two boilers servicing the Museum supplies 860,000 Btu/hr while 696,000 Btu/hr was found to be necessary in order to meet the needs of the building.

The Lighting section was the only section found to fail compliancy. Due to the fact that the Museum could not take advantage of natural day lighting and also has many visual displays which need strong lighting in order to be properly viewed, the Museum failed to be compliant with this section. Also, a large portion of the lighting was found within the Lecture Hall which lighting is never lighted to full capacity.

References

ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality

ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

Appendix A – Tables and Calculations (Standard 62.1)

Walt Disney Family Museum Air Handling Unit Analysis								
	P_z (Zone Population)	**A_z (ft^2)**	**V_{pz} (Zone Primary Airflow)**	**Diversity Factor** $D=P_s/SUM(P_z)$; $P_s=190$	**Uncorrected Outdoor Air Rate** $V_{ou}=DSUM(R_p)(P_z)+SUM(R_a)(P_z)$	$V_{ot}=V_{ou}/E_v$	Minimum Outside Air at AHU	CFM Over/Under Supply
AHU 104-1	167	3689	18425.00	0.718562874	1060	1515.2	5200	3684.8
AHU 104-2	240	5103	24860	0.791666667	1852.9	2058.75	3000	941
AHU 104-3	88	1873	5910	0.852272727	779.99	779.99	5100	4320.01
AHU 104-4	111	520	3960	0.765765766	668.7	873.24	2500	1626.75

Room Number (AHU 1)	**Room Title**	**Occupancy Category**	**R_p (cfm/person)**	**Occupant Density (#/1000 ft^2)**	**P_z (Zone Population)**	**R_a (cfm/ft^2)**	**A_z (ft^2)**	**Breathing Zone Outdoor Airflow** $V_{bz}=R_pP_z+R_aA_z$
011	Group Lobby	Lobby	5	150	4.2	0.06	28	22.68
012	Storage	Storage	-	-	-	0.06	62	3.72
013	Light Lock	Corridor	-	-	-	0.06	16	0.96
013A	Vestibule	Lobby	5	150	2.1	0.06	14	11.34
014	A/V Closet	Telephone/Data Entry	5	60	0.84	0.06	14	0.84
015	Elec. Closet	Telephone/Data Entry	5	60	0.72	0.06	12	0.72
016	Group Lobby	Lobby	5	150	31.5	0.06	210	170.1
017	Light Lock	Corridor	-	-	-	0.06	18	3.72
018	Control Room	Telephone/Data Entry	5	60	2.4	0.06	40	14.4
020	Stair/Elev. Lobby	Lobby	5	150	9.6	0.06	64	3.84
020A	Coatroom	Storage	-	-	-	0.06	27	1.62
021	Drinking Fountains	Corridor	-	-	-	0.06	16	0.96
022	Janitor Closet	Storage	-	-	-	0.06	30	1.8

023	Men's Room	N/A	N/A	N/A	N/A	N/A	90	-
024	Women's Room	N/A	N/A	N/A	N/A	N/A	90	-
102	Gallery Scene 10	Museums/galleries	7.5	40	5.76	0.12	144	60.48
103	Elec. Closet	Telephone/Data Entry	5	60	0.72	0.06	12	4.32
104	A/V Closet	Telephone/Data Entry	5	60	0.84	0.06	14	5.04
105	Galley 108	Museums/galleries	7.5	40	9	0.12	225	94.5
106	Exit Lobby	Lobby	5	150	21	0.06	140	113.4
107	Coffee Shop	Restaurant dining room	7.5	70	7.7	0.18	110	77.55
108	Bookstore	Libraries	5	10	3.25	0.12	325	55.25
109	Mngr. Office	Office space	5	5	0.1	0.06	20	1.7
201A	WC	N/A	N/A	N/A	N/A	N/A	14	-
202	Gallery 7B	Museums/galleries	7.5	40	4	0.12	100	42
203	Elec. Closet	Telephone/Data Entry	5	60	0.72	0.06	12	4.32
204	A/V Closet	Telephone/Data Entry	5	60	0.84	0.06	14	5.04
205	Gallery 7	Museums/galleries	7.5	40	9.6	0.12	240	100.8
206	Gallery 6	Museums/galleries	7.5	40	16	0.12	400	168
207	Gallery 5	Museums/galleries	7.5	40	13.6	0.12	340	142.8
302	Coffee/Break Room	Restaurant dining room	7.5	70	5	0.12	64	41.28
303	WC	N/A	N/A	N/A	N/A	N/A	25	-
304	Elec. Closet	Telephone/Data Entry	5	60	-	0.06	10	-
305	Storage	Storage	-	-	-	0.06	25	1.5
306	Corridor	Corridor	-	-	-	0.06	125	7.5
307	IT Room	Telephone/Data Entry	5	60	5	0.06	75	29.5
308	Storage	Storage	-	-	-	0.06	40	2.4
309	Elev. Mech. Room	Storage	-	-	-	0.06	14	0.84
310	Corridor	Corridor	-	-	-	0.06	70	4.2
312	Open Office	Office space	5	5	8	0.06	250	55
312A	Storage	Storage	-	-	-	0.06	20	1.2
312B	Storage	Storage	-	-	-	0.06	30	1.8
313	Office	Office space	5	5	4	0.06	100	26
Totals					166.49		39	

Room Number (AHU 1)	E_z (Zone Air Distribution Effectiveness)	Zone Outdoor Airflow $V_{oz}=V_{bz}/E_z$	V_{pz} (Zone Primary Airflow)	Zone Primary Outdoor Air Fraction $Z_p=V_{oz}/V_{pz}$	E_v (System Ventilation Efficiency)	Diversity Factor $D=P_s/SUM(P_z)$; $P_s=120$	$(R_p)(P_z)$	$(R_a)(A_z)$	Uncorrected Outdoor Air Rate $V_{ou}=DSUM(R_p)(P_z)+SUM(R_a)(P_{z)}$
011	1	22.68	60	0.378	0.7	0.718563	21	1.68	1060.6218
012	1	3.72	100	0.0372	1	0.718563	-	3.72	1060.6218
013	1	0.96	-	-	-	0.718563	-	0.96	1060.6218
013A	1	11.34	-	-	-	0.718563	10.5	0.84	1060.6218
014	1	0.84	-	-	-	0.718563	4.2	0.84	1060.6218
015	1	0.72	-	-	-	0.718563	3.6	0.72	1060.6218
016	1	170.1	740	0.229864865	0.9	0.718563	157.5	12.6	1060.6218
017	1	3.72	-	-	-	0.718563	-	1.08	1060.6218
018	1	14.4	560	0.025714286	1	0.718563	12	2.4	1060.6218
020	1	3.84	825	0.004654545	1	0.718563	48	3.84	1060.6218
020A	1	1.62	-	-	-	0.718563	-	3.84	1060.6218
021	1	0.96	-	-	-	0.718563	-	1.62	1060.6218
022	1	1.8	-	-	-	0.718563	-	0.96	1060.6218
023	1	-	-	-	-	0.718563	-	1.8	1060.6218
024	1	-	-	-	-	0.718563	-	-	1060.6218
102	1	60.48	200	0.3024	0.8	0.718563	43.2	17.28	1060.6218
103	1	4.32	-	-	-	0.718563	3.6	0.72	1060.6218
104	1	5.04	-	-	-	0.718563	4.2	0.84	1060.6218
105	1	94.5	600	0.1575	0.9	0.718563	67.5	27	1060.6218
106	1	113.4	870	0.130344828	1	0.718563	105	8.4	1060.6218
107	1	77.55	710	0.10922535	1	0.718563	57.75	19.8	1060.6218

				2					
108	1	55.25	1965	0.028117048	1	0.718563	16.25	39	1060.6218
109	1	1.7	150	0.011333333	1	0.718563	0.5	1.2	1060.6218
201A	1	-	-	-	1	0.718563	-	-	1060.6218
202	1	42	500	0.084	1	0.718563	30	12	1060.6218
203	1	4.32	-	-	1	0.718563	3.6	0.72	1060.6218
204	1	5.04	-	-	1	0.718563	4.2	0.84	1060.6218
205	1	100.8	2550	0.039529412	1	0.718563	72	28.8	1060.6218
206	1	168	3150	0.053333333	1	0.718563	120	48	1060.6218
207	1	142.8	2250	0.063466667	1	0.718563	102	40.8	1060.6218
302	1	41.28	630	0.06552381	1	0.718563	37.5	7.68	1060.6218
303	1	-	-	-	-	0.718563	-	-	1060.6218
304	1	-	-	-	-	0.718563	-	0.6	1060.6218
305	1	1.5	-	-	-	0.718563	-	1.5	1060.6218
306	1	7.5	200	0.0375	1	0.718563	-	7.5	1060.6218
307	1	29.5	-	-	-	0.718563	25	4.5	1060.6218
308	1	2.4	-	-	-	0.718563	-	2.4	1060.6218
309	1	0.84	-	-	-	0.718563	-	0.84	1060.6218
310	1	4.2	-	-	-	0.718563	-	4.2	1060.6218
312	1	55	1440	0.038194444	1	0.718563	40	15	1060.6218
312A	1	1.2	125	0.0096	1	0.718563	-	1.2	1060.6218
312B	1	1.8	-	-	-	0.718563	-	1.8	1060.6218
313	1	26	800	0.0325	1	0.718563	20	6	1060.6218
Totals			18425				1009.1	335.52	1060.62

Room Number (AHU 1)	$V_{ot}=V_{ou}/E_v$	Minimum Outside Air at AHU	CFM Over/Under Supply
011	1515.174	5,200	+3684.8
012	1060.622		
013	-		
013A	-		
014	-		
015	-		
016	1178.469		
017	-		
018	1060.622		
020	1060.622		
020A	-		
021	-		
022	-		
023	-		
024	-		
102	1325.777		
103	-		
104	-		
105	1178.469		
106	1060.622		
107	1060.622		
108	1060.622		
109	1060.622		
201A	1060.622		
202	1060.622		
203	1060.622		
204	1060.622		

205	1060.622		
206	1060.622		
207	1060.622		
302	1060.622		
303	-		
304	-		
305	-		
306	1060.622		
307	-		
308	-		
309	-		
310	-		
312	1060.622		
312A	1060.622		
312B	-		
313	1060.622		
Totals	1515.2	5200	3684.2

Room Number (AHU 2)	Room Title	Occupancy Category	R_p (cfm/person)	Occupant Density (#/1000 ft²)	P_z (Zone Population)	R_a (cfm/ft²)	A_z (ft²)	Breathing Zone Outdoor Airflow $V_{bz}=R_pP_z+R_aA_z$
025	Corridor	Corridor	-	-	-	0.06	270	16.2
026	Nurse's Room	Office space	5	5	2	0.06	70	4.2
027	Learning Area	Classrooms (Age 9+)	10	35	15	0.12	210	175.2
028	Learning Area	Classrooms (Age 9+)	10	35	36	0.12	252	390.24
029	Warming Kitchen	Cafeteria/fast food dining	7.5	100	8	0.18	80	74.4
030	Corridor	Corridor	-	-	-	0.06	20	1.2
030A	Trash	N/A	N/A	N/A	N/A	N/A	8	-

031	Elev. Pit	N/A	N/A	N/A	N/A	N/A	25	-
032	Elec. Closet	Telephone/Data Entry	5	60	-	0.06	20	1.2
033	Staff Rm/Green Rm.	Conference Room	5	50	16	0.06	60	83.6
034	Mail Room	Shipping/Receiving	-	-	-	0.12	50	6
036	Staff Entry	Main Entry Lobbies	5	10	2	0.06	72	14.32
037	Security	Office space	5	5	2	0.06	48	12.88
038	Security Closet	Storage	-	-	-	0.06	32	1.92
110	Reception/Info	Reception Areas	5	30	12	0.06	325	79.5
111	Pre-Show/Assembly	Lobbies/Prefunction	7.5	30	12	0.06	380	112.8
208	Gallery 4	Museums/galleries	7.5	40	15	0.12	360	155.7
209	Gallery 3	Museums/galleries	7.5	40	15	0.12	380	158.1
216	Gallery 9	Museums/galleries	7.5	40	65	0.12	1660	686.7
315	Corridor	Corridor	-	-	-	0.06	100	6
316	Corridor	Corridor	-	-	-	0.06	10	0.6
317	Conference Room	Conference Room	5	50	18	0.06	96	95.76
318	Work Station	Office space	5	5	2	0.06	50	13
319	Open Office	Office space	5	5	8	0.06	160	49.6
319A	Conference Room	Conference Room	5	50	6	0.06	30	31.8
321	Office	Office space	5	5	1	0.06	28	6.68
322	Office	Office space	5	5	1	0.06	28	6.68
323	Corridor	Corridor	-	-	-	0.06	25	1.5
323A	Storage	Storage	-	-	-	0.06	75	-
324	Electrical Room	Storage	-	-	-	0.06	8	-
325	Office	Office space	5	5	4	0.06	96	25.76
326	Corridor	Corridor	-	-	-	0.06	45	2.7
327	Elevator Mech. Room	Storage	-	-	-	0.06	12	0.72
328	WC	N/A	N/A	N/A	N/A	N/A	18	-
					240		5103	

Room Number (AHU 2)	E_z (Zone Air Distribution Effectiveness)	Zone Outdoor Airflow $V_{oz}=V_{bz}/E_z$	V_{pz} (Zone Primary Airflow)	Zone Primary Outdoor Air Fraction $Z_p=V_{oz}/V_{pz}$	E_v (System Ventilation Efficiency)	Diversity Factor $D=P_s/SUM(P_z)$; $P_s=190$	$(R_p)(P_z)$	$(R_a)(A_z)$	Uncorrected Outdoor Air Rate $V_{ou}=DSUM(R_p)(P_z)+SUM(R_a)(P_z)$
025	1	16.2	-	-	-	0.792	-	-	1852.883
026	1	4.2	120	0.04	1	0.792	-	16.2	1852.883
027	1	175.2	1300	0.13	1	0.792	150	-	1852.883
028	1	390.24	1250	0.31	1	0.792	360	25.2	1852.883
029	1	74.4	350	0.21	0.9	0.792	60	30.24	1852.883
030	1	1.2	200	0.01	1	0.792	-	14.4	1852.883
030A	1	-	-	-	-	0.792	-	1.2	1852.883
031	1	-	-	-	-	0.792	-	-	1852.883
032	1	1.2	-	-	-	0.792	-	-	1852.883
033	1	83.6	350	0.24	1	0.792	80	1.2	1852.883
034	1	6	300	0.02	1	0.792	-	3.6	1852.883
036	1	14.32	280	0.05	1	0.792	10	6	1852.883
037	1	12.88	280	0.05	1	0.792	10	4.32	1852.883
038	1	1.92	-	-	-	0.792	-	2.88	1852.883
110	1	79.5	1620	0.05	1	0.792	60	19.5	1852.883
111	1	112.8	2685	0.04	1	0.792	90	22.8	1852.883
208	1	155.7	2160	0.07	1	0.792	112.5	43.2	1852.883
209	1	158.1	2835	0.06	1	0.792	112.5	45.6	1852.883
216	1	686.7	6630	0.10	1	0.792	487.5	199.2	1852.883
315	1	6	200	0.03	1	0.792	-	6	1852.883
316	1	0.6	-	-	-	0.792	-	0.6	1852.883
317	1	95.76	1600	0.06	1	0.792	90	5.76	1852.883
318	1	13	400	0.03	1	0.792	10	3	1852.883
319	1	49.6	1200	0.04	1	0.792	40	9.6	1852.883
319A	1	31.8	300	0.11	1	0.792	30	1.8	1852.883

321	1	6.68	100	0.07	1	0.792	5	1.68	1852.883
322	1	6.68	100	0.07	1	0.792	5	1.68	1852.883
323	1	1.5	-	-	-	0.792	-	1.5	1852.883
323A	1	-	-	-	-	0.792	-	4.5	1852.883
324	1	-	-	-	-	0.792	-	0.48	1852.883
325	1	25.76	600	0.04	1	0.792	20	5.76	1852.883
326	1	2.7	-	-	-	0.792	-	2.7	1852.883
327	1	0.72	-	-	-	0.792	-	0.72	1852.883
328	1	-	-	-	-	0.792	-	-	1852.883
			24860				1732.5	481.32	1852.9

Room Number (AHU 2)	$V_{ot}=V_{ou}/E_v$	Minimum Outside Air at AHU	CFM Over/Under Supply
025	-	3000	941
026	1852.883		
027	1852.883		
028	1852.883		
029	2058.758		
030	1852.883		
030A	-		
031	-		
032	-		
033	1852.883		
034	1852.883		
036	1852.883		
037	1852.883		
038	-		
110	1852.883		
111	1852.883		

208	1852.883		
209	1852.883		
216	1852.883		
315	1852.883		
316	-		
317	1852.883		
318	1852.883		
319	1852.883		
319A	1852.883		
321	1852.883		
322	1852.883		
323	-		
323A	-		
324	-		
325	1852.883		
326	-		
327	-		
328	-		
	2058.75	3,000	941

Room Number (AHU 3)	Room Title	Occupancy Category	R_p (cfm/person)	Occupant Density (#/1000 ft²)	P_z (Zone Population)	R_a (cfm/ft²)	A_z (ft²)	Breathing Zone Outdoor Airflow $V_{bz}=R_pP_z+R_aA_z$
112	Gallery	Museums/galleries	7.5	40	12	0.12	224	116.88
113	Electrical Room	Telephone/Data Entry	5	60	2	0.06	20	11.2
114	Gallery 1C	Museums/galleries	7.5	40	10	0.12	144	92.28
117	Blue Sky/Scene 9	Museums/galleries	7.5	40	38	0.12	920	395.4
210	Gallery 2B	Museums/galleries	7.5	40	10	0.12	255	105.6
211	Electrical Closet	Telephone/Data Entry	5	60	-	0.06	10	-
211A	Janitor/Storage	Storage	-	-	-	0.06	20	1.2

212	Gallery 2A	Museums/galleries	7.5	40	8	0.12	144	77.28
218	Gallery 8	Museums/galleries	7.5	40	8	0.12	136	76.32
					88		1873	

Room Number (AHU 3)	**E_z (Zone Air Distribution Effectiveness)**	**Zone Outdoor Airflow** $V_{oz}=V_{bz}/E_z$	**V_{pz} (Zone Primary Airflow)**	**Zone Primary Outdoor Air Fraction** $Z_p=V_{oz}/V_{pz}$	**E_v (System Ventilation Efficiency)**	**Diversity Factor** $D=P_s/SUM(P_z)$; $P_s=75$	$(R_p)(P_z)$	$(R_a)(A_z)$	**Uncorrected Outdoor Air Rate** $V_{ou}=DSUM(R_p)(P_z)+SUM(R_a)(P_z)$
112	1	116.88	1410	0.082894	1	0.85227273	90	26.88	779.9986
113	1	11.2	-	-	-	0.85227273	10	1.2	779.9986
114	1	92.28	1050	0.087886	1	0.85227273	75	17.28	779.9986
117	1	395.4	2970	0.133131	1	0.85227273	285	110.4	779.9986
210	1	105.6	1600	0.066	1	0.85227273	75	30.6	779.9986
211	1	-	-	-	1	0.85227273	-	0.6	779.9986
211A	1	1.2	-	-	1	0.85227273	-	1.2	779.9986
212	1	77.28	1000	0.07728	1	0.85227273	60	17.28	779.9986
218	1	76.32	4500	0.01696	1	0.85227273	60	16.32	779.9986
			5910				655	221.76	

Room Number (AHU 3)	$V_{ot}=V_{ou}/E_v$	Minimum Outside Air at AHU	CFM Over/Under Supply
112	779.9986	5100	4320
113	-		
114	779.9986		
117	-		

210	779.9986		
211	779.9986		
211A	779.9986		
212	779.9986		
218	779.9986		
	779.99	5100	4320

Room Number (AHU 4)	Room Title	Occupancy Category	R_p (cfm/person)	Occupant Density (#/1000 ft²)	P_z (Zone Population)	R_a (cfm/ft²)	A_z (ft²)	Breathing Zone Outdoor Airflow $V_{bz}=R_pP_z+R_aA_z$
019	Lecture Hall	Lecture hall (fixed seats)	7.5	150	111	0.06	520	863.7

Room Number (AHU 4)	E_z (Zone Air Distribution Effectiveness)	Zone Outdoor Airflow $V_{oz}=V_{bz}/E_z$	V_{pz} (Zone Primary Airflow)	Zone Primary Outdoor Air Fraction $Z_p=V_{oz}/V_{pz}$	E_v (System Ventilation Efficiency)	Diversity Factor $D=P_s/SUM(P_z)$; $P_s=85$	$(R_p)(P_z)$	$(R_a)(A_z)$	Uncorrected Outdoor Air Rate $V_{ou}=DSUM(R_p)(P_z)+SUM(R_a)(P_z)$
019	1	019	3960	0.00479798	0.9	0.765765766	832.5	31.2	668.7

Room Number (AHU 4)	$V_{ot}=V_{ou}/E_v$	Minimum Outside Air at AHU	CFM Over/Under Supply
019	873.2435294	2500	1626.756471