Mechanical Tech Report 3

Mechanical Systems Existing Conditions Report

M Resort Spa and Casino

Henderson, Nevada

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Mechanical Option

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1.0 Executive Summary

The purpose of this report is to summarize the existing mechanical systems located at the M Resort. Design objectives and operation specific information was utilized to attain a better understanding of the design criterion used for this resort.

Throughout this report calculations and tables from past technical assignments have been included in order to observe how the various systems affect one another and the system as a whole. For instance, heating and cooling, loads along with utility rates were used to determine the systems energy consumption.

This system has been found to meet the owner's requirements for the resort. Without a detailed comparison to other methods, the system chosen works well with the diverse loads and space types found throughout the building. Design conditions as well as schematics and equipment schedules have been provided to help understand the system.

A critique of the system has been included which evaluates the system to be sufficient and logical based on the design objectives. There have been some discrepancies found in the heating, cooling, and ventilation loads, however these seem to point towards issues with the precision of the Trace model. Therefore before further analysis is conducted for the project, a second simulation must be run.

2.0 Design Objectives and Requirements

Project Information

Marnell Corrao Associates have designed and constructed many of the top resorts in Las Vegas including the Wynn of Las Vegas, the Bellagio and the Mirage, and now decided to create a resort of their own. The M Resort is a casino and guest resort located on approximately 90 acres in Henderson, Nevada with an initial cost of one billion dollars. When designing and building resorts in Las Vegas cost cannot be the basis of design rather quality and luxury, which Marnell Corrao Associates have chosen to uphold. The owners have decided to locate the complex on an area south of the main Las Vegas Strip on the intersection of Las Vegas Boulevard and St Rose Parkway. The owners feel that this will be the prime location for their property based on what research has indicated for the future of Las Vegas as well as their plans to expand the resort in the future.

The M Resort Spa Casino consists of two areas. The first being the low rise portion which is approximately 500,000 square feet including a spa level, kitchens, ballrooms, meeting rooms, administration, and back of the house as well as a casino level that consists of kitchens, restaurants, and casino space. The high rise portion of the building includes approximately 440 guest suites along with a restaurant atop the guest tower.

Guest Tower Summary

The guest tower will include the guest suites and lofts on floors 2 through 14. These spaces will primarily be occupied during the evening and overnight hours and will require individual temperature control. Each of the guest rooms will be served by a vertical fan coil unit located along the exterior wall of the suite. Outside air will be brought in through integrated wall mullions with the interior space being negatively pressurized through the bathroom exhaust system. Common non-ducted gypsum board exhaust shafts will be used for adjacent suites with an exhaust fan mounted on the roof. Chilled water will be supplied from the central plant and heating will be achieved through an electric resistance coil.

These systems must not only deliver a comfortable climate for the guests, however they must also remain reasonably quiet as to not disturb the guests. The units have are required to meet a minimum of an NC 30 rating. They have also been designed and installed to facilitate maintenance and repair although it is important that the systems are reliable enough that they do not require constant attention.

The guest corridors are conditioned by two constant volume makeup air units mounted on the roof of the tower. The maid and service rooms will be served by fan coil units similar to those used in the guest rooms.

Low Rise Summary

The low rise portion of the M Resort contains a variety of spaces which include, restaurants, spa areas, food preparation, administration, ballrooms, casino space, lobbies and other pertinent areas that have variable occupancies and requirements. The offices and meeting rooms could be completely filled or empty on a given business day while the ballrooms and restaurants would tend to be occupied mainly during the evening hours. The widely variable occupancies of each of the spaces thus lent itself to a variable air volume (VAV) system fed by air handling units on the roof. Smoke control through the spaces is another key priority. Smoking is permitted in the casino spaces and thus the air system must not re-circulate the particulate in the air. One hundred percent outdoor air has been listed as a requirement for the casino and gambling spaces to purge the contaminated out of the air. Smoke control has also been integrated into the control of each air handler in the event of a fire.

Service Space Summary

The central chilled water plant is designed to serve the guest suite fan coil units, restaurants and low rise spa and casino level air handling units as well as support space fan coil units. It is sized to handle an initial 3900 tons of cooling with a future capacity of 7500 tons.

The central hot water plant is designed to serve the guest tower restaurant, low rise spa and casino level air handling units and support service space fan coil units. In addition it will serve the domestic hot water heat exchangers, kitchen hot water heat exchangers and the pool heat exchanger. This plant is capable of expanding from 46,800 MBH to a future capacity of 70,200 MBH.

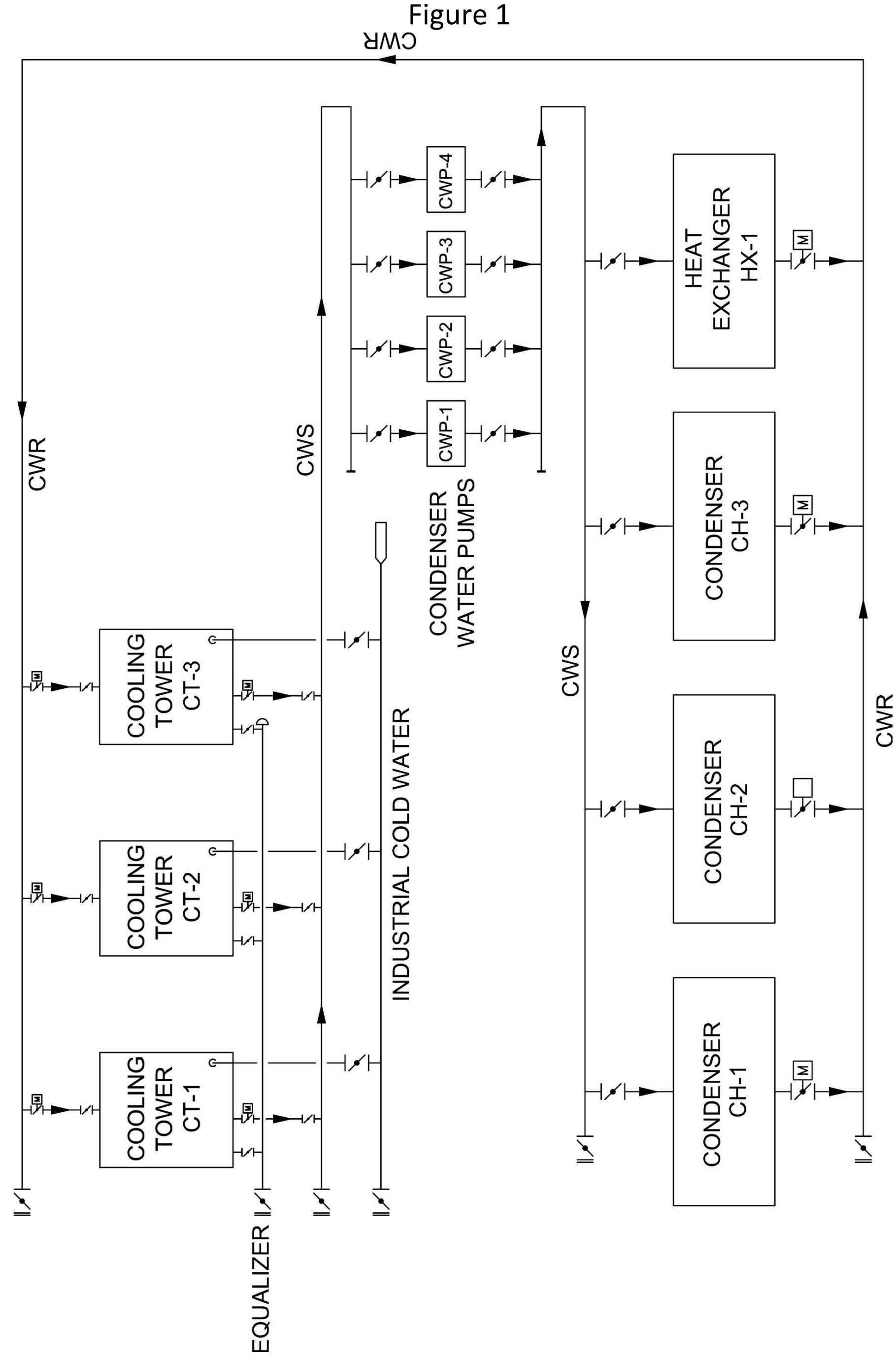
3.0 Description of System Operation

The heart of the mechanical system for the M Resort is found in the central utility plant (CUP) located at the northeast corner of the building site, which includes the chillers, boilers, heat exchangers, all necessary pumps and support equipment, as well as the cooling towers on the roof of the CUP. The air handling units and make up air units are located on either the low rise roof or the roof of the tower. Each guest room has a modular high rise fan coil unit with the support spaces also using fan coil units.

The chiller plant consists of three water cooled centrifugal chillers that distribute water to the air handling units and fan coil units. For clarity the condensing and evaporative water loops have been separated. Schedules of all major pieces of equipment have been included in section 16.0 Appendix B.

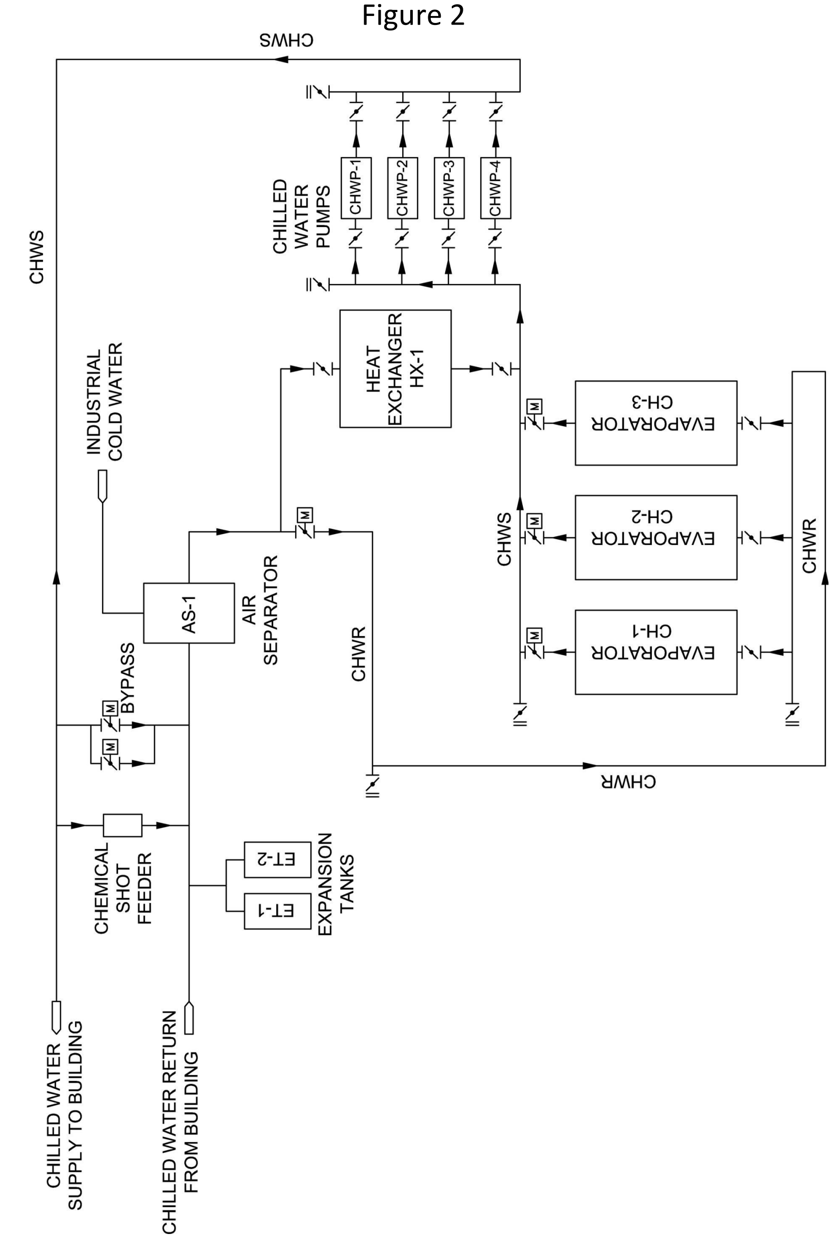
Water flows through the condenser where heat is rejected into the water; the water enters at 85 F and leaves at 97 F, shown in Figure 1. The water then flows to the cooling towers located on the roof where an induced draft cross flow of air, evaporatively cools the water. The water collects in the basin, which is kept level through an equalizer, and is then pumped back through the condensers. This basin also is the point in which make up water can be added. A heat exchanger has been provided to allow free cooling of the chilled water directly from the condenser water piping.

Figure 1



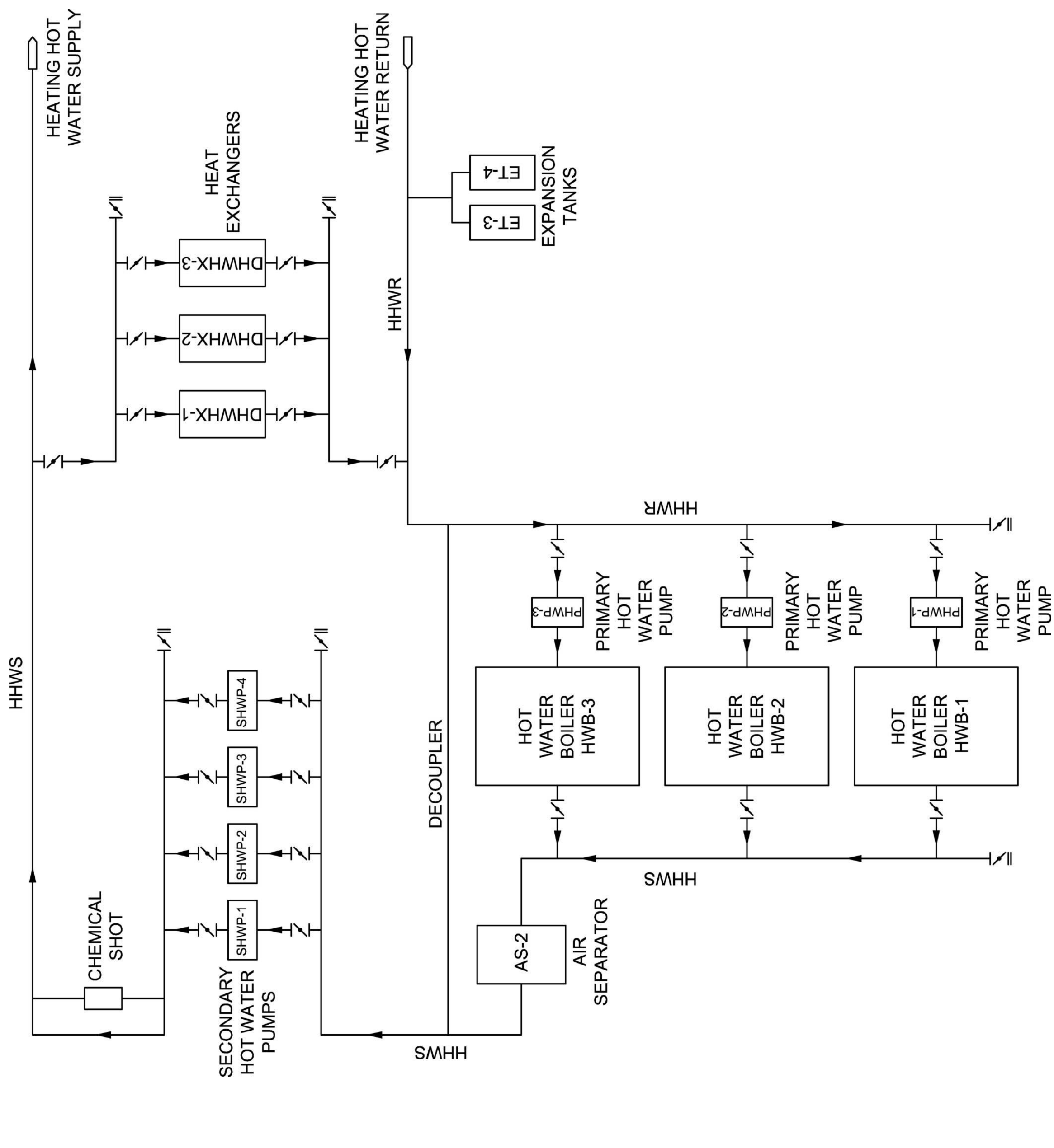
Refrigerant 123 transfers the heat-load from the evaporator and rejects it to the condensing water loop, shown in Figure 2. Water enters the evaporator at 58 F and leaves at 42 F. From the evaporator the water is pumped to the various loads throughout the building. Upon returning from the building loads the water enters an air separator where makeup water can be added and is then returned to the evaporator. A heat exchanger is shown in this schematic as is shown in the condenser water loop. These heat exchangers are the same piece of equipment and it allows for the free cooling of the chilled water from the condensing water piping. Also shown are the expansion tanks and chemical shot feeder to treat the water and reduce scale and biological growth.

Figure 2



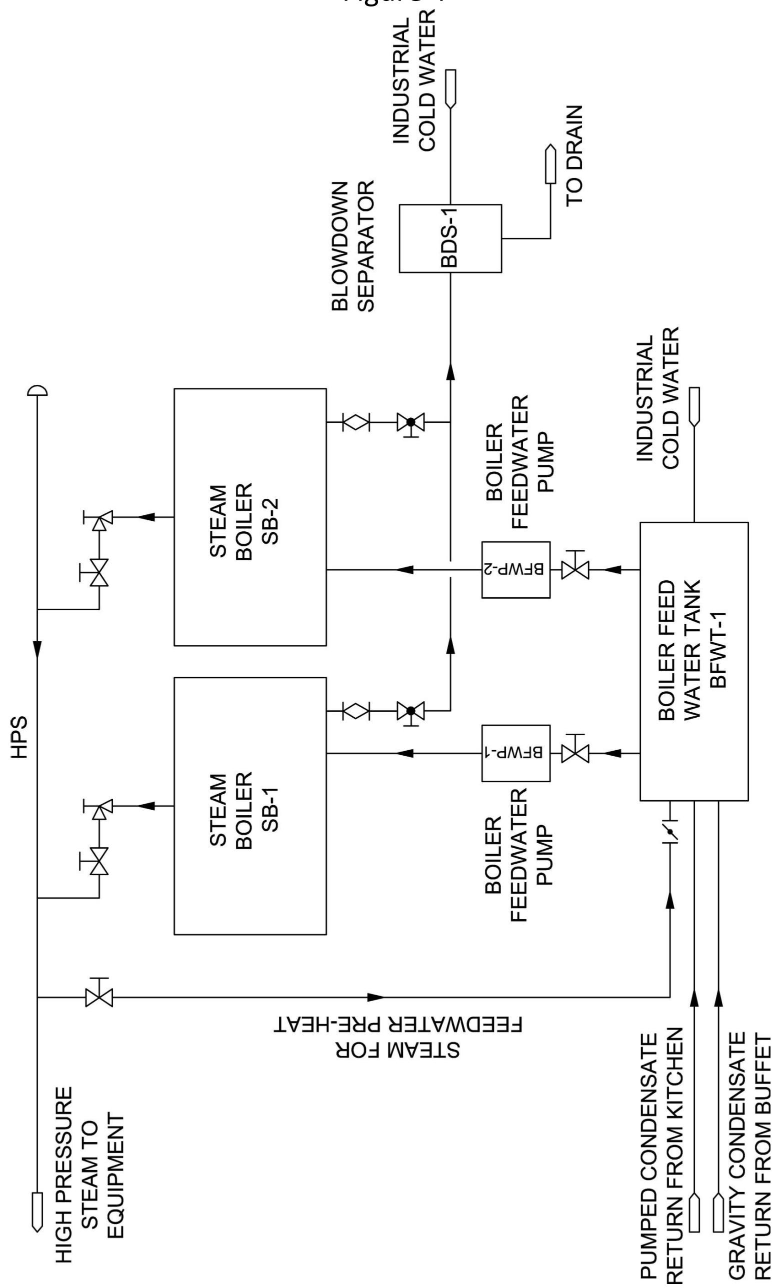
Heating hot water returns to the central plant and is pumped through the hot water boilers by the primary hot water pumps, shown in Figure 3. The hot water then travels through an air separator and then moves to the secondary hot water pumps where it is pumped to the system for hot water heating. These pumps also direct the hot water to three heat exchangers for domestic hot water, kitchen hot water, and the pool heater. Also shown are the expansion tanks and chemical shot feeder to treat the water and reduce scale and biological growth.

Figure 3



Steam at 80 psig exits the steam boilers where it goes to the required equipment, shown in Figure 4. It also braches off to the feed water tank for pre heat. Condensate is pumped from the kitchen equipment while gravity condensate returns from the buffet. The returns enter the boiler feed water tank where it is mixed with make up water and preheated. Boiler feed water pumps then direct the water to the steam boilers where it is heated up and leaves the boilers again. Also shown is a blow down separator to remove any particulate and scale that may accumulate in the boilers.

Figure 4



4.0 Controls

Building Management System BMS will be utilized to manage all of the equipment and sensors. The system has been specified to require open protocol which will likely eliminate the need for additional hardware or gateways. The BMS monitors and collects data, using the information to save energy through its control of the equipment cycles.

The chillers have their own on board controls which will communicate with the BMS through a hard wire connection. The cooling towers each has a VFD which is controlled based on the amount of heat being rejected from the chillers. The pumps are started and stopped based on the number of chillers that are operating. The boiler plant is controlled in much the same manner. The boilers have their own on board controls hardwired to the BMS and the VFDs for the pumps are controlled based on demand. The BMS constantly monitors the supply and return temperatures along with the loads to control the output of each piece of equipment.

The air handlers will also be connected to the BMS which controls the fans and supply air temperature. The BMS also controls the economizer function of the AHU based on the design and outside air conditions. Each of the VAV boxes is connected to the respective AHU to help control temperature and provide feedback. Since the air handling units are used for smoke control, the fire alarm system overrides the BMS when the unit goes into smoke control mode.

The guest room fan coil units are connected to a digital thermostat for adjustment by the room occupants. These units will not be connected to the BMS. The other respective fan coil units for all other back of the house spaces will also be wired for individual control without communication with the BMS.

5.0 Indoor and Outdoor Design Conditions

The indoor and outdoor design conditions listed in Table 1 and Table 2 below were values specified in Southland Industries' Basis of Design for the M Resort Spa Casino. These values were used by the design team for all load calculations. These values were determined using ASHRAE Fundamentals and Standards as well as information known about the local climate and space use.

Table 1

Indoor Design Conditions		
Room Type	Indoor Temperature (°F) and Relative Humidity (%RH)	
	Summer	Winter
Back of House (unassigned)	75F DB +/- 2	70F DB +/-2
Ballroom	72F DB +/- 2	70F DB +/-2
Casino	72F DB +/- 2	70F DB +/-2
Chiller room	80F DB +/- 5	65F DB +/- 5
Coffee Shop	72F DB +/- 2	70F DB +/-2
Control Room	75F DB +/- 2	70F DB +/-2
Corridor	74F DB +/- 2	70F DB +/-2
Data / I.T. Room	68F DB +/- 2	68F DB +/-2
Dining	72F DB +/- 2	70F DB +/-2
Electrical Room	80F DB +/- 5	65F DB +/- 5
Elevator Mech. Room	80F DB +/- 5	65F DB +/- 5
Employee Lounge	74F DB +/- 2	70F DB +/-2
Entertainment Lounge	72F DB +/- 2	70F DB +/-2
Hotel Room	74F DB +/- 2	70F DB +/-2
Janitor Closet	75F DB +/- 5	65F DB +/- 5
Kitchen / Bakery	75F DB +/- 5	70F DB +/-5
Locker Room	75F DB +/- 2	75F DB +/-2
Mechanical Room	80F DB +/- 5	65F DB +/- 5
Office (executive)	72F DB +/- 2	70F DB +/-2
Office (staff)	75F DB +/- 2	70F DB +/-2
Pantry	75F DB +/- 5	65F DB +/- 5
Race/Sports Bet A/V Room	68F DB +/- 2	68F DB +/-2
Reception Lobby	72F DB +/- 2	70F DB +/-2
Restroom	75F DB +/- 5	70F DB +/- 5
Retail	72F DB +/- 2	70F DB +/-2
Salon	72F DB +/- 2	72F DB +/-2
Security Control Room	74F DB +/- 2	70F DB +/-2
Spa Treatment Room	72F DB +/- 2	72F DB +/-2
Spa Waiting Room	72F DB +/- 2	72F DB +/-2
Spa Wet Area	78F DB +/-2	78F DB +/-2
Storage Rooms	75F DB +/- 5	65F DB +/- 5
Telephone Room	68F DB +/- 2	68F DB +/-2
Warehouse	75F DB +/- 5	65F DB +/- 5

Table 2

Outdoor Design Conditions	
Temperature	°F
Summer Dry Bulb and Coincident Wet Bulb	115/74
Summer Wet bulb for evaporative heat rejection	78
Summer Ambient Air dry bulb for air cooled equipment	120
Winter Dry Bulb	23.1

6.0 Design Ventilation Requirements

Table 3 compares the design ventilation requirements scheduled in the design documents with those values calculated from Mechanical Technical Report One in accordance with ASHRAE Standard 62.1.2007. The table shows that for the majority of the air handlers the outdoor air required is less that that supplied. For three of the systems the ventilation air needed was less than design; however assumptions made according to space classification and occupancy could cause the values to be different. It is also important to note that the casino spaces are supplied with 100 percent outdoor air even though the OA was calculated in this section as a check.

Table 3

Ventilation Air Design and Calculated					
Equipment	Area Served	Scheduled Min OA CFM	Tech 1 Calculated OA CFM	Difference	Percent Different
AHU B-1	Wine Bar/ Kitchen	11,000	5,878	5,122	-30
AHU 1-1	Chiller Room	4,300	440	3,860	-81
AHU 1-2	Spa/Fitness Center	7,050	12,323	-5,273	27
AHU 1-3	Promenade	18,525	16,678	1,847	-5
AHU 1-4	Meeting Rooms	19,735	7,199	12,536	-47
AHU 1-5	Back of House Offices	4,510	2,664	1,846	-26
AHU 1-6	Main Kitchen Bakery EDR Kitchen	22,300	17,496	4,804	-12
AHU 1-7	Promenade	3,560	2,022	1,538	-28
AHU 1-8	Ballroom	31,850	15,737	16,113	-34
AHU 1-9	Warehouse Facilities Offices	725	944	-219	13
AHU 1-10	Back of House Offices	8,730	7,717	1,013	-6
AHU 1-11	Promenade	3,225	1,506	1,719	-36
AHU 2-1	Steak/Seafood Restaurant and Kitchen	11,540	11,207	333	-1
AHU 2-3	Italian Restaurant and Kitchen	8,170	4,711	3,459	-27
AHU 2-4	Entertainment and High Limit Salon	17,660	3,645	14,015	-66
AHU 2-5	Casino Floor SW	50,000	17,903	32,097	-47

Table 3 cont.

Ventilation Air Design and Calculated					
Equipment	Area Served	Scheduled Min OA CFM	Tech 1 Calculated OA CFM	Difference	Percent Different
AHU 2-6	Casino Floor SE	55,000	19,007	35,993	-49
AHU 2-7	Casino Floor NW	62,000	24,092	37,908	-44
AHU 2-8	Casino Floor N	62,000	22,862	39,138	-46
AHU 2-9	Café and Grille	7,445	4,680	2,765	-23
AHU 2-10	Casino Floor NE	62,000	23,715	38,285	-45
AHU 2-11	Buffet	16,690	13,440	3,250	-11
AHU 2-12	Food Court	6,370	4,702	1,668	-15
AHU 2-13	Sports Book and Poker Room	29,500	11,121	18,379	-45
AHU 3-1	Executive and Corporate Offices Registration and Lobby	14,710	10,040	4,670	-19
AHU 3-2	Public Circulation, Lobby and Patisserie	13,700	12,736	964	-4
AHU 3-3	Offices, Money Cage, and Room Service	7,300	8,260	-960	6
AHU T1	Tower Restaurant/Kitchen	8,600	7,736	864	-5

7.0 Design Heating and Cooling Loads

Cooling loads were calculated in Mechanical Technical Report Two using Trane Trace. The results of this analysis can be seen in Table 4. The cooling and heating loads have been compared on a square footage basis using tons and MBH respectively. It is of interest and worth further analyzing in the future that the cooling loads were largely under-estimated by Trace; however the heating loads were, for the most part, over-estimated. It will be necessary to further analyze these discrepancies in the load estimates and subsequently the manner in which spaces were defined in Trace, before making any redesigns in future portions of this project.

Table 4

Load Calculations					
System	Output	Cooling ft^2/ton	Percent Different Cooling	Heating ft^2/MBH	Percent Different Heating
AHU-T1	TRACE	116.7	-7.3	33.8	4.7
	DESIGN	135.0		30.8	
AHU-1-1	TRACE	31.4	-10.5	8.0	0.9
	DESIGN	38.8		7.9	

Table 4 cont.

Load Calculations					
System	Output	Cooling ft^2/ton	Percent Different Cooling	Heating ft^2/MBH	Percent Different Heating
AHU-1-2	TRACE	201.9	-0.6	65.8	0.7
	DESIGN	204.3		64.9	
AHU-1-3	TRACE	155.8	4.5	36.5	17.0
	DESIGN	142.5		25.9	
AHU-1-4	TRACE	183.5	-14.7	38.3	10.1
	DESIGN	246.7		31.3	
AHU-1-5	TRACE	409.5	-9.7	129.6	3.2
	DESIGN	497.7		121.5	
AHU-1-6	TRACE	304.0	12.7	55.4	16.6
	DESIGN	235.6		39.6	
AHU-1-7	TRACE	170.8	-20.7	123.6	-0.8
	DESIGN	260.2		125.5	
AHU-1-8	TRACE	85.0	1.5	26.9	16.9
	DESIGN	82.4		19.1	
AHU-1-9	TRACE	431.1	-29.0	351.86	-25.6
	DESIGN	782.6		594.62	
AHU-1-10	TRACE	317.6	1.1	113.65	28.7
	DESIGN	310.6		63.01	
AHU-2-1	TRACE	109.1	-8.2	31.65	14.4
	DESIGN	128.6		23.67	
AHU-2-3	TRACE	143.6	-2.3	48.90	16.3
	DESIGN	150.4		35.18	
AHU-2-4	TRACE	104.9	9.1	17.52	11.7
	DESIGN	87.3		13.85	
AHU-2-5	TRACE	59.1	7.7	6.81	3.6
	DESIGN	50.6		6.33	
AHU-2-6	TRACE	48.2	-2.0	6.83	4.0
	DESIGN	50.1		6.31	
AHU-2-7	TRACE	12.9	-3.0	1.71	3.4
	DESIGN	13.7		1.60	
AHU-2-8	TRACE	47.7	-3.8	6.27	2.3
	DESIGN	51.5		5.99	
AHU-2-9	TRACE	226.6	-21.2	73.96	1.8
	DESIGN	348.8		71.28	
AHU-2-10	TRACE	33.5	-1.6	4.29	3.1
	DESIGN	34.6		4.03	
AHU-2-11	TRACE	87.4	-16.6	30.75	11.8
	DESIGN	122.2		24.27	
AHU-2-12	TRACE	152.5	1.9	28.62	9.4
	DESIGN	146.8		23.72	
AHU-2-13	TRACE	115.0	-7.7	23.12	8.1
	DESIGN	134.1		19.66	

Table 4 cont.

Load Calculations					
System	Output	Cooling ft^2/ton	Percent Different Cooling	Heating ft^2/MBH	Percent Different Heating
AHU-3-1	TRACE	126.0	-7.3	37.77	14.4
	DESIGN	145.7		28.27	
AHU-3-2	TRACE	44.5	-5.8	10.88	5.9
	DESIGN	49.9		9.67	
AHU-3-3	TRACE	294.3	-14.0	89.21	2.8
	DESIGN	389.7		84.32	
Building Summary	TRACE	154.3	-9.4	53.9	-2.8
	DESIGN	186.2		57.0	

Note: Negative percentages for cooling and heating indicate that the Trace value is smaller than the design value.

8.0 Utility Rates

Electricity is supplied to The M Resort from Nevada Power Company, natural gas is supplied from Southwest Gas Company and water is supplied from Las Vegas Valley Water District, the rates of each service are listed in Table 5.

Table 5

Electric Utility Rates (Nevada Power Company) Rate Structure LGS-3				
Period	Time	Service Charge Per month	Consumption Charge Per kW	Demand Charge Per kW
Summer On-Peak	1PM-7PM	$167.70 + $0.00627/kWh	$0.10034	$8.47
Summer Mid-Peak	10AM-1PM, 7PM-10PM		$0.08649	$0.63
Summer Off Peak	10PM-10AM		$0.06281	$0.50
All Other Periods	Winter (October-May)		$0.06281	$0.50
Natural Gas Utility Rates (Southwest Gas Corporation) Rate Structure SG-5L				
Period	Time	Service Charge Per month	Consumption Charge Per therm	Demand Charge Per therm
All Periods	All Times	$150.00	$1.1310	$0.00
Water Utility Rate (Las Vegas Valley Utility)				
Period	Time	Service Charge Per month	Cost per 1000 gallons	
All Periods	All Times	151.27	3.09	

9.0 Annual Energy Use

As calculated in Mechanical Technical Report Two, the overall cooling cost per square foot is $9.86. This value seems relatively high, however this is due in large part to the high demand charges for electricity during the peak cooling periods.
The results of the energy analysis completed in Mechanical Technical Report Two can be seen in Figures 4-7 below. The design team did not complete any type of in-depth energy analysis therefore there are no values to compare to the following numbers.

Upon review of the energy analysis breakdown shown in Figure 4, it is evident that something is not completely correct in the energy model. Receptacle loads are the highest percentage with lighting and cooling close behind. Heating, however, is only two percent of the energy use per year. There is a great deal of electric resistance heat in the building which should make this value rise, however temperatures do not get as low as in other parts of the country thus requiring less tempering. The yearly fan power is also low considering the quantity of fans throughout the building. Before any redesigns or alternatives are carried out it will be necessary to consult the design engineering team to determine any and all discrepancies.

The M Resort is currently in the construction phase with a completion time of March 2009. Therefore there is no operational history of the system nor are there any metered data to compare to the estimates. For now the energy estimates are the only source of data to be used in energy cost, therefore it is imperative that the model be carefully reviewed before any redesign is completed.

Figure 4

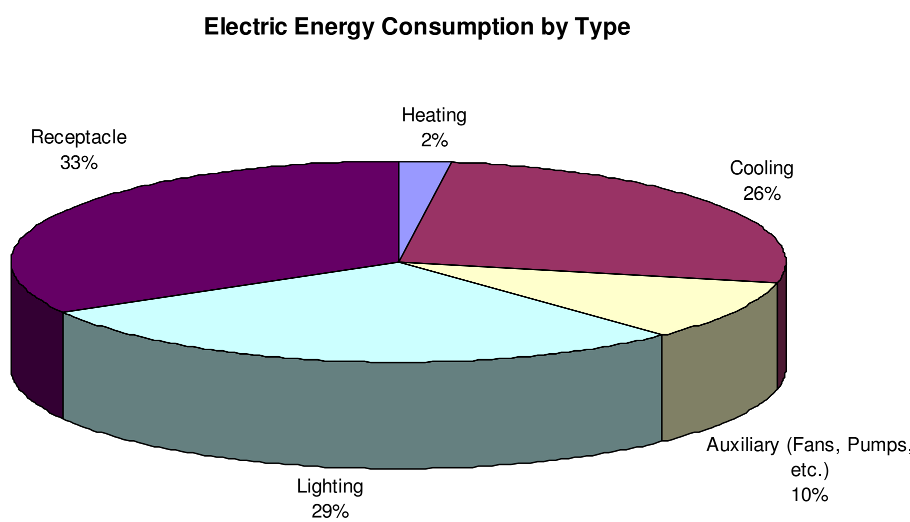


Figure 5

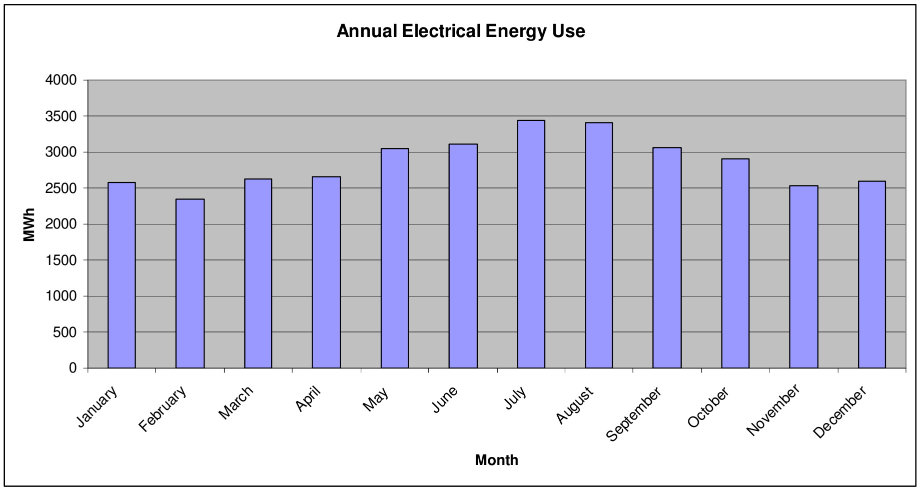


Figure 6

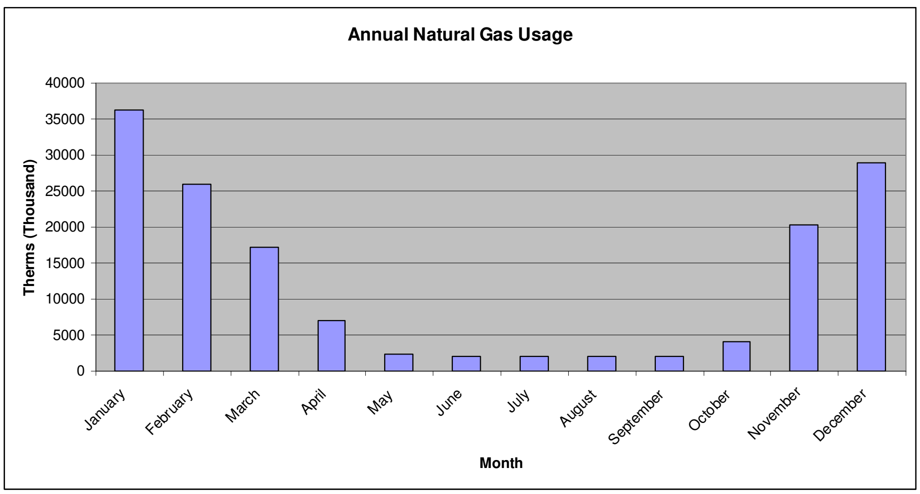
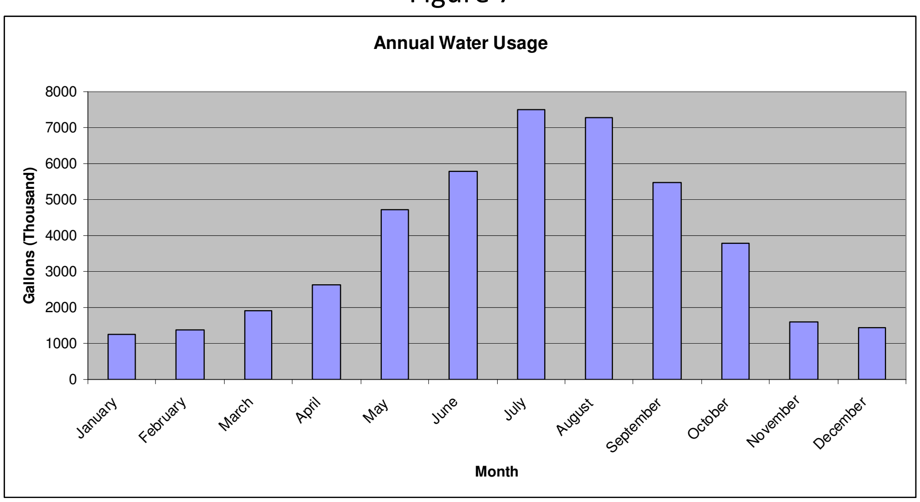


Figure 7



10.0 LEED NC Assessment

Leadership in Energy and Environmental Design Rating system, LEED, is a green building rating system that provides standards for environmentally sustainable construction. The M Resort was not designed according to any energy standards in addition to those required by code and sustainable design was not a requirement. Throughout the entire process of design and construction, the LEED NC rating system was not followed. There are principles of good design and construction that met some of the LEED points; however the M Resort was unable to attain any type of rating. Section 15.0 Appendix A is a breakdown of the M Resorts compliance with the LEED NC 2.2 rating system. The building was able to achieve 8 points with 15 in question. It should be noted that with incorporation from the beginning, a more points would be attainable although it would be difficult to attain certification based on the assessment completed in this report.

11.0 Mechanical System First Cost

The overall estimated cost of the M Resort is roughly $1 billion dollars. Of that price, approximately $29.9 million is HVAC costs and $22 million in plumbing costs along with a $2 million general conditions fee. Due to proprietary reasons the bidding documents could not be released, however Table 6 shows a general break down of the mechanical system cost based on the sections of the building, also included are the plumbing costs. The HVAC system cost per square foot was calculated as $32.47.

Table 6

Mechanical System First Cost	
Central Plant	
HVAC Cost	$5,275,254
Plumbing Cost	$1,198,047
Low Rise	
HVAC Cost	$20,850,428
Plumbing Cost	$13,539,352
Tower	
HVAC Cost	$3,819,232
Plumbing Cost	$7,289,150
General Condition for all work	$2,081,669
Total HVAC	$29,944,914
Total Plumbing	$22,026,549
Grand Total	$54,053,132
HVAC Cost per SF	$32.47
HVAC and Plumbing cost per SF	$58.62

12.0 Lost Rentable Space

Rentable space is one of the most valuable aspects of a commercial building. Therefore it is necessary for the entire design team and especially the mechanical designers to minimize their footprints while not compromising the functionality and serviceability of the equipment.

The mechanical system in the M Resort is designed to minimize the space used by the mechanical system. The air handling units are located on the low rise and tower roofs to eliminate the extra mechanical space that would be needed to locate them within the building. Also the fan coil units in the guest tower receive outside air from the integrated wall mullions which eliminate the extra ducts that would have had to be run otherwise.

The amount of lost space was determined by totaling the areas of all mechanical spaces and shafts. A total of 21,903 sq. ft of rentable space was lost due to the mechanical system, or roughly 2.4% of the building's total rentable space. It is important to note that the future expansion of the central utility plant is also included in this figure. A detailed breakdown of where this space was lost can be seen in Table 7.

Table 7

Lost Rentable Space Analysis			
Type	Room #	Space	Area (ft^2)
Room	1S118	Mechanical	120
Room	T1608	Mechanical	422
Room	S-149	CUP Control	180
Room	S-151	Central Plant	7098
Room	S-152	Boiler Room	3640
Room	S-540	Future Expansion	3588
Room	S-146	Fire Pumps	755
Room	S-144	Fire Control	330
Shaft	N/A	Low Rise Shafts	2160
Shaft	N/A	VFCUs	2640
Shaft	N/A	Guest Tower Shaft	970
		Lost Rentable space	21903
		Low-rise ft^2	569559
		High-rise ft^2	340614
		Total ft^2	910173
		Percentage Lost Rentable Space	2.4

13.0 Critique of System

The mechanical system employed in the M Resort has many good aspects. After reviewing the space types and demands of the system, the central plant design appears to be a quality design choice. The M Resort is in a warmer climate and has very high cooling loads, especially in the summer. Therefore it is more efficient to create a central plant that creates chilled water that is distributed to the various portions of the building. If every air handler had a direct expansion (DX) system with it, there would be a lot more equipment crowding up the low rise roof.

The guest tower would have to incorporate units that would have air cooled compressors vented to the outside. This could create an eye sore and destroy the owner's intention of a smooth glass façade. The integrated wall mullions that are used to attain outside air are a real innovation that totally disguises the intakes. Also, no other fan has to be added since the exhaust system negatively pressurizes the room to draw in the outside air.

A VAV system would not work well for the guest suites due to the amount of extra ductwork and piping that would have to be run. The vertical fan coil units are compact and effective at condition the space to specification. However the VAV system works well for the low rise portion because of the varying loads of the spaces.

The energy efficiency of the overall system seems to be something that was kept in mind but not fully realized in the design phases of the building due to the fast paced schedule. Picking energy efficient equipment is one way to attain efficiency however it is also important to look at the total system efficiency and how the equipment interacts together. It could be possible that the individual pieces are efficient, however when combined with everything else the results might point elsewhere. With today's energy prices, the efficiency of the building seems to be a great place to explore for the proposal.

14.0 References:

1. ASHRAE Handbook of Fundamentals 2005.
2. Trane Trace 700h.
3. Southland Industries, Mechanical Drawings and Specifications.
4. Mike Hallenbeck and Jessica Lucas Ben Johnson, Thesis Consultants, Southland Industries.
5. JBA Consulting Engineers, Electrical Drawings and Specifications.
6. Kimley-Horn and Associates, Civil Drawings and Specifications.
7. Marnell Architecture, Drawings and Specifications.
8. Tom Chirdon Technical Reports One and Two.
9. The Pennsylvania State University Architectural Engineering Program, Thesis Advisor, Dr. William P. Bahnfleth
10. Past Thesis Technical Reports, e-Studio Archives, 2006-2008

15.0 Appendix A

LEED for New Construction v 2.2
Registered Project Checklist

Project Name: M Resort Spa Casino

Project Address: Henderson, Nevada

Yes	?	No			
8	15	46	**Project Totals** (Pre-Certification Estimates)		69 Points
			Certified: 26-32 points **Silver**: 33-38 points **Gold**: 39-51 points **Platinum**: 52-69 points		

Yes	?	No			
2	6	6	**Sustainable Sites**		14 Points
Yes			Prereq 1	**Construction Activity Pollution Prevention**	Required
1			Credit 1	**Site Selection**	1
	1		Credit 2	**Development Density & Community Connectivity**	1
	1		Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel Efficient Vehicles	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
	1		Credit 5.1	**Site Development**, Protect or Restore Habitat	1
	1		Credit 5.2	**Site Development**, Maximize Open Space	1
	1		Credit 6.1	**Stormwater Design**, Quantity Control	1
		1	Credit 6.2	**Stormwater Design**, Quality Control	1
		1	Credit 7.1	**Heat Island Effect**, Non-Roof	1
		1	Credit 7.2	**Heat Island Effect**, Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
		5	**Water Efficiency**		5 Points
		1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
		1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

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LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No				
	1	16	**Energy & Atmosphere**			**17 Points**
Yes			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**		Required
Yes			Prereq 1	**Minimum Energy Performance**		Required
Yes			Prereq 1	**Fundamental Refrigerant Management**		Required

***Note for EAc1:** All LEED for New Construction projects registered after June 26, 2007 are required to achieve at least two (2) points.

Yes	?	No				
		10	Credit 1	**Optimize Energy Performance**		1 to 10
				Credit 1.1	10.5% New Buildings / 3.5% Existing Building Renovations	1
				Credit 1.2	14% New Buildings / 7% Existing Building Renovations	2
				Credit 1.3	17.5% New Buildings / 10.5% Existing Building Renovations	3
				Credit 1.4	21% New Buildings / 14% Existing Building Renovations	4
				Credit 1.5	24.5% New Buildings / 17.5% Existing Building Renovations	5
				Credit 1.6	28% New Buildings / 21% Existing Building Renovations	6
				Credit 1.7	31.5% New Buildings / 24.5% Existing Building Renovations	7
				Credit 1.8	35% New Buildings / 28% Existing Building Renovations	8
				Credit 1.9	38.5% New Buildings / 31.5% Existing Building Renovations	9
				Credit 1.10	42% New Buildings / 35% Existing Building Renovations	10
		3	Credit 2	**On-Site Renewable Energy**		1 to 3
				Credit 2.1	2.5% Renewable Energy	1
				Credit 2.2	7.5% Renewable Energy	2
				Credit 2.3	12.5% Renewable Energy	3
		1	Credit 3	**Enhanced Commissioning**		1
		1	Credit 4	**Enhanced Refrigerant Management**		1
	1		Credit 5	**Measurement & Verification**		1
		1	Credit 6	**Green Power**		1

LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No		Materials & Resources	13 Points
	3	10			
Yes			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse,** Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	**Building Reuse,** Maintain 95% of Existing Walls, Floors & Roof	1
		1	Credit 1.3	**Building Reuse,** Maintain 50% of Interior Non-Structural Elements	1
	1		Credit 2.1	**Construction Waste Management,** Divert 50% from Disposal	1
		1	Credit 2.2	**Construction Waste Management,** Divert 75% from Disposal	1
		1	Credit 3.1	**Materials Reuse,** 5%	1
		1	Credit 3.2	**Materials Reuse,** 10%	1
		1	Credit 4.1	**Recycled Content,** 10% (post-consumer + 1/2 pre-consumer)	1
		1	Credit 4.2	**Recycled Content,** 20% (post-consumer + 1/2 pre-consumer)	1
	1		Credit 5.1	**Regional Materials,** 10% Extracted, Processed & Manufactured	1
	1		Credit 5.2	**Regional Materials,** 20% Extracted, Processed & Manufactured	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Yes	?	No		Indoor Environmental Quality	15 Points
5	5	5			
Yes			Prereq 1	**Minimum IAQ Performance**	Required
Yes			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
1			Credit 1	**Outdoor Air Delivery Monitoring**	1
		1	Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan,** During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan,** Before Occupancy	1
	1		Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1
	1		Credit 4.2	**Low-Emitting Materials,** Paints & Coatings	1
	1		Credit 4.3	**Low-Emitting Materials,** Carpet Systems	1
		1	Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber Products	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
	1		Credit 6.1	**Controllability of Systems,** Lighting	1
1			Credit 6.2	**Controllability of Systems,** Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort,** Design	1
		1	Credit 7.2	**Thermal Comfort,** Verification	1
	1		Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1

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LEED for New Construction v 2.2
Registered Project Checklist

Yes	?	No			
1		4	**Innovation & Design Process**		**5 Points**
		1	Credit 1.1	**Innovation in Design:** Provide Specific Title	1
		1	Credit 1.2	**Innovation in Design:** Provide Specific Title	1
		1	Credit 1.3	**Innovation in Design:** Provide Specific Title	1
		1	Credit 1.4	**Innovation in Design:** Provide Specific Title	1
1			Credit 2	**LEED® Accredited Professional**	1

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Air Handling Unit Schedule																
				Cooling Coil						Heating Coil						
Equipment	Area Served	Supply CFM	Min OA CFM	MBH	EAT DB (°F)	LAT DB (°F)	Flow GPM	EWT (°F)	LWT (°F)	MBH	EAT DB (°F)	LAT DB (°F)	Flow GPM	EWT (°F)	LWT (°F)
AHU B-1	Wine Bar/ Kitchen	11,000	11,000	742.2	115.0	52.0	92.6	42.0	58.0	590.0	23.0	85.0	29.4	190.0	150.0
AHU 1-1	Chiller Room	23,000	4,300	857.0	86.8	52.0	106.8	42.0	58.0	352.0	61.3	76.6	17.6	190.0	150.0
AHU 1-2	Spa/Fitness Center	21,000	7,050	957.3	89.2	51.3	119.3	42.0	58.0	251.0	32.7	60.0	12.6	190.0	150.0
AHU 1-3	Promenade	38,000	18,525	1926.9	93.9	51.3	240.0	42.0	58.0	883.0	24.7	70.0	44.2	190.0	150.0
AHU 1-4	Meeting Rooms	29,000	19,735	1176.9	101.8	51.3	213.9	42.0	58.0	733.0	23.0	60.0	36.7	190.0	150.0
AHU 1-5	Back of House Offices	15,000	4,510	623.8	87.1	51.3	77.7	42.0	58.0	213.0	44.0	70.0	10.7	190.0	150.0
AHU 1-6	Main Kitchen Bakery EDR Kitchen	37,000	22,300	2116.2	99.0	51.3	263.6	42.0	58.0	1048.0	23.0	70.0	52.4	190.0	150.0
AHU 1-7	Promenade	19,000	3,560	683.4	82.6	51.3	85.2	42.0	58.0	118.0	41.2	60.0	5.9	190.0	150.0
AHU 1-8	Ballroom	63,000	31,850	3378.6	95.4	51.3	420.9	42.0	58.0	1214.0	23.0	60.0	60.7	190.0	150.0
AHU 1-9	Warehouse Facilities Offices	11,000	725	310.0	76.4	51.3	38.5	42.0	58.0	34.0	63.5	70.0	1.7	190.0	150.0
AHU 1-10	Back of House Offices	24,000	8,730	1041.6	89.1	51.3	129.8	42.0	58.0	428.0	33.8	70.0	21.4	190.0	150.0
AHU 1-11	Promenade	15,000	3,225	484.3	80.7	51.3	60.3	42.0	58.0	48.0	54.4	60.0	2.9	190.0	150.0
AHU 2-1	Steak/Seafood Restaurant and Kitchen	25,500	11,540	1496.2	103.3	52.0	186.4	42.0	58.0	677.0	23.0	60.0	33.9	190.0	150.0
AHU 2-3	Italian Restaurant and Kitchen	15,500	8,170	769.2	94.8	52.0	95.8	42.0	58.0	274.0	23.0	60.0	13.7	190.0	150.0
AHU 2-4	Entertainment and High Limit Salon	27,000	17,660	1395.0	97.3	52.0	173.8	42.0	58.0	733.0	23.0	70.0	36.7	190.0	150.0
AHU 2-5	Casino Floor SW	50,000	50,000	3531.3	115.0	52.0	440.0	42.0	58.0	2350.0	23.0	70.0	117.5	190.0	150.0
AHU 2-6	Casino Floor SE	55,000	55,000	3904.4	115.0	52.0	486.8	42.0	58.0	2585.0	23.0	70.0	129.3	190.0	150.0
AHU 2-7	Casino Floor NW	62,000	62,000	4388.4	115.0	52.0	546.7	42.0	58.0	2820.0	23.0	70.0	141.0	190.0	150.0
AHU 2-8	Casino Floor N	62,000	62,000	4388.4	115.0	52.0	546.7	42.0	58.0	2820.0	23.0	70.0	141.0	190.0	150.0
AHU 2-9	Café and Grille	13,000	7,445	743.4	100.9	52.0	92.6	42.0	58.0	303.0	23.0	60.0	15.2	190.0	150.0

Air Handling Unit Schedule Cont.																
Equipment	Area Served	Supply CFM	Min OA CFM	Cooling Coil						Heating Coil					
				MBH	EAT DB (°F)	LAT DB (°F)	Flow GPM	EWT (°F)	LWT (°F)	MBH	EAT DB (°F)	LAT DB (°F)	Flow GPM	EWT (°F)	LWT (°F)
AHU 2-10	Casino Floor NE	62,000	62,000	4388.4	115.0	52.0	546.7	42.0	58.0	2820.0	23.0	70.0	141.0	190.0	150.0
AHU 2-11	Buffet	38,000	16,690	1886.6	93.7	52.0	253.0	42.0	58.0	791.0	27.9	70.0	39.6	190.0	150.0
AHU 2-12	Food Court	16,000	6,370	828.3	96.6	52.0	103.2	42.0	58.0	427.0	26.0	70.0	21.4	190.0	150.0
AHU 2-13	Sports Book and Poker Room	29,500	29,500	1720.2	102.8	52.0	214.3	42.0	58.0	978.0	23.0	70.0	48.9	190.0	150.0
AHU 3-1	Executive and Corporate Offices Registration and Lobby	42,000	14,710	1746.2	90.3	52.0	217.5	42.0	58.0	750.0	34.0	70.0	37.5	190.0	150.0
AHU 3-2	Public Circulation, Lobby and Patisserie	36,000	13,700	1747.1	93.2	52.0	217.6	42.0	58.0	752.0	25.5	70.0	37.6	190.0	150.0
AHU 3-3	Offices, Money Cage, and Room Service	24,000	7,300	1023.8	89.1	52.0	127.6	42.0	58.0	394.0	28.5	70.0	19.7	190.0	150.0
AHU T1	Tower Restaurant/Kitchen	16,000	8,600	870.0	100.0	52.0	108.9	42.0	58.0	318.0	23.0	60.0	15.9	190.0	150.0

Makeup Air Unit Schedule												
		Cooling Coil						Heating Coil				
Mark	Supply CFM	MBH	EAT DB (°F)	LAT DB (°F)	Flow GPM	EWT (°F)	LWT (°F)	MBH	Flow GPM	EWT (°F)	LWT (°F)
MAU-1	7,000	382	115.0	52.0	47.8	42.0	58.0	343	17.5	190.0	150.0
MAU-2	12,500	639	115.0	52.0	79.9	42.0	58.0	574	28.7	190.0	150.0
MAU-3	10,400	655	115.0	52.0	81.8	42.0	58.0	588	29.4	190.0	150.0
MAU-4	6,250	314	115.0	52.0	39.3	42.0	58.0	282	14.1	190.0	150.0
MAU-5	6,900	304	115.0	52.0	38.0	42.0	58.0	273	23.7	190.0	150.0
MAU-6	7,200	498	115.0	52.0	62.2	42.0	58.0	447	22.4	190.0	150.0
MAU-7	3,550	241	115.0	52.0	30.1	42.0	58.0	216	10.8	190.0	150.0
MAU-9	8,550	398	115.0	52.0	49.8	42.0	58.0	357	17.9	190.0	150.0
MAU-10	7,800	456	115.0	52.0	57.0	42.0	58.0	409	20.5	190.0	150.0
MAU-11	4,250	230	115.0	52.0	28.8	42.0	58.0	207	10.4	190.0	150.0
MAU-12	15,000	1,026	115.0	52.0	128.3	42.0	58.0	921	46.1	190.0	150.0
MAU-13	6,200	450	115.0	52.0	56.3	42.0	58.0	404	20.2	190.0	150.0
MAU-14	3,350	121	115.0	52.0	17.7	42.0	58.0	127	6.4	190.0	150.0
MAU-15	4,700	304	115.0	52.0	38.0	42.0	58.0	273	13.7	190.0	150.0

Chiller Schedule																
Mark	Type	Capacity	kW/ton	Refrigerant	Refrigerant Quantity	Evaporator				Condenser				Electrical Data	
						Fluid Type	Flow	EWT	LWT	Fluid Type	Flow	EWT	LWT	kW	Voltage
		Tons			LBS		GPM	°F	°F		GPM	°F	°F	796	460-3-60
CH-1	Centrifugal	1300	0.609	R-123	1850	Water	1940	58.0	42.0	Water	3060	85.0	97.0	797	460-3-60
CH-2	Centrifugal	1300	0.609	R-123	1850	Water	1940	58.0	42.0	Water	3060	85.0	97.0	798	460-3-60
CH-3	Centrifugal	1300	0.609	R-123	1850	Water	1940	58.0	42.0	Water	3060	85.0	97.0	799	460-3-60

Cooling Tower Schedule								
Mark	Type	Capacity	Ambient WB	Flow	EWT	LWT	Electrical Data	
		MBH	°F	GPM	°F	°F	HP	Voltage
CT-1	Induced Draft Cross flow	19,980	78	3,060	97.0	85.0	75.0	460-3-60
CT-2	Induced Draft Cross flow	19,980	78	3,060	97.0	85.0	75.0	460-3-60
CT-3	Induced Draft Cross flow	19,980	78	3,060	97.0	85.0	75.0	460-3-60

Pump Schedule								
Mark	Number	Type	Flow	Efficiency	TDH FT WC	RPM	BHP	HP
CHWP-1	4	Vertical Inline Centrifugal	1940.0	78.9	160.0	1780	99.29	125
CWP-1	4	Vertical Inline Centrifugal	3060.0	87.0	75.0	1180	66.61	75
PHWP-1	4	Vertical Inline Centrifugal	670.0	71.0	35.0	1750	8.01	10
SHWP-1	4	Vertical Inline Centrifugal	670.0	71.4	130.0	1760	27.02	40
SCHWP-1	6	Vertical Inline Centrifugal	20.0	31.0	40.0	1750	0.65	1

Boiler Schedule									
Mark	Type	Capacity		HP	Flow	EWT	LWT	Fuel Type	Fuel Flow
		Output MBH	Input MBH			°F	°F		CFH
HWB-1	Wet-Back Fire tube	13,390	16,800	400	670	150.0	190.0	Natural Gas	16,800
HWB-2	Wet-Back Fire tube	13,390	16,800	400	670	150.0	190.0	Natural Gas	16,800
HWB-3	Wet-Back Fire tube	13,390	16,800	400	670	150.0	190.0	Natural Gas	16,800

Steam Boiler Schedule										
Mark	Type	Capacity		HP	Flow (GPM)	Operating Pressure	Rated Pressure	Fuel Type	Fuel Flow
		Output	Input						
		MBH	MBH			psig	psig		CFH
SB-1	Wet back Fire tube	2,678	3,360	80	3,360	80	150	Natural Gas	3,360
SB-2	Wet back Fire tube	2,678	3,360	80	3,360	80	150	Natural Gas	3,360