Technical Report 2

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Lighting/Electrical

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University of California, Riverside Student Recreation Center

Riverside, CA

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Executive Summary

The University of California, Riverside Student Recreation Center (UCR Recreation Center) is currently undergoing a renovation and expansion that will provide the university with a larger work out facility, more offices, a pool, additional locker rooms and another gymnasium. To supply both buildings with power, the existing electrical system needed to be expanded upon. The majority of the loads in the existing building remained on the existing switchboards and the new loads from the addition were placed on the new switchboards.

This report contains three main sections: Development of Electrical System, Currently Designed Electrical System, and Evaluation of Currently Designed System. In the Development of Electrical System section there is first an estimate of the building's kilowatt load. This square foot estimate yielded an estimated load of about 1240 kW. This section also describes decisions about rate schedules, utilization voltages, equipment and other systems needing to be integrated with the electrical system. The Currently Designed Electrical System contains information about how the electrical system is currently designed and its equipment. The actual connected load for the building, 912 kVA, is slightly below the estimated value. Finally, the Evaluation of Currently Designed System describes changes that could be made to the system that could either save on cost, or simply just change the design of the system.

Contents

Building Overview

Location: Riverside, CA

Building Occupant Name: University of California, Riverside

Occupancy or Function Types: A-3 Recreation Center

Size: 15,984 SF Renovation, 79,936 SF Addition

Stories Above Grade: Two

Dates of Construction: August 2012 to January 2014

Building Cost: $36.9 Million including construction costs

Project Delivery Method: Design-Bid-Build

Development of Electrical System

The simplest way to estimate the initial electrical load for the building at the beginning of the design phase is to use a watt per square foot analysis. This analysis must account for lighting, mechanical and other electrical loads in the building. A table summarizing estimated watt per square foot values and a total power density value for the building can be seen below. The UCR Recreation Center renovation and expansion is 95,380 square feet.

Type	Power Density (W/SF)	Load (kW)
Lighting	2	190.76
Mechanical	10	953.80
Other Equipment	1	95.38
Total	**13**	**1239.94**

Electrical Service

The University of California, Riverside buys electricity from the Riverside Utility Company at sixty-six kilovolts. These feeders go to different substations around campus, where electricity is then distributed to individual buildings at twelve kilovolts. Based on these voltage selections the University should use the contract service rate schedule. This rate schedule is offered to customers with demand in excess of 500 kilowatts per month and rates vary on the contract with each client. A copy of the contract service rate schedule can be found in Appendix A.

Electrical System

To initially design the electrical system for the building, a priority assessment should be done so it can be determined what is most important to the system and what can be compromised if needed. A priority analysis of the electrical system can be seen in the table below.

Category	Priority
Power Quality	Medium
Reliability	Medium
Redundancy	Medium
Flexibility	High
Initial Cost	Low
Long Term Ownership Cost	High

Flexibility and long term ownership cost are the most important to the building because the building is going to be a part of campus for a long time and the University would like to pay as little as possible to maintain the electrical system. It is also important for the system to be flexible because it is important to keep the building running during testing or maintenance. Power quality, reliability and redundancy are on the next priority level. This is because there are some data racks to serve the offices in the building and if they or the offices themselves lose power, university employees will be unable to get work done. This is not the most crucial portion of the university's data system because it only serves this building, so it is not a very high priority. Lastly, initial cost is low simply because if high priority is placed on long term ownership cost, the university will have to pay more up front.

Because the building is so large and has many different pieces of equipment, it is important to select the appropriate voltages to reduce the amount of raceway and wire used. The lighting should mainly be operated at 277 volts except for fixtures that must be operated at 120 volts. Any mechanical and HVAC motors, along with the building elevators, should be run at 480 volts. Receptacles must be run at 120 volts. The major pieces of equipment that will be powering and controlling this equipment are transformers, switchgear/switchboards, a generator, automatic transfer switches, and possibly uninterruptible power supplies. This equipment will all need to be located in or around the building.

Code Requirements

This building does not does not have any special occupancy requirements based on the National Electric code, but the building does have elevators and a swimming pool which will require special design considerations. The International Building Code requires the building to have egress illumination and exit signs on emergency power, as well as elevators and a smoke control system on standby power. In addition to these general requirements, the building is required to have automatic a fire detection system, a fire alarm system and an emergency voice/alarm communications system because it is considered a special amusement building. Additional loads that should be considered to use optional backup power are some of the mechanical equipment and some of the exercise equipment. The mechanical equipment would help to ventilate and cool the building filled with exercising people while the providing additional power to the exercise equipment would prevent injury for someone running on a treadmill, for example.

Other Systems

The UCR Recreation Center will also require other systems that will be required to be integrated with the electrical distribution system. A telephone and data system will be required to provide telephone and internet access to the offices, classrooms and desk stations in the building. Along with this system, cable television service should be provided so patrons exercising can watch television as they exercise. A security system for the building should also be installed to monitor the building and the surrounding area.

Currently Designed Electrical System

The current electrical system for the UCR Recreation Center uses two new switchboards along with the two existing switchboards to power all of the equipment in the building. A load summary for the building can be found in the table below. A complete riser diagram for the building can be found in Appendix B.

Type	Load (kVA)
Lighting	199.60
Receptacles	42.50
Mechanical	326.73
Miscellaneous/General	298.50
Elevator	44.87
Total	**912.20**

Electrical Service

The University of California Riverside buys electricity from the Riverside Utility Company on a contract service rate schedule at sixty-six kilovolts. Under this rate schedule the utility and the customer form a contract and the rates vary by contract. A copy of the contract service rate schedule can be found in Appendix A

Electrical System

The electrical system for the building uses 480/277 volt switchgear and 208/120 volt switchgear to power all of the equipment in the building. The majority of the lighting is powered at 277 volts. The only two fixtures that are powered at 120 volts are the luminaire in the elevator shaft and the LED task lights at the work stations around the building. Receptacles are supplied 120 volts. The mechanical system uses a variety of voltages depending on the size and type of equipment. All of the air handling units and pumps use 480 volts. Exhaust fans that are above half a horsepower also use 480 volts while exhaust fans of half a horsepower and under use 120 volts. The fan coil units all use 208 volts and the control valves use either 120 volts or 24 volts. The elevators in the building both use 480 volts while the 120 volt switchboard serves the miscellaneous loads such as data racks, kitchen equipment and hand dryers in the restrooms. The emergency power system is a 480/277 volt system powered by a bank of batteries that also has a connection for a portable generator. The only pieces of equipment on the emergency power system are the emergency lighting and one of the air handling units. Their loads are summarized in the table below. The system currently does not support any

Equipment	Load (kVA)
AHU-3	34.97
Lighting	20.83
Total	55.80

There are no special occupancy requirements for the building but there are elevators and a pool which require special design considerations. The building does not use any energy reduction equipment or strategies such as photovoltaic panels or cogeneration.

Electrical Equipment

The UCR Recreation Center's electrical system has specific requirements for each piece of equipment based on voltage and location, among other factors. A summary of equipment and requirements can be found below.

Switchboard

The new system is designed in the same way as the existing system, with one 480/277 volt switchboard and one 208/120 volt switchboard. Panelboards are fed from the switchboards and the building loads are fed from the panelboards. These switchboards are located in the main electrical room of the addition and are single ended.

Main Service Transformers

There are two main service transformers located outside the building that step the voltage down from twelve kilovolts to either 480/277 or 208/120, depending on which switchboard they are serving. These are pad mounted, liquid type transformers.

Distribution Step-down Transformers

One dry type transformer is used to step the voltage down from 480/277 to 208/120 between two panelboards. This transformer is located inside the building.

Panelboards

The UCR Recreation Center uses a combination of panelboards with a main circuit breaker and panelboards with main lugs only. However, all of the panelboards used are bolt in type with copper a bus. All panelboards are to have a NEMA 1 enclosure except where specified differently on the drawings.

Main Risers and Feeders

All medium and low voltage main risers and feeders are copper conductors in conduit.

Conductors

Conductors are made of copper.

Conduit

The building uses multiple different types of conduit, such as rigid galvanized steel conduit (GMS), electrical metallic tubing (EMT), rigid nonmetallic conduit (RNC), flexible metal conduit and liquid tight flexible metal conduit.

Receptacles

All standard receptacles are commercial spec grade and all standard ground fault interrupting receptacles are premium specification grade with LED protection assurance.

Switch and Receptacle Faceplates

Standard faceplates should be nylon and match the wiring device unless otherwise specified. The standard color for wiring devices is white but all color selections must be verified with the architect.

Motor Starters

Each of the motors is started by an individual motor controller. Many motors use variable speed drives to reduce the energy consumption of the building.

Uninterruptible Power Supply

There is no universal power supply for this system.

All of the switchboards, step-down transformers, panelboards and data racks are located in 971 square feet of electrical and data rooms, which make up about one percent of the building’s area.

Other Systems

Other systems in the building that will need to be integrated with the electrical system include telephone and data, cable television, fire alarm, and security. The security system consists mostly of video surveillance. This system is also tied into the fire alarm system.

Evaluation of Currently Designed System

The actual connected load for the UCR Recreation Center is slightly lower than the load estimated by the watt per square foot analysis. This is most likely because the two existing air handling units are simply receiving larger supply and exhaust fans. These units will serve part of the expansion but will still run off of the existing electrical system. Based on the rate schedules given by the utility company, there would not be any advantage to changing rate schedules.

Electrical System

One aspect of the electrical distribution system that could possibly be changed is to see if any of the mechanical equipment could be run at a higher voltage. There is a lot of mechanical equipment that is run at either 208 volts or 120 volts. The load on the 208/120 volt switchboard could be reduced if these loads could be moved over to the 480/277 volt switchboard. This would reduce the amps used by the system and could possibly reduce panelboard sizes as well. Another area that could be redesigned is the step down transformer that is used. This transformer is used because the voltage for the equipment for the pool in the pump room varies between 480/277 and 208/120. For this transformer to be removed it would have to be less expensive to bring a feeder from the 208/120 switchboard to the pump room than to purchase an extra transformer. This would have the advantage of separating the equipment from each other so that if one feeder goes down the other equipment will still function. However, this will also mean that you could have problems with both feeders and have to dig up each feeder if they both have problems.

Emergency Power System

The only difference between identified code requirements and currently designed conditions is that there is no separation of the standby power for the smoke control system and elevators, and the emergency power system for exit signs and egress lighting. There does not seem to be standby power provided to these systems at all. This could be changed in the electrical system design but it would require another automatic transfer switch. If more loads are going to be backed up on emergency or standby power, a generator might be a better option than a bank of batteries. This would have to be analyzed based on initial cost, whether the current battery bank would have to be expanded, maintenance cost for both options and lifetime of each system. If a generator were selected, it would require additional space inside or outside the building.

Electrical Equipment

Based on the priority assessment previously performed, the one of the changes that could be made to the electrical system is to change all of the wires and bus bars from copper to aluminum. This could be done by performing a cost analysis based on initial cost, lifetime, and building efficiency. As previously stated it may also be possible to eliminate the step-down transformer from the system completely. An uninterruptible power supply could also be added to the system if some loads were chosen to be supplied with optional back-up power.

Optional Power System

None of the loads on the current system use optional back-up power so this would be something that would need to be analyzed. Most of the analysis would be how much the addition to the system would cost. The cost of the system would include a power source, an additional automatic transfer switch and possibly an uninterruptible power supply. Whether or not the system should be implemented would have to do with the benefits of the system and how frequently it might be used.

Potential Systems Integration

One way that the building could reduce energy would be to integrate the lighting control system and the mechanical control system. If these systems were integrated the daylight sensors and occupancy sensors could send information to the mechanical control system telling it what rooms are in use and how much daylight is in spaces. This could help the mechanical system control the amount of air brought to spaces through the use of variable frequency drives. The electrical system would have to account for these changes in speed from the VSDs which will create noise in the electrical system.

Reduced Cost of Ownership

There is not much room to reduce cost of ownership by increasing the quality of the equipment used because it is already high quality. The transformers, for example, have over 90% efficiency so upgrading to another transformer would not make much of a difference. Therefore cost would mainly be saved by reducing electricity and overall energy consumption. This could be done with photovoltaic arrays, fuel cells or cogeneration. If fuel cells were chosen to be an alternate fuel source the building would then have special occupancy requirements for hazardous areas because hydrogen is flammable. Whether or not any of these strategies would make sense would depend on the electricity rate, what peak demand is, and any grants and/or refunds that could possibly be obtained for these systems.

Appendix A

Appendix B