Lindsay Frederick

Lighting + Electrical

Ron Dodson | Faculty Advisor

Native American Cultural Center | Arizona

Technical Report 2

Executive Summary

The Native American Cultural Center in Arizona is a 48,000 sf facility created for tribe members and visitors to learn about the culture and heritage of the Arizona tribe. The electrical design is based on cost-savings and efficiency.

The following report determines the criteria for the electrical system, examines the existing design, and explores alternative solutions.

The nature of its function as a cultural center determined the criteria. The Cultural Center has short and specific operating hours of occupancy. It contains no important data or data storage and no important special equipment that relates to life-safety. The engineers at SmithGroupJJR created a practical design that meets code and is sensitive to both initial costs and long term costs.

The analysis determined that, even with the other options available, the design from SmithGroupJJR is the best alternative for the Tribe.

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Electrical Systems Criteria

Electrical Load Estimate

Assume the following load approximations:

Lighting: 3 W/sf
Receptacles: 1 W/sf
HVAC: 5 W/sf

The resulting energy use would be

Lighting: 145800 VA
Receptacles: 48600 VA
HVAC: 243000 VA.

There is no special equipment to take into consideration.

Demand Factors are as follows:

Lighting: 125%
Receptacles: First 10kVA 100%, Remainder 50%
Mechanical/Other: 100%

Arizona Public Service Rate Schedule[1]

The Cultural Center should have a secondary service from the power company. For a facility this small, it would make the most sense for the power company to own the transformer. Additionally, the service should be provided at 277/480V to support the larger mechanical equipment and allow for smaller currents corresponding with the lighting.

General Service (metered kW demand)

Basic Service Charge:	$1.068 per day
Bundled Package Demand Charge:	$21.149 per kW for the first 100 kW, plus $14.267 per kW for all additional kW

[1] Arizona Public Service <http://www.aps.com/main/services/business/rates/>

Building Utilization Voltages

Service Entrance: 277/480V

- Lighting – 277V
- Receptacle – 120V
- Mechanical –208V or 480V
- Special Equipment – Elevator: 480V

Emergency Power Requirements

IBC

Smoke Control Systems: Smoke Control Systems must have two sources of power: the normal building power and the second approved standby by ICC Electrical Code.

Emergency Lighting: Aisles and egress require automatic illumination in the event of a power outage that lasts greater than or equal to 90 minutes and provides at least 1fc with a uniformity ratio of 40 to 1.

Elevators: "Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power[2]."

NEC

Emergency power is required for systems that are essential for life safety. The capacity must be adequate for all loads to be operated simultaneously. Wiring for emergency circuits must be kept independently of other wiring, i.e. in different conduit.

Emergency power source must take occupancy and type of service into consideration. These sources include batteries, generators, uninterruptable power supplies, separate service, fuel cell system, and unit equipment. I would recommend the use of a battery source system because it is a low initial cost and because fire alarms and emergency lighting are the only necessary items for life safety in this facility.

Emergency Lighting accounts for approximately 18000 VA. The elevator adds 13815 VA. Assuming another 20000 VA for Security and Fire Alarm systems, back-up power would need to support 60kVA at a voltage of 277/480V.

Special Occupancy Requirements

There are no special occupancy requirements for the Native American Cultural Center.

[2] IBC 2006 3003.1.2

Special Equipment

There should be an elevator in the cultural center to move individuals to and from the ground floor to the lower level.

Priority List for Electrical System Design

Reliability - Medium
Power Quality - Low
Redundancy - Low
Initial Cost - High
Long term ownership cost - Medium
Flexibility - High

Loads with Optional Back-up Power

Access Control – Card readers
Security System

Special/Communications Building Systems

Telephone/data
Fire Alarm – IBC requirements listed on page 6
CATV
Access Control – Card swipes
Security – Intrusion and Video Surveillance

Special/Communications Service to Building

Telephone
Data
CATV

Major Equipment needed

Space will be needed for the switchboard. There is no need for a generator, meaning no need for extra space. The rest of the equipment is small enough that it doesn't require a significant amount of extra space.

Existing Electrical System Analysis

Electrical Loads

Mechanical Systems	422011 VA
Panelboards	757209 VA

Panelboard	Connected Load (VA)	Estimated Demand Load (VA)
BHA	245293	235940
1HA	68247	58194
1HB	215562	191717
1LK	37800	37800
1LK2	12600	12600
1LB1	95624	67053
1LB2	45116	34551
1LB3	15498	14153
BLA1	54180	43236
BLA2	7680	7680
BLA3	3177	3177
1LA1	44990	31585
1LA2	20560	16835
1LA3	2230	2688

Connected Building Loads

- Lighting: 65249 VA
- Receptacle: 351704 VA
- Mechanical: 299254 VA
- Special Equipment: n/a
- Total: 678681 VA

Existing Electrical Rate Schedule and Service Voltage

General Service (metered kW demand)
Basic Service Charge: $1.068 per day
Bundled Package Demand Charge: $21.149 per kW for the first 100 kW, plus
$14.267 per kW for all additional kW

Existing Building Utilization Voltage

The existing design utilizes 277/480V for the lighting system and the majority of the mechanical system. Receptacles and select mechanical equipment uses 120/208V.

By operating the lighting on the higher voltage, the lighting will draw less current and reducing the operating cost.

Existing Emergency Power

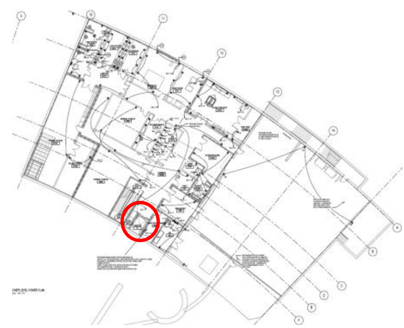
There is no emergency power generation for the Cultural Center. The lighting is powered by batteries in case of an emergency.

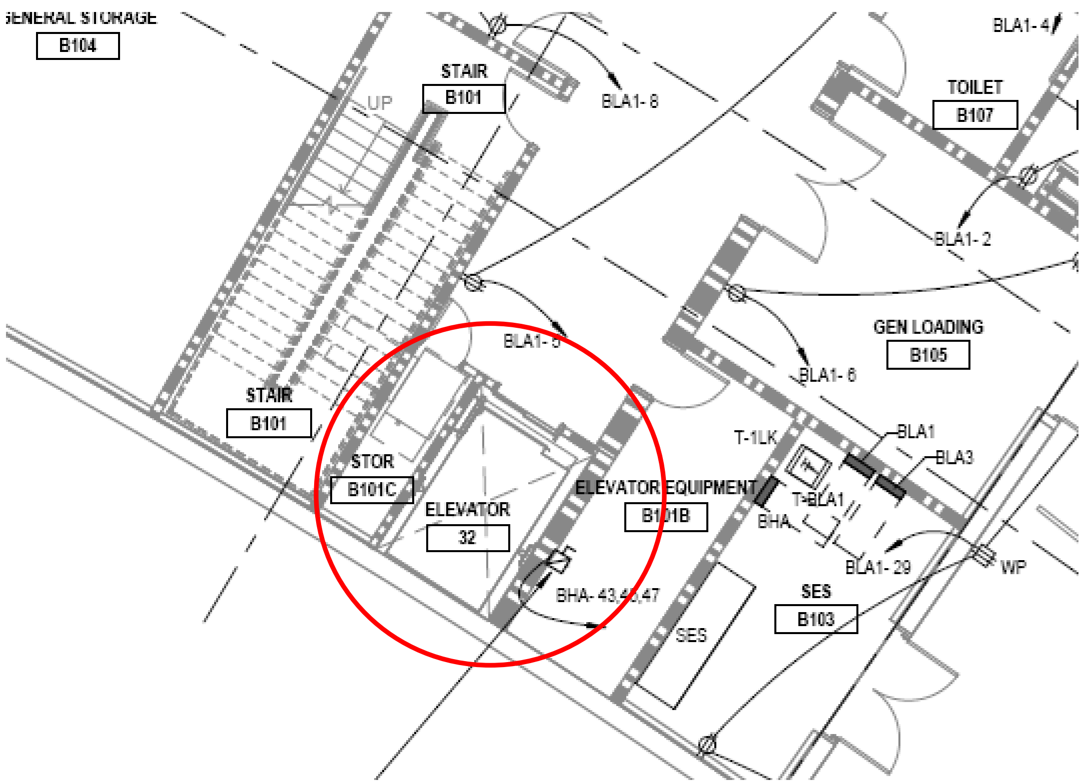
Special Occupancy Requirements

There are no special occupancy requirements.

Special Equipment

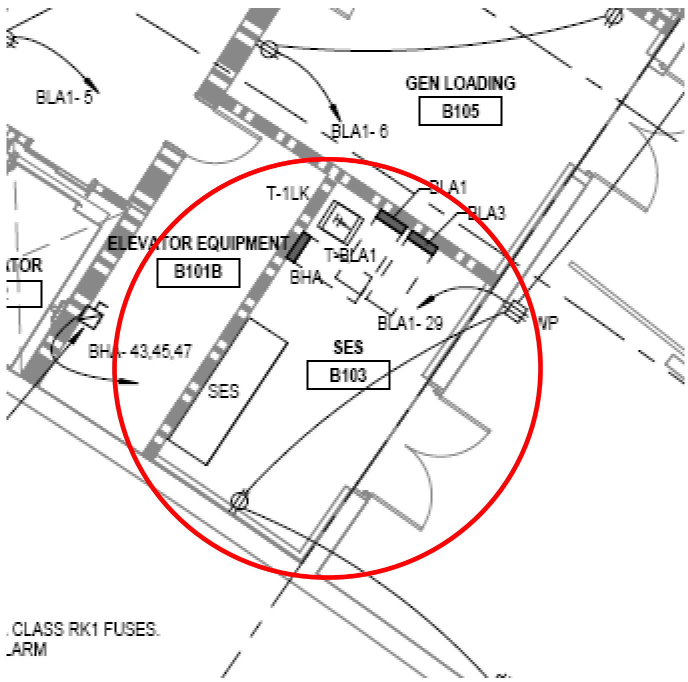
There is an Elevator from the ground to lower level of the cultural center.





Existing Electrical Equipment

The **main service** is a single ended system with a1200A, 277/480V, 3 phase – 4 wire switchboard. The switchboard is a steel, NEMA 250, Type 1 enclosure and contains a IEEE C62.41-compliant surge protection device. It is located in the lower level "SES" room.



The **main transformer** is outdoor, liquid-type, and utility-owned by the Arizona Public Service.

There are 5 **step down transformers**, 3 – 75kVA and 2 – 112.5kVA, that connect to the panelboards with receptacle loads. They are NEMA 250, Type 2 with copper coils. The transformers are a NEMA TP-1 efficiency.

The **panelboards** are MLO, NEMA 250, Type 1, copper. They utilize molded-case circuit breakers with mechanical type lugs.

There are three **distribution panels** fed from the switchboard. The **feeder** for each is 2 sets of 4#3/0 + 1#3 ground in two 2" EMT conduit.

Conductors are copper and comply with NEMA WC 70. Conductor insulation complies with NEMA WC 70 for types THHN=THWN and XHHW.

The **conduit** is rigid steel where it is exposed and EMT where it is concealed.

Receptacles are either straight blade 5-20R or GFCI straight blade, class A with indicator light.

Switch and receptacle faceplates are smooth, high-impact thermoplastic with metal plate-securing screws that color-match the faceplate.

The **motor starters** are individual starters for multispeed motors.

There is no existing **UPS** for this system.

Existing Loads on Optional Back-up Power

There is no emergency back-up power for optional systems. The only back-up power for the whole building is with the emergency lighting which utilizes battery power.

Special/Communications Systems

Telephone/data

There is a Main Distribution Frame on the lower level of the Cultural Center for the telecommunications system. Four electrical conduits run under the building out to a 4'x4'x4' Telecommunications vault to the east of the building. The vault is provided service via six – 4" electrical conduit stemming from the service telecom vault to the north. Additionally, six – 4" electrical conduit lead out of the vault to an existing casino telecom vault to the south.The rack is then connected to the appropriate panelboard.

Fire alarm

Each space in the cultural center has at least one fire alarm horn and strobe. Smoke detectors are in the transition spaces.

CATV

There is CATV cable running from the telecommunications rack throughout the building.

Security – Intrusion Detection, Video Surveillance

There is one fixed security camera for each section of parking lot (2). Three security cameras capable of rotating 180 degrees protect the main entry area. The conduits for the exterior cameras route back to MDF B106 on the lower level.

Other

There is power fed to the door operators for ADA access.

The drawings do not indicate that any of these systems are integrated, nor are there demand management systems in place.

Square footage of Electrical and Communications Spaces

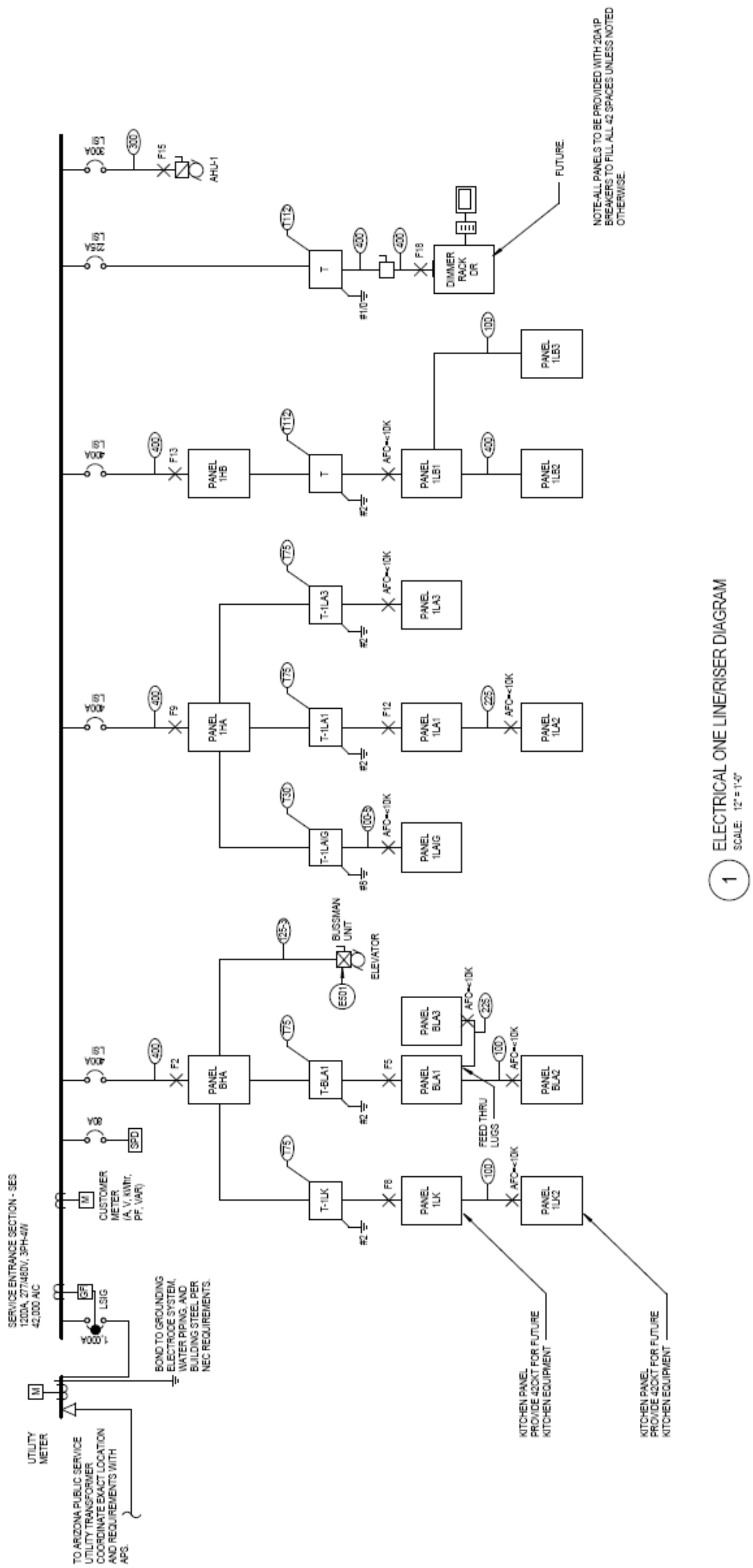
Five rooms totaling in 653sf of 48,600sf total building. This means that the electrical and communications rooms make up 1.34% of the total building square footage.

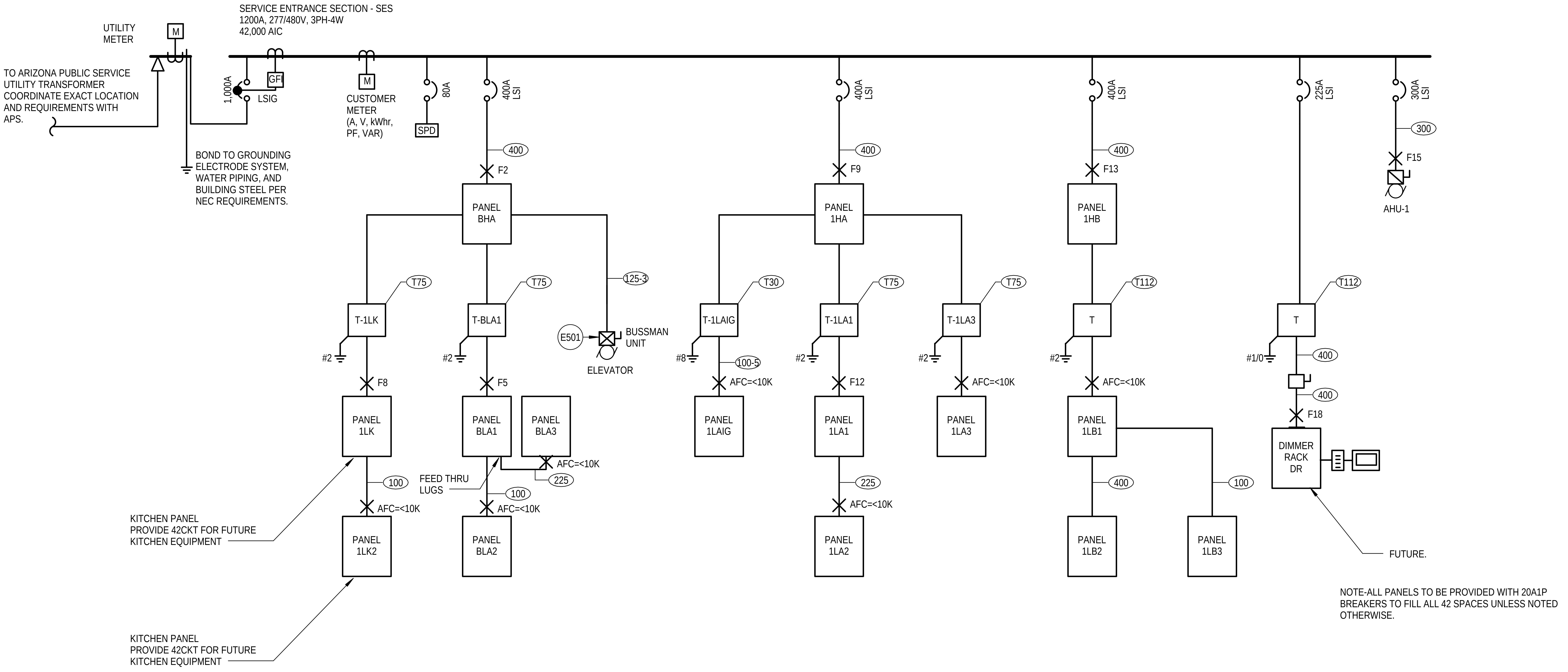
Energy Cost Savings/Energy Reduction Techniques

The building is not LEED certified, but due to the location in Arizona and the state's dark sky ordinances, the Native American Cultural Center employs curfews to turn off the exterior lighting.

Electrical One Line Diagram

Not to scale. Provided by SmithGroupJJR.





1 ELECTRICAL ONE LINE/RISER DIAGRAM

SCALE: 12" = 1'-0"

Existing Electrical System Evaluation and Potential Changes

Comparison of Estimated vs. Actual Connected Building Loads

	Estimated Loads (VA)	Actual Loads (VA)
Lighting	145,800	65,249
Receptacles	48,600	351,704
Mechanical	243,000	299,254

The estimates were based on averages for commercial buildings. In this case, the cultural center incorporates LED technology which reduces the watts consumed. The receptacle loads were greatly under-estimated, which could be due to the fact that there are many receptacles in each room, i.e. more than a normal office building. The mechanical estimate is relatively similar to the actual connected load.

Power Company Rate Schedule

Arizona Public Service is the only electric provider in the area. The voltage provided by APS is 277/480V which is necessary to provide power to the HVAC units; therefore, I wouldn't suggest a change there. The rate schedule is based on the building system's capacity and therefore the rate cannot vary from the existing rates.

Note that there are advantages to a 120/208V system, in that there would be no need for step-down transformers that end up taking up space in the electrical rooms. It also means that the owner is reducing the initial cost of buying more transformers. With that in mind, by running the lighting on 277/480V the owner will see another cost savings. The existing lighting is specified at 277/480, but most of the light fixtures have a 120V counterpart.

A 227/480V service also provides a better quality in that it reduces the harmonics.

I think it is still necessary, considering the equipment in the building to use a 277/480V service.

Building Utilization Voltage

Lighting: The existing is 277/480, but it could be operated at 120/208V. For longer runs however, wire size will increase a size or two just by using 120/208V over 277/480V; this also means a higher voltage drop across the length of the wire. For initial cost concerns, this could be a savings on the cost of copper.

Receptacle: Receptacles are operated on 120V.

Mechanical: Mechanical systems should be operated at 277/480V. For the size of the loads and the corresponding equipment, it would be very costly to attempt to run the mechanical system at 120/208V.

All in all, 277/480V allows for flexibility throughout the building systems and reduces some initial cost with regards to the wiring.

Emergency Power System

The as-designed emergency power system is in accordance to code. All of the emergency power for life-safety systems comes from batteries.

Using batteries over another source such as a UPS or a generator could mean more maintenance and testing of the systems and their batteries.

Due to the priority being placed on initial costs over reliability, batteries appear to be the better option.

With that in mind, it is not that reliability is not important. A generator would provide further reliability and would not require any component to be exchanged regularly as would batteries. It would also mean that there would need to be more wiring and more space occupied in the electrical rooms. Any added equipment could provide an added load on the mechanical systems (cooling) and structural systems (dead load).

Electrical Equipment Analysis

The existing **Main Service Equipment** is a switchboard. A switchboard is the cheaper solution for a flexible electrical system. In the case of the cultural center, the operations of the building are not as important to require that the system must be operating at all times; therefore, it is not detrimental to the center to shut down the whole system to make repairs or changes. For the previous reasons, I do not think it is necessary to upgrade to something like a switchgear.

The system is, as well as should be, single-ended as redundancy is not important here.

The **main service transformer** is owned by the electric company and cannot be changed unless the voltage.

The **step-down transformers** as existing are the highest efficiency transformers. Though this would provide an overall savings with a short pay-back period, there is also the option of installing lower efficiency transformers to reduce the initial cost. The as-designed system is the most cost-effective choice for the Tribe.

Optional Back-up Power

If a generator were added into the design, it may be beneficial to connect the card readers (access control) and security systems. This would provide a more reliable source of power with less maintenance. If a generator is not part of the design, I believe that battery power would make the most sense in terms of initial cost.

Integration Possibilities

While full building system coordination for the building is not necessary, it could be beneficial for the lighting and the shades to be controlled together in order to make the most of the daylight coming in as well as reduce the mechanical loads by dropping the shades on sunny days.

Energy Reduction Techniques

The Tribe could save further costs by using the technique of demand shifting in order to reduce the overall cost of electricity by turning off unnecessary electrical loads during peak hours.