HCRO Power Distribution Overview

1. Main power distribution schematic

The schematic describes the main power distribution and wiring of HCRO. Shown in black is the part of the system before the transfer switch, which is not backed up at all. In case of a PG&E outage the Main Lab Building and the SPR ceiling HVAC units will be offline.

Shown in blue is the part of the system that is backed up by the generator. In case of a power outage these parts will be reenergized once the backup generator is running and the transfer switch changed the input to generator. Note that when changing back to utility these parts will experience another power outage during transfer. This includes the Lab2 building and the main SPR HVAC system.

Shown in green are the parts of the system that are fully backed up by the UPS any device here will not experience any power outages. In case of an PG&E outage the UPS will cover the time until the backup generator is on and the transfer switch has moved the load to the generator. The UPS has a hold time of approximately 10 min at the current load.

A diagram of a computer

Description automatically generated

1. Required upgrades to the system

In this section we will break down the required upgrades to the power distribution and UPS system to ensure a stable and reliable operation of the observatory and its instruments.

* 1. HVAC system for UPS shed

The UPS shed is the building next to the main power distribution area, see picture. It was build to house the UPS in 2008. The UPS has a heat load of 5kW (8kW after upgrade) and is cooled using two residential window AC units which we replaced in 2020. These units run 24/7 and are critical for the UPS to operate.

A small shed with a window

Description automatically generatedA small shed with a window

Description automatically generated

A room with a white wall and a black box

Description automatically generated

The shed is powered by one transformer shown in the main diagram as “*UPS Shed Transformer”*. We can’t get the information from it anymore due to its age and no readable data plate. But we assume it is around 10kW which is enough to run the residential window AC units. Note that the circuit breaker for it tripped recently which caused the cooling to fail. We were lucky and discovered the problem in time. However, this is a failure mode which would take the entire observatory offline.

Therefore, we would like to replace the old transformer with a new one capable of powering two Minisplit AC units each at least 2 Tons. We would also want to replace the residential AC units in the UPS shed with said Mini Splits, to have a redundant system. The heat rejection of the UPS is 24kBTU which is exactly 2 Ton.

The quote for this upgrade is not complete yet, but one of the highest priority items.

A metal box on a fence

Description automatically generated

* 1. Backup generator replacement

The HCRO backup generator was installed in 1986 and has a capacity of 100kW (125kVA). We perform regular maintenance on this unit, but due to its age and increasing power demand on site it does not provide a reliable backup source anymore. Pictures of the generator are shown below.

In the last couple of months we had two generator failures which would have prevented the unit from running in case of a PG&E power outage. Over the last couple of years we had at least 5 failures, most caused by old age, broken water pump, broken control board, bad connections, etc.

We would like to replace the generator as soon as possible with a new CAT GC C9 250kW standby generator. The cost of the generator including a 48 hour diesel tank is approximately $140k plus installation. This also includes the replacement of our transfer switch which is about 10 years old. The installation includes an extension of the fenced area, concrete pad and installation of a new transfer switch and wiring. We are still waiting for a second quote from a vendor in Redding.

The increase from 100kW to 250kW will allow us to support the additional power consumption of the full buildout of the ATA and SPR.

A green power generator on a concrete surface

Description automatically generated

A green machine with dials and buttons

Description automatically generatedA sign on a wall

Description automatically generated

A close-up of a machine

Description automatically generatedA electrical box with wires

Description automatically generated

* 1. UPS replacement

The HCRO UPS currently covers all antennas and the Signal Processing Room. It is a Mitsubishi 9900A 100kVA double conversion model. The unit is 15years old and at the end of its recommended lifetime. We either need to replace the unit or perform extensive maintenance, replacing capacitors and other components, in order to ensure reliable operation. We had one incident this year where the UPS failed and temporarily switched to bypass before it restarted itself. The maintenance contractor recommended monitoring the output of the UPS to ensure we get data if the unit fails again.

We investigated multiple replacement units and based on this the most reliable units on the market today are the Mitsubishi and Toshiba units (same unit sold by both vendors). Even NRAO uses this model for their backup. With the replacement of this unit, we would want to upgrade it to 225kW as well. This will ensure us to support the additional power requirements of the full buildout of the ATA and SPR. Currently we are at 60% UPS capacity on our 100kW unit. With the full buildout we will be above 100kW.

The replacement of the UPS is quoted at around $200k. We explored the possibility of using Lithium-Ion batteries, however these have strict building and fire regulations, which we are not sure if we can meet with our UPS building.

A two large white cabinets

Description automatically generated with medium confidence

* 1. Power distribution changes

As part of the main power, generator, and UPS upgrades we would also like to move the SPR ceiling AC units from only PG&E mains (PDP-1) to the generator backed up power (PDP-2) this will ensure that in case of a power outage and a simultaneous main HVAC system failure, we still have cooling in the SPR by the ceiling units.

* 1. Summary

Our current uninterruptable power system relies on a 37 year old generator, which already showed multiple problems in recent times. The increase of power demand by the observatory puts extra stress on the generator. We already had three outages this year.

In addition to that the current size of our UPS (100kW), and its age leads me to recommend replacing it in the near future.

The cooling of the UPS shed which uses residential window AC units was a short-term solution that allowed us to operate with moderate risks during a time where four antennas were operational, and a power outage of the system would not have had a significant risk to equipment and investment.

However, since we have half of the array operational with refurbished receivers, the risk of a power outage disrupting, and breaking equipment is significant. Therefore, we would like to address this issue as soon as possible.

The priorities to upgrade and reduce risk are as follows:

1st Replace the window AC units in the UPS shed with Mini Splits and replace the old UPS Shed Transformer.

2nd Replace the generator with a 250kW CAT and replace the transfer switch.

3rd Replace the UPS with a Toshiba or Mitsubishi 225kW unit

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