EATON | Cutler-Hammer

Extending Battery Life

Application Note

Description ***Page***

General Description....1
Reducing Battery Aging....1
Open Transition Transfer Switch....2
Closed Transition Transfer Switch....2
Soft Load Transfer SwitchReducing UPS Connect Time....2
Reducing UPS Connect Time....3
Financial....3

General Description

According to the Electric Power Research Institute (EPRI), the reliability of power at the point it enters your facility is approximately 99.97%. That sounds good until you realize that 0.03% of the time the power is not available. 0.03% of 8760 hours per year is 2.6 hours per year.

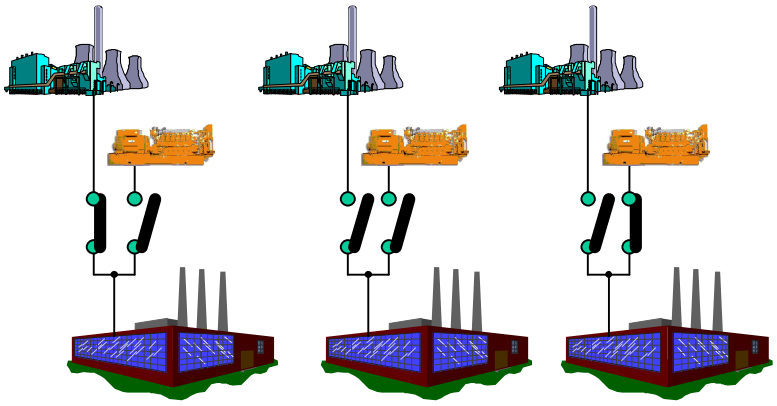
Certain applications cannot tolerate a power interruption for even a few hundred milliseconds. To compensate, installations use uninterruptible power supplies (UPS) and backup generators. The UPS is used to provide limited duration but immediate backup power while the generator provides delayed but long term backup.

While the use of a UPS is probably unavoidable, a particular problem occurs when attempting to switch back to utility power.

Reducing Battery Aging

Batteries are an unavoidable maintenance expense. The capacity decays over time and is accelerated by more frequent use. Eventually, the capacity is too low to provide a reliable source of backup power. Accurately knowing when a battery must be replaced usually requires periodically manual testing of the battery. However, changing the battery system must be carefully coordinated since the system will not be protected during the time the battery is being removed. Also, the cost of a replacement battery is a substantial maintenance expense.

Open Transition Transfer Switch

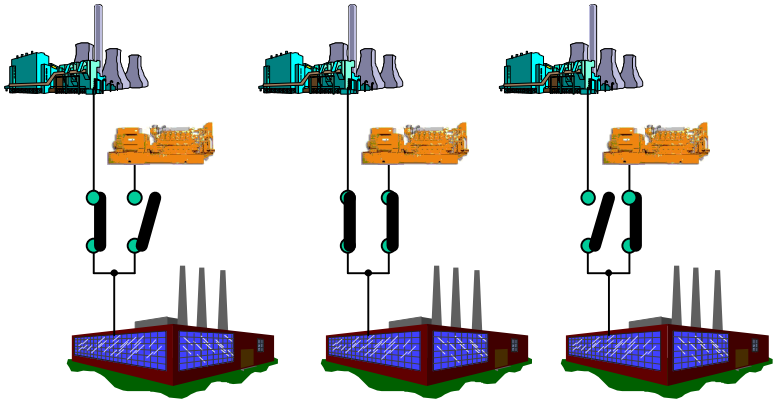


The open transition transfer removes power to the load when it switches from one source to another.

This results in a “second” outage when returning to the utility source.

UPS batteries are then again required to provide power during this transition, accelerating their decay.

Closed Transition Transfer Switch

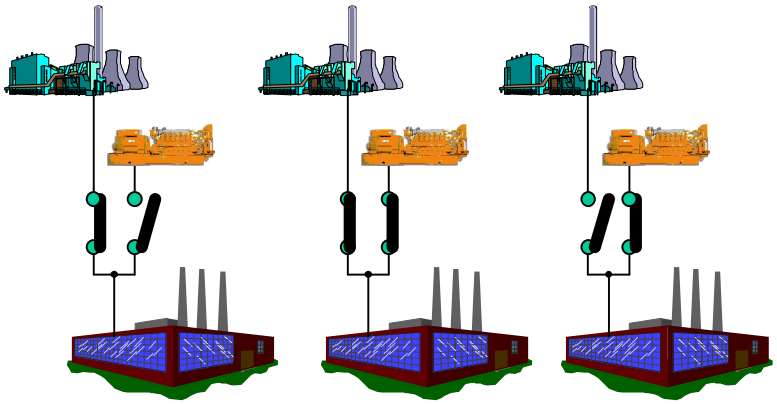


The closed transition transfer switch waits until the two sources are “synced”.

This permits the two sources to be paralleled without causing excessive current or voltage swings.

However, sensitive electronic equipment is affected by small transients that are produced during this transfer. A UPS system will detect this transient and switch over to the battery system.

Soft Load Transfer Switch



The soft-load transfer is similar to a “closed transition” except that the transfer is made without any detectable change to the downstream voltage.

As a result the UPS does not switch over to battery power during the return to utility.

This means that the UPS batteries can be used for ½ the time of the other transfer switch schemes.

Reducing UPS Connect Time

Because battery life and replacement costs are substantial problems, we look for ways to increase the life of the batteries.

One method is to insure that the UPS is not switched to battery more times than is necessary. So how do we reduce the times the UPS switches to batteries?

We do it by better managing how the load is transferred from the utility to the generator during generator testing.

Generator systems need to be tested periodically under load. If the site does not have a load bank sized to supply sufficient load, then the facility load must be used. Operating a generator unloaded contributes to 'wet-stacking' and causes damage to the engine generator.

Using the facility load for the test means that it must be switched off the utility and onto the generator. During this test, conventional transfer switches (even the more expensive switches with "closed" or "in-phase" operation), cause a momentary power disturbance that will be seen by the UPS and cause the UPS to switch over to batteries. This transfer will be very short, less than a few seconds, but it is enough time to cause an electrochemical reaction in the battery. To prevent this, a new type of transfer switch called a "Soft-Load" transfer switch can be used.

The Soft-Load switch switches the load without any detectable effect to the power.

The Soft-Load switch accomplishes this by precisely controlling the voltage and the frequency of the generator; so-called "Active Control", versus the "Passive Control" of a Closed-Transition or In-Phase transfer switch. The result is that a Soft-Load transfer switch causes a switching transient that is so small that the UPS deems the power sufficiently good to not switch to batteries.

Financial

Battery maintenance programs and battery replacement are costly. Typically battery systems cost $300 / kVA. A 300 kVA battery system would cost (not including labor and downtime) $90000. If a transfer switch is causing twice as many battery operations as would occur with a soft-load switch, this battery maintenance cost could be reduced by ½ or $45000. How quickly this money is saved is a function of the utility power quality and how often you test your geneator. Poorer power quality and more frequenty generator load testing results in more frequent battery usage and the need for quicker battery replacement.

Small battery systems range from $4000 replacement cost (including labor) to over $100000, with an average cost of approximately $130/kVA. A 1000 kVA engine would therefore support a battery system worth $130000. Assuming a system is tested from once a week (52 times per year) to once per month (12 times per year) and since each test causes 2 transient events (one going from utility to generator and the second returning from generator back to utility), the number of transient events varies from 104 to 24. The average cost to add Soft-Load functionality to a conventional transfer switch is $17000. VRLA battery systems are advertised to support 400 discharge-charge cycles, so a system that causes 104 transient events per year will cause 104 discharge (followed by charge) events, or 26% of the battery capacity or $33800 value reduction (130000 x .26) or a 199% IRR. Using the most conservative assumption of 24 events (6% or $7000 value reduction per year), this works out to an IRR of 40%. Both paybacks are based on a 10 year project life. Taxes and depreciation have not been considered.