Technical Bits … *of knowledge*

Substation Battery Charger – TB002

One of the most important (if not the most important) components of a high-voltage industrial/utility substation is the DC system. The DC system provides the energy required to operate protective devices and high-voltage components for proper isolation of electrical faults. In the event that the DC system is not available when required, severe damage to equipment as well as harm to personnel is a high probability. A typical high-voltage industrial/utility substation DC system consists of a flooded-cell battery bank (***see TB001***) and a battery charger(s). Too often, too little attention is given to the proper application of the battery charger.

Under normal operating conditions, the battery provides very little current. The battery charger provides the continuous load current (i.e. relay/meter power supplies, indication lights, etc) and maintains a charge on the battery bank. The battery bank begins to contribute current when the load increases beyond the output capability of the battery charger (i.e. trip/close coils, charging motors, etc). Typically, such operations last between several cycles to several seconds. The true test of a battery comes about when the battery charger is removed (i.e. battery charger fails or feeder to battery charger trips) and the battery alone must support the DC load. A typical battery load profile (duration that a battery is designed to support the DC system with the battery charger disconnected) is eight (8) hours. The eight (8) hour period is a fairly common load profile duration, but the actual duration can be adjusted as required by the installation/application.

The correct charging system means everything to the performance and service life of the station battery system. The environment, duty cycle and battery chemistry play a crucial part in selecting the correct charging system. Some of the most common factors to be considered when determining the proper battery charger include:

- Nominal DC output voltage rating and allowable ripple
- Output DC current rating and current limiting ability
- Float and equalize voltage settings
- Battery discharge levels and recharge duration time
- Charger efficiency
- Input AC voltage (single or three phase)
- Alarm and communication capabilities
- Ambient temperature
- Altitude

A common equation for sizing the battery charger is shown below:

$$A = \left(\frac{CfxAh}{T} + L\right) x \frac{1}{C1} x \frac{1}{C2}$$

where,

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- A is the battery charger rating in amperes
- Cf is the charger correction factor, typically 1.1 (check with manufacturer)
- Ah is the recharge in ampere-hours
- T is the recharge time in hours
- L is the continuous load current in amperes
- C1 is the temperature correction factor, use 1.0 if < 50 deg C (check with manufacturer)
- C2 is the altitude correction factor, use 1.0 if < 3,300 ft (check with manufacturer)

It should be noted that if the battery eliminator option (chargers will operate as DC power supplies without batteries) is utilized, it is important that the charger rating (A) is greater than the DC system maximum load current. This will ensure that in the event the batteries are inadvertently disconnected or unavailable, the battery charger will be capable of supplying the required DC current.

Additionally, the following considerations are recommended when specifying the battery charger(s) to maximize the reliability of the substation DC system:

- Install redundant battery chargers (load sharing configuration) such that the loss of a single battery charger does not jeopardize the DC system. The battery chargers should be sourced by two (2) independent AC sources, and the failure of a single charger should initiate a high priority alarm.
- In the event that the system configuration will not support a second battery charger, it is recommended that a spare battery charger is kept on-site. As indicated above, the typical battery load profile is eight (8) hours. This means that a failed battery charger will need to be replaced within the eight(8) hour period. Having a spare battery charger would ensure this.

Recommendations for maintaining and testing station battery chargers include:

- Perform visual inspections at intervals to coincide with inspections of the batteries
- Clean vents to ensure proper ventilation/cooling
- Check tightness of electrical connections and ensure that the connections are corrosion free
- Measure and record AC input voltage
- Measure and record the DC output voltage, including AC ripple
- Test and exercise individual alarms and summary alarm
- Test communications
- Exercise function controls

Proper selection and maintenance of the DC system will greatly improve the safety and reliability of an electrical substation.