Emergency Standby Power For Water and Wastewater Facilities – Electrical Considerations

Syed Raza, P.Eng., Associate, R.V. Anderson Associates Limited

The Ontario Ministry of Environment has mandated emergency standby power for all newly built water and wastewater treatment plants. Diesel generating sets are the most obvious choice of standby power application due to their reliability and ease of availability. This article deals primarily with the main electrical considerations involved in sizing diesel generators for water and wastewater facilities.

Sizing Considerations

The first consideration in sizing a standby generator is identifying the critical loads to be powered by the generator. For small stations, the complete load may be considered since the non-critical load may not have significant impacts on the generator sizing. For larger stations, however, it may be necessary to isolate the non-critical loads, as these loads will have significant effects on the generator sizing. Isolation will require load-shedding provisions in the electrical distribution system for the non-critical loads, which must be considered at the time of designing the Motor Control Centres (MCCs), starters, and PLC programming.

A second important consideration is the sequence of loading to the diesel generator. The size of generator will increase considerably if the full load is applied to the generator in a single step. This issue is magnified due to limits on maximum allowable voltage and frequency dips and the subsequent recovery time related to applying load on the diesel generator.

However, if the process allows for applying load in multiple steps, then the generator size can be significantly reduced. This multiple-step process will require an in-depth understanding of the process flow to figure out the steps for starting, and will require close coordination between the electrical and process components. It is to be noted that the emergency load may be required to start in the first step within as little as ten seconds, while the rest of the loads may be started with sequenced time delay.

Requirement for parallel operation is another important consideration for larger or “mission-critical” facilities. Parallel operation provides the flexibility of switching power from the generator to the utility without the power interruption and time delay associated with a standard transfer switch. It also allows for regularly testing the generator by using actual facility loads without interrupting power.

The downside of synchronizing the power supplies through parallel operation is that the works will require additional control and protection circuitry, along with additional capital cost. However, the potential benefit of parallel operation is something that needs to be discussed between the consultant and client at the initial design stage.

Another important consideration in generator sizing relates to non-linear loads. With the advancements in power electronics, non-linear loads—like Variable Frequency Drives (VFD) and Uninterrupted Power Supplies (UPS)—are now becoming significant part of a facility's electrical load. It is to be noted that the harmonic distortions caused by the non-linear loads create heating problems in the alternator and malfunctioning of the Automatic Voltage Regulator (AVR).

This issue should be addressed on the generator manufacturer's side by employing an alternator with PMG (permanent magnet generator) excited AVRs, a 2/3 pitch winding alternator, or by over-sizing the alternator. The VFD supplier should also provide suitable harmonic filters. It is therefore very important to size the generator considering the data of all non-linear loads to be supplied and whether or not harmonic filtering is employed.

Finally, consideration should be given to any future upgrading at the facility as power requirements tends to increase with time.

Sizing Calculations

Once the requirements are established, the next step is the sizing calculation. Thanks to advancement in sizing software by various generator manufacturers, the sizing calculation is simplified and can be done in fraction of time compared with the tedious manual calculation required in past. While performing the calculation, ensure correct data is specified in the sizing software for the following:

- Generator voltage and frequency.
- Site ambient conditions (e.g., temperature, altitude).
- Maximum allowable voltage and frequency dips.
- Load sequencing / step loading.

It is to be noted that Emergency Standby Power (ESP) Diesel Generating Sets are suitable for supplying variable emergency loads for the duration of power interruption of a reliable utility source for up to 200 hours per year. With proper sizing and maintenance, the diesel generator will provide reliable operation throughout its design life.