techUK Data Centres Technical Committee

Briefing Note: Emergency Generation

January 2017

What is emergency generation in a data centre context?

Data centres rely on mains electricity to function. A single data centre may support the core IT function of dozens, or even hundreds, of organisations, many of whom in turn rely on the facility to support services to their own customers and so on. Functions range from batch processing to financial transactions and air traffic control, so the purpose of the data centre is to provide a secure, resilient environment with guaranteed power and connectivity. Electronic equipment cannot work without a continuous supply of electricity (IT systems can handle a maximum outage of as little as 6 milliseconds) and is also very sensitive to variations in the quality of that supply. Data centres therefore have emergency power supplies in case of interruptions to, or fluctuations in, mains electricity.

What do we mean by emergency generation?

Emergency generation within the data centre sector means generating electricity on site to enable a facility to continue functioning. There are two main criteria.

1. The generated power flows into the facility and not into the grid.
2. Emergency generation is reactive, not elective. This means that it is triggered by an inadequacy, malfunction, failure, or other fluctuation in the incoming power supply, not by operator choice. In very rare circumstances, operators may manually switch to back-up power if there is high risk of an imminent interruption to incoming power supply, for instance in the case of flood or fire.

Emergency generation for data centres is usually designed to provide the maximum amount of power that a site could require, plus a margin and usually, additional redundancy. So a site moving to generator standby to relieve pressure on the grid will release less power than its generating capacity might indicate.

How is emergency power delivered in data centres?

Data centres need both instantaneous and longer term emergency power. Instantaneous emergency power is usually provided from on-site storage, either from batteries or from the momentum within a flywheel. This is usually short term and simply bridges the time delay whilst longer term capacity, usually in the form of diesel generators, comes online and accepts load. Common industry practice is to use a combination of stored and generated power, which can take several forms. Simplistically the main approaches to emergency power provision in data centres are: UPS plus generator plus batteries or flywheel, combined UPS and generator with no batteries or UPS and batteries only.

Generator backed static or rotary UPS: The majority of data centres use UPS (Uninterruptible Power Supply) backed up by both generator and battery or rotating energy storage. The UPS does what it says on the tin, ensuring a continuous power feed into the data centre irrespective of the quality or availability of external supply. Static UPS uses electronics and rotary UPS uses an internal flywheel but they both detect and address perturbations in power, bringing standby power online and removing “noise” such as frequency variations. Batteries provide instantaneous emergency power while the generators get going. It takes 7-30 seconds for the generators to start and accept load but the start command is usually delayed by 4-5 seconds because the majority of utility disturbances are less than 3 seconds in duration. This time delay reduces the number of incidents when generators start in anger.

Diesel Rotary UPS (DRUPS): Emergency power in some larger scale data centres is supplied via DRUPS, where the UPS and generator are integrated into a single operating unit, accepting load within 5-10 seconds. A large flywheel provides instantaneous power so there is no need for batteries. This rotating flywheel slows as it provides power while the generators start but can only maintain that power for a short period (autonomy time) before the energy stored becomes expended. This short autonomy time makes DRUPS, by necessity, more sensitive to utility disturbances than UPS backed by emergency diesel generators and battery. In the UK DRUPS probably accounts for 12.5-15% of the large data centre market. While not suitable for low loads, they take up less space. Opinions vary on their efficiency.

UPS and battery-only back-up: some data centres have UPS plus battery back up that works instantaneously but for short duration (as the batteries will soon be exhausted). This kind of back up is designed to allow the system to be shut down safely and may be used in server rooms, small scale operators or where site activity is mirrored with another site. Battery only back up applies to a very small proportion of the UK data centre market by energy consumption. Obviously, this power is not generated on site from fuel, it is stored.

Frequency of standby generation

Emergency generation "in anger" in the UK is rare. On average, short term failures may result in emergency running perhaps once every 18 months for traditional generators. DRUPS will run more frequently, perhaps a few hours a year. Longer term outages to the UK grid are statistically very rare (as National Grid data will testify) and are unlikely to affect sites more than once in 30 years. Most sites will never deal with a major grid outage.

Generator configuration

Data centres are highly resilient and frequently have "n+1" standby provision in the form of an extra generator in case one of the standby plant fails or malfunctions. In practice all the generators start when called for in an emergency event (so that the load is taken quickly). However they will only ever generate the equivalent of the "n" supply as this is the total demand of the site. For example if the total demand is 3MVA the site will have four 1MVA emergency generator sets (n+1, three can carry all the load if one set fails or is out for maintenance). In the event of a power failure and all four generators being available they will all start and will then each run at 75% load (3MVA). On this basis the rating for the site should be the n value, not the n+1, because the total demand of the site is n. Sites adopt different configurations: some are "2n" and some are "n+2", or even "2n+2" for exceptional resilience, but the principle is the same.

Testing and maintenance

Generators must be test-fired regularly for maintenance and drills, usually for up to an hour once a month. Some operators are obliged to schedule maintenance well in advance to meet customer SLAs and minimise impacts to local air quality; others have more flexibility regarding testing and maintenance regimes.

About techUK's Data Centres Technical Committee

techUK's Data Centres Technical Committee was originally established to advise techUK's Data Centres Council and provide expert technical input to policy responses, publications and other communications. However, the Committee's expertise is increasingly being sought during dialogue between industry and external stakeholders (predominantly government) for objective advice about the technical and market characteristics of the sector. Members collectively possess a wide spectrum of technical expertise, and while the core focus is on engineering and technology, some specialise in business processes, others cover operational aspects and some are experts on market trends, policy or legislation. The Committee includes external observers to ensure objectivity. Formal Terms of Reference provide governance for the group and a list of members is available. The Chairman is Professor Ian Bitterlin and the Vice Chair is Mark Acton.

Further information: These notes are only intended to provide a brief rule-of-thumb. The Technical Committee is on hand to provide further detail on the contents of this communication.

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