From:	Bumar, Rich
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Subject:	Walt Disney World Diesel Generators - additional information
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October 7, 2012

Ms. Melanie King
Energy Strategies Group
Sector Policies and Programs Division
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Mail Code D243-01
RTP, NC 27711
RE: Walt Disney World
Diesel Generator Emergency Reclassification under RICE
Additional Information

Dear Ms. King,

This is a follow-up to your phone call on October 4, 2012 regarding what constitutes a "power conditioning system" and how these systems are related to the availability of grid power for determination of what is considered an "emergency" in the context of the RICE rule at the DISC facility at the Walt Disney World Resort.

The DISC facility's purpose and operations are similar to other data centers that are located in many areas of the country. In general, a data center typically consists of computer systems and associated components, such as telecommunications and data storage systems. Data centers also typically rely on redundant/backup system for power supply such as an uninterruptable power supply and backup generators, electrical busses and switches, and data communications connections. Not to be overlooked, one of the most critical systems at data centers are environmental controls such as air conditioning systems. Data centers are typically used for internet servers, such as those that are employed by companies such as Google or Amazon, for example, or for internal company computer operations, such as at the DISC facility. For either internal or external computer data services, the operations and configuration of data centers are similar and they are expected to operate continuously without interruption.

To respond to your questions, this letter will discuss the concept of "power conditioning", electric power reliability at data centers, and provide examples of power supply failure modes that can occur and how the facility avoids losses or damage by switching to generator power.

Power Conditioning

Power conditioners are devices used to provide high quality electrical power to electrical loads. Power conditioners take in power and modify it based on the requirements of the equipment to which they are connected. In the simplest sense, a surge protector on a home computer could be considered a power conditioner. Surge protectors are designed improve the quality of power supplied to an electronic device by eliminating power surges, for

example, from fluxuations in line power as supplied by the power generation system or from lightning strikes. At data centers, the cost of the equipment, the sensitivity of the computer equipment to power quality fluxuations and the cost of downtime necessitate greater control of the incoming power. “High quality” power at data centers consists of electrical power that, through a power conditioning system, maintains control over factors such as:

- maintaining smooth and constant voltage over varying loads
- transient spikes – abrupt, very brief increases in voltage, also known as "impulses", or "surges", generally caused by large inductive loads (e.g., electric motors) being turned off, malfunctions in the grid power lines, or more severely by lightning
- electrical “noise”
- sinusoidal A.C. wave form
- A.C. frequency- the normal frequency of AC power in North America is 60 cycles/second (“Hz”)

The power conditioner for incoming grid power at DISC is comprised of the uninterruptable power supply system, switchgear, voltage regulators, a control and self-diagnostic system, and power filters (i.e., capacitors, controls, etc.) The diesel generators’ electrical output is not passed through the uninterruptable power supply or any other specific power conditioning system. “High quality” power is provided by the diesel generators by the generators’ control systems. Since the generators are controlled locally and are not connected to the grid, power quality from the generators is sufficient for the needs of the data center and is equivalent in quality to grid power that has passed through the power conditioning system.

Electric Power Reliability

Electric power reliability and quality is a key factor in the operation of data centers. Therefore, data centers often are configured for backup redundant systems in what has become known in the industry as “N+1 redundancy.” Wikipedia defines N+1 redundancy as “…a form of resilience that ensures system availability in the event of component failure. Components (N) have at least one independent backup component (+1).”

The DISC facility utilizes N+1 redundancy to provide electric power reliability. An uninterruptable power supply provides short-term power backup and power conditioning services as the electrical power from the grid is passed through batteries and the power conditioning system as described in the previous section of this letter. The uninterruptable power supply system itself is comprised of many components, such as multiple banks of lead-acid batteries, switches, cooling fans, cables, and electronic controls, to name a few. (For the purposes of simplifying this discussion and because the power conditioner and uninterruptable power supply systems are closely linked as described above, going forward in this letter, the uninterruptable power supply and power conditioning system together will be referred to simply as “UPS”.) The operation of the diesel generators are specifically reserved, by company policy and for economic reasons, with the exception of maintenance and testing of the generators themselves, to backup power only, either for emergencies or to provide power during planned maintenance when the normal power supply would be interrupted. In addition, there are redundancies in critical switchgear and power busses, to name only a few redundant systems. Again, these systems are typical to data centers and this case the DISC facility is not unique.

All incoming electrical power from the grid is routed through the UPS, which is then distributed to all of the systems at the data center. Critical systems at the data center include, but are not limited to, the power supply to computers, control systems (systems that monitor the "health" of the facility and allows, among other duties, automatic and manual control and switching between primary grid power and backup generator power), and environmental control systems that provide air conditioning to manage thermal load from the computers.

The computer system's primary power backup at DISC is the UPS. Environmental controls such as lighting and air conditioning do not receive power any from the UPS. For short-term power interruptions (i.e., less than three seconds), the UPS provides backup power to the computer systems. For sub-Hz level interruptions, capacitors in the UPS frequently can provide the required power, while longer interruptions up to 3 seconds long are fed by batteries. The secondary power backup system consists of the diesel generators. If a power interruption occurs for longer than three seconds, the generators automatically come online. All power to the facility at that point will be supplied by the diesel generators, including environmental controls. In addition to scenarios where the generators are automatically switched on, there are other failure modes where human intervention may be required.

Failure Modes

The following discussion of failure modes in the power supply will be in the context of the circumstances that would require switching to backup power by the diesel generators. For the DISC facility, the failures can be classified into two mode types: "Power Loss" and "Power Supply Component Failure". During either of these failure mode types, it is conceivable that grid power could be available to the wider world, even into the facility, yet the failure mode is such that switching to backup power would be necessary to protect the facility from damage and/or to keep the facility operating. Sudden losses of power, as well as spikes in voltage could damage components at the facility.

There is a commonality and overlap between the two failure modes. If, through loss of power or through component failure, certain systems were to be compromised, the diesel generators must be operated to keep the facility online. For example, if the power supply to either the computers themselves or the air conditioning system were compromised for a certain period of time, the diesel generators would be required to maintain the operation. The UPS can theoretically supply backup power to the computers at DISC for up to 20 minutes, but it does not and cannot supply power to any other systems at the facility, including the air conditioners. In a case where all other sources of power (including the diesel generators) were to go offline simultaneously for an extended time, the computers could be supplied with power for that period of time. However, the air conditioners would be offline. Depending on the weather at the time, the thermal loading from the operation of the computers would cause a buildup of heat in the facility such that the computers would be shut down automatically in five to seven minutes. Operation of the air conditioning system is therefore critical to keeping the facility in operation.

<u>Power Loss Mode Types</u>

During this type of failure mode, there would be a loss of power to the facility as a whole or a loss of power to a critical power supply component(s) of the facility. A loss of power to the facility as a whole can be described as what fits the strict regulatory definition of an emergency. That is, grid power is unavailable and backup power is required by either primary or secondary means. As described in the previous section, if the power loss is longer than

three seconds, the diesel generators automatically come online. However, there are power loss failure modes in which grid power is “available” but is unable to be routed to critical components such as computers or air conditioning, to name just two components. The same three second loss would cause the generators would come on automatically, but the cause of the loss of power would typically be failure of internal switchgear and/or internal electrical power distribution equipment. In those cases, even though grid power was available at the “front door”, it would necessitate switching to the emergency backup power from the diesel generators in order to keep the facility operating.

Power Supply Component Failure Mode Types

During power supply component failure modes, grid power would likely also still be available. Some component failures would require immediate switching to emergency generator power while other failures could be repaired at a later time without needing to switch to emergency backup power. As described previously, there are many critical components that make up the power distribution system at DISC. Many of these components are monitored through a computer diagnostics system.

An example of a monitored system is the UPS. The UPS is a “smart” system in that it continuously monitors itself for faults. When any fault is detected, the system notifies facility personnel of the fault. At that point the engineering technician on duty would make the decision as to whether or not it was a critical fault. If the failure is determined to be critical by the engineering technician, the facility would be switched to emergency power. If the fault was not deemed critical, the facility would continue on grid power and the fault would be addressed on a non-emergency basis.

The scenario above is used as an example only. There are other critical components in the power supply system as described in the “Power Loss Mode Type” discussion that are monitored for diagnostics. However, in this component failure mode discussion, the term “component failure” means that diagnostics indicated that imminent failure of a component that could cause the facility to go down is likely, instead of the actual failure of the components, or that such a component has failed but has not yet caused the system to switch over to emergency power automatically. As described above, the engineering technician on duty would decide if the imminent failure was an emergency and what action to take. To make the decision, the technician would take several factors into account, including, but not limited to, whether or not failure of the component could indeed cause the facility to go off line, and whether or not failure of the component could cause damage to other equipment at the facility.

Summary

Like other data centers, the mission of the DISC facility is to provide uninterrupted data services, 24 hours per day, year round. The DISC facility provides these services to various business units within the Walt Disney Company. Downtimes at the center are costly, so diesel electric generators were installed for backup/emergency power. Operation of the diesel generators are limited by company policy to maintenance/readiness testing and emergency operations. In limited cases, the generators are operated during planned (non-emergency) maintenance events. During those non-emergency operations, the generators would be operated under the 50-hours per year that is allowed under the RICE rule for general purpose operation. Unplanned situations can occur at the DISC facility in which grid power may be available but the power is either unable to reach critical systems, or critical components of the internal power supply system are compromised and/or are in imminent danger of failure.

Those unplanned events, where generators must be operated to allow the facility to continue uninterrupted operations, whether or not grid power is available, should be classified as emergencies. We are seeking agreement by the US EPA that in these situations, the operation of the diesel generator at DISC could be classified as "emergency" operations under the RICE rule.

If you need any further information, please contact me by email at rich.bumar@disney.com or by phone at 407-390-5003.

Sincerely,

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Environmental Engineer
Walt Disney World Resort

cc: Dan Azevedo
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