The Diesel Technology Forum held a webinar on March 18, 2013 on emergency backup generators. You can watch the full recorded webinar including presentations from the Department of Homeland Security and U.S. Army Corps of Engineers, Caterpillar, Cummins Power Systems and HO Penn (Caterpillar dealer).

**Summary of Webinar:** The loss of electrical grid power due to storms, natural disasters or high power demands are increasingly common. The cost of electrical outrages on annualized basis to the U.S. Economy range from $80 billion to over $100 billion annually, according to recent studies. Two-thirds of the outages are weather related, ranging from ice storms, hurricanes, lightning strikes and other incidents.

With a growing dependence on technology and interconnected systems that rely on electricity, power reliability becomes increasingly critical. Hospitals, data centers, water and sewage facilities, fueling stations, and communication and transportation systems require continuous power to protect public health and safety.

Diesel-powered generators provide a steady supply of high-quality power and superior performance for transient or fluctuating power demands due to the high-torque characteristics of diesel engines. Beyond these most critical applications, the power needs for food and medical refrigeration, building operations such as elevators and sprinklers as well as banking and business networks further highlight the significant economic and other losses from power outage.

Two most recent blackout events have garnered international attention. The August 11, 2003 blackout of the Northeast impacted more than 50 million people through a loss of 61,800 MW in power in eight states and one Canadian province. The event, caused by a series of cascading generation and transmission issues in the Northeast, took 30 hours to restore, disrupting manufacturing operations, retail outlets, air traffic...
control systems (more than 1,000 flights were cancelled) banking centers and government operations. The event caused 531 generators to come online, including 19 generators at 10 nuclear power plants. The total cost to the economy was estimated at $7 to $10 billion.

Superstorm Sandy October 29-November 1 impacted 17 states from Maine to North Carolina and as far west as Michigan and Indiana and resulted in a loss of power to 8.1 million electrical customers.

This educational webinar sponsored by the Diesel Technology Forum provides an overview of emergency backup power systems, the different types, fuel uses and considerations for technology choices, use and siting of these critical systems. Case studies are reviewed and presentations from the Department of Homeland Security and the U.S. Army Corps of Engineers are also included.

Matt Menzel, application engineer for Cummins Power Systems gave an overview of the options for modern standby power systems, breaking down the electrical demands of a facility to include uninterruptable loads (those from computer servers, medical imaging etc.) which utilize uninterruptable power supply (UPS) for their primary 30 to 60 second function backed up by a generator.

The UPS options available are battery banks and rotary (Flywheel) energy storage systems. The full range of options for backup generators includes natural gas, diesel, and propane.

There are advantages and disadvantages of each technology depending on system need and desired levels of performance. The importance of self-contained fuel supplies and the fuels and technologies available and best-suited for handling “life-loads”- critical power needs that protect life and safety pointed to diesel and in some cases natural gas technologies.

Gasoline units though familiar as generators to consumers and available at local hardware supply stores, can handle only limited electrical loads and are generally smaller and portable.

Diesel generators, along with their self-contained fuel supply have superior response/start time, transient performance and durability and reliability, while natural gas was a viable option for some applications that did not have life-safety loads.
T.J. Tarabulski from Caterpillar outlined the various applications of generator sets and their purposes, including stationary emergency, non-road mobile, peaking units, demand response units, combined heat and power units and continuous or prime applications.

He also highlighted the increasingly low-emissions nature of the generator sets, as meeting EPA Tier 2 or better emissions since 2006, with further reductions in emissions levels achieving a 97 percent reduction in nitrogen oxide emissions and 98 percent reduction in particulate emissions.

The features and benefits of non-road mobile (portable and rental) and stationary generator applications (emergency only and non-emergency) were noted with substantial differences in allowable use times and availability of power evaluating the time to power, maintenance costs, emissions regulations and other considerations fuel technologies.

Further discussions centered on the advantages of pre-planning for emergency events and all the special considerations required including code compliance, permitting, quick-connect options and fuel supply and stability.

Rental generators are available from 20 to 5200 kW; stationary units are available from 36-4000KW.

Safety in design and connection of generators was emphasized and the need for qualified and certified electricians to connect and properly design and install units.
John Callahan from H.O. Penn Caterpillar in Holtsville NY presented a case study and shared perspective on response to regional power outages and crisis in the northeast over the last 13 years ranging from the World Trade Center attacks in 2001 to storms, hurricanes and brownouts that have occurred in the region. The importance of having an emergency plan was underscored. Important considerations for placing generator units and responding to power outage events includes a contingency for reduced or displaced operations—being impacted by the event directly; the operational difficulties of moving equipment- generators and service vehicles – to sites regarding vehicle permitting and operational restrictions and finally day to day support of the responders and logistics team.

Important considerations in the site or locating of the generators were noted, including the importance of accessibility for service and fueling, the distance to the electrical connection points, and how the sound and exhaust will affect the surrounding environment.

David Bishop – subject matter expert for the United States Army Corps of Engineers shared the USACE perspective and role in providing assistance and power solutions for disaster response and recovery and their coordination with DHS and local authorities. The USACE has 8 planning and response teams located around the country with up to 20 personnel per team. The Army Corp served as the implementation arm of FEMA which has approximately 800 generators available for deployment and 100 others. Several resources of the USACE were provided including

http://eportal.usace.army.mil/sites/ENGLink/default.aspx; and

Richard Alt, Branch Chief in the U.S. Department of Homeland Security, operational integration branch and Homeland Infrastructure Threat and Risk Analysis Center (HITRAC), outlined HITRAC’s role in leading up to and responding to Superstorm Sandy. Some of the lessons learned and areas for continued work include the need for communication with owners and operators of critical infrastructure,
particularly in the need for refueling of generators. The storm resulted in secondary impacts such as the loss of overhead refueling racks in New Jersey that prevented the ready access to refueling supplies, with Philadelphia being the closest area to fuel up tank trucks for deliveries into the affected zone.

Mike Dysart with Cummins Power Systems presented a case study on the town of Seaside Heights, New Jersey. This Jersey Shore town on a barrier island experiences high seasonal demands for power due to its seasonal beach destination and ten-fold increase in resident population during the summer months. In this case study, Cummins Power Systems had in 2012 deployed three 2000 kW generators for the purpose of peak-shaving for summer electrical load demands, where the local power company dispatches (activates) the generator sets as needed to prevent brownout or blackout conditions in Seaside heights. The 2MW systems deployed after treatment technology from Johnson Matthey to reduce emissions during operation.

Superstorm Sandy decimated the town of Seaside Heights and the utility service was knocked offline by the severe storm. Cummins Power Systems responded to requests from the local utility and moved in to operate the generators in emergency response mode to restore electrical power to the island, running for 20 days straight, receiving 1000 gallons of fuel daily. They also responded to 450 customer service requests and had 260 actual site visits, including 25 that involved life safety circumstances from a range of businesses including banking operations, biotech and life sciences laboratories and investment and financial brokerages.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Typical Generator Size</th>
<th>Fuel Consumption at typical loads (gallons per hour, diesel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Building</td>
<td>2000 kW</td>
<td>138</td>
</tr>
<tr>
<td>Gas Station</td>
<td>70 kw</td>
<td>5</td>
</tr>
<tr>
<td>Cell Tower</td>
<td>40 kW</td>
<td>3</td>
</tr>
<tr>
<td>Home</td>
<td>10 kW</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

**Examples of Power Demands and Fuel Consumption**
*(Note these are general examples only; each application and site will have different requirements)*

**Questions & Answers:**

**Q:** Why is it often that the news reports the “generators failed”?

**A:** Backup power systems are complex systems, with the actual generator unit being only one part. Other critical aspects of the system include switchgear, circuit breakers, cables, and fuel supply. Each incident has its own unique circumstances so generalizations are typically not well advised. In the instances where generator failure is traced to the actual generator itself, more than half of the failures are the result of improper maintenance of the unit, with battery failure being the most frequent occurrence.

**Q:** What is the recommended testing frequency for backup generators?
A: Monthly testing for one hour is generally the recommended standard. On an annual basis full load test is recommended that operates the engine at load and simulates an actual event. Check with individual generator manufacturers and service experts.

Q: How long does diesel fuel remain stable?

A: Diesel fuel stability is a function of many factors. Assuring a good quality fuel supplier and regular fuel tank maintenance plan and proper fuel additive package are essential and can extend the life of a fuel supply for up to two years. Other options exist to actively condition the fuel that can extend the life of the fuel in storage for longer periods. Nearly all fuel used in diesel generators today is ultra-low sulfur diesel fuel. Check with local dealers for more details.

Q: What about the use of biodiesel fuels in emergency generators?

A: Check with the engine manufacturer and local dealer for recommendations on use of non-petroleum fuels. High-quality biodiesel fuels in limited blend quantities can be used in emergency diesel generators. (Typically up to 20 percent mixed with 80 percent regular diesel fuel), however special considerations must be made to assure fuel quality and fuel system stability that do not interfere with overall readiness and response of the unit. Biodiesel fuels have a tendency to attract water and separate over periods of non-use, which could impact start and response readiness. Check with engine manufacturers and dealers for more specific recommendations.

Q: What are the emissions controls technologies possible for installing on existing emergency generator units?

A: Emergency generator installations are governed by federal emissions requirements and state and local permitting conditions that govern the use and hours of operation for each unit. Generally speaking, the units are designed for emergency use and limited operations and as such do not contribute significantly to air pollution. EPA permitting requirements are based on this premise and allow for a limited amount of use annually (100 hours) for testing and maintenance. Performance, load and operating conditions for emergency backup generators are vastly different than those for other diesel engines used in mobile construction equipment and highway trucks. Evaluation of emissions control technology feasibility is on a case by case basis based on many factors such as the impact of a device or solution on operational readiness, overall effectiveness given the duty cycle and operating conditions of the unit, cost and maintainability.

<table>
<thead>
<tr>
<th>Types of Generators</th>
<th>Stationary (indoor applications)</th>
<th>Stationary (enclosed outdoor generator application with self-contained fuel supply)</th>
</tr>
</thead>
</table>
Stationary Generator and Flywheel System

Mobile Portable Rental Power Unit