Information Sheet # 09

GenPower® PRODUCTS • INC

Your Reliable Guide for Power Solutions

To fulfill our commitment to be the leading supplier in the power generation industry, the GenPower Products, Inc. team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service our **Information Sheets** are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.

Wet stacking and how to avoid it

The majority of standby generator systems up to five mega watts utilize the reciprocating internal combustion engine as the power source to drive the generator that produces the electrical power. The engines of choice are either diesel, natural gas or LPG fueled. A large percentage of standby power systems use the diesel engine. Diesel is a convenient independent fuel source and the compression ignition system of a diesel has a much higher thermal efficiency than the spark ignition system used by gas engines. However, one factor to be considered when selecting a diesel power source is the potential for "Wet Stacking."

The National Fire Protection Agency (NFPA), in their NFPA 110 code for Emergency and Standby Power Systems section 6 - 4.2 (1996 edition) refer to "Wet Stacking" as a field term indicating the presence of unburned fuel or carbon in the exhaust system. The later 1999 edition suggests a more quantitative method for determining the presence of "Wet Stacking" by measuring the exhaust gas temperature, explained later in this information sheet.

This information sheet discusses the causes of Wet Stacking, the effect on the engine, why it should be avoided and methods for eliminating the condition.

The designer of a generator system must take into account the potential for "Wet Stacking" when determining equipment for the system, load calculations and maintenance and service programs. The system designer should consider the following regarding "Wet Stacking."

Causes: A diesel engine, like all internal combustion engines, to operate at maximum efficiency has to have exactly the right air to fuel ratio and be able to sustain the operational temperature it was designed to run at for a complete burn of the fuel. When a diesel engine is operated on light loads it will not attain its correct operating temperature.

When the diesel engine is allowed to run for extended periods below its designed operating temperature, unburned fuel is exhausted and noticed as wetness in the exhaust system, hence the phrase "Wet Stacking."

Engine Effect: When unburned fuel is exhausted out of the combustion chamber it starts to build up in the exhaust side of the engine resulting in fouled injectors and a build up of carbon on the exhaust valves, turbo charger and exhaust.

An excessive amount of deposits can result in a loss of engine performance as gases bypass valve seatings, exhaust buildup produces back pressure and deposits on the turbo blades reduces turbo efficiency. Over short periods permanent damage will not be incurred, but over longer periods damage will occur as deposits scar and erode key engine surfaces. (see diagram one)

Another result of running below the designed operational temperature is the pistons rings, fitted to the piston to allow expansion of the piston as the engine temperature rises, do not attain their level of designed tightness required to adequately seal the space between the cylinder walls. This results in unburned fuel and gases escaping into the oil pan and diluting the lubricating properties of the oil, leading to premature engine wear.

Why Avoid: Having discussed the effect of "Wet Stacking" on the diesel engine, the reasons for avoiding the condition are now known, but in addition to the adverse engine effect the designer and user of a system have to consider:

- Expense: Excessive "Wet Stacking" will shorten engine life by many years and before planned replacement.
- Pollution: Many urban areas are restricting the level of smoke emissions "Wet Stacking" produces.
- Power: Even before an engine is damaged deposits will reduce maximum power. A prematurely worn engine will have a lower maximum power than it was designed to develop.
- Maintenance: An engine experiencing the effects of "Wet Stacking" will require considerable more maintenance than an engine that is adequately loaded.

NFPA Guidelines:

Wet-Stacking is a recognized condition with organizations that write codes for standby generator set systems, such as the National Fire Protection Association (NFPA) who have issued several guide lines for controlling the effects of Wet-Stacking.

The NFPA guidelines in Level 1 and 2 applications are to exercise the unit at least monthly for 30 minutes under either of 2 methods:

1) Under operating temperature conditions and not less than 30 percent of the EPS nameplate kW rating, or
2) Loading to maintain the minimum exhaust gas temperature as recommended by the manufacturer. (See NFPA 8.4.2.)

Exhaust gas temperature specifications are available from the manufacturer of the unit.

Additional Conditions:

The Joint Commission on Accreditation of Health Care Organizations (JCAHO) the organization that accredits health care institutions has taken this testing to a level beyond the NFPA. They require testing of 12 times per year with testing intervals between 20-40 days. Testing generators for at least 30 minutes under a dynamic load of 30% or greater of the nameplate rating. Systems that do not meet the 30% load capacity have three options. (Continued over)

(Continued from page one)

1) Increase the load to meet or exceed 30% of the name plate rating.
2) Maintain the minimum exhaust temperature as recommended by the engine manufacturer.
3) Undertaken load bank testing for a total of 2 hours continuous loading as follows:
   a) Load at 25% of name plate for 30 minutes
   b) 50% for 30 minutes
   c) 75% for 60 minutes.

It is also recommended that all automatic transfer switches (ATS) are tested 12 times per year with intervals between 20 and 40 days. The provider of the power system through planned maintenance programs can undertaken load testing when testing the ATS.

Solutions to "Wet Stacking"

The obvious solution is to always run the generator set with an electrical load that attains the designed operational temperature of the diesel, which is approximately 75% of full load. If Wet Stacking has not yet reached the level where carbon buildup can only be removed by a major engine overhaul, built-up fuel deposits and carbon can be removed by running the diesel engine at the required operational temperature for several hours.

The following load bank solutions should prevent an reoccurrence of Wet Stacking.

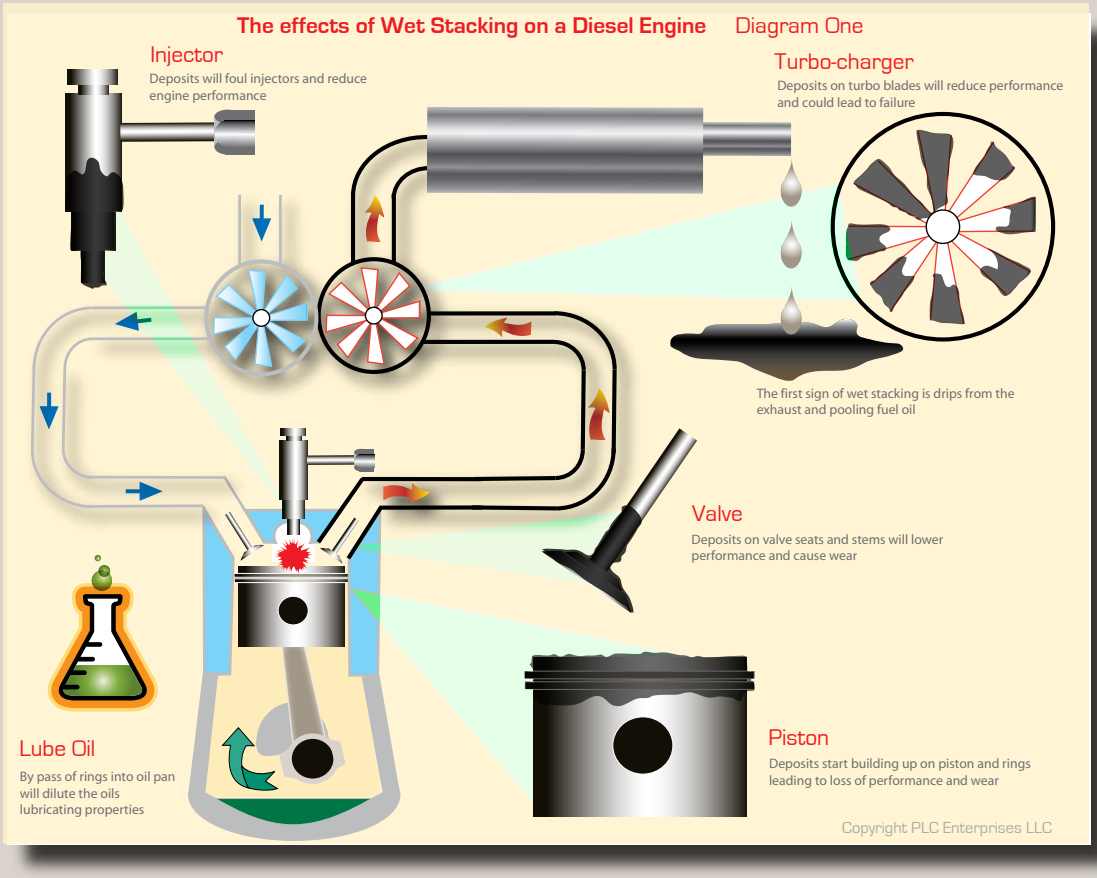
Automatic auxiliary loading: This solution is usually only used when the diesel generator set is the primary source of power. When only the lighter loads are present the "auxiliary load bank" will be switched into the system and switched out when the larger load is connected.

Facility manual load bank: Operated as described for the automatic load bank, but a manually operated system for use with light loads and when the larger load is also manually initiated. The load bank can also be used for load testing a system primarily used for standby power.

Portable load bank: The distributor for the diesel generator set is in many cases the best qualified to undertaken the maintenance of the system. Today it is very common for the owner of a standby generator system to out-source complete maintenance of the system and have a Planned Maintenance (PM) contract with a complete service generator set supplier.

During a regularly scheduled PM maintenance call the distributor will bring in a portable load bank and run the generator at a load that maintains the designed operational temperature. (see photo)

Portable load banks range from a few kWs to 1 - 3MW units mounted on large trailers.



Typical Portable Load Bank

The load bank shown above is used for loading sets up to 600kW

The professional power distributor has available portable load banks from 10kW to more than 2MW

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