CHOOSING THE RIGHT TECHNOLOGY FOR YOUR STANDBY DIESEL GENERATOR

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Introduction

In today's world we are surrounded by concerns for the environment. We talk about long term sustainability and about preserving the planet for our children and these concerns are rightly driving technological development and the decisions we make every day either at work or at home. Keeping those issues at the forefront of our minds when making the right choice for backup power generation for a data centre might seem to be something over an overreaction, but the choices are no longer as simple as 'I need a quality diesel generator system'. From operational needs of the business, supply chain issues, new environmental regulation, to a forward thinking and clear focus on environmental issues, the standby diesel power generation market has seen the introduction of many technological innovations which is defining the field.

What issues do you face when selecting the right technology for your needs?

There are, of course, a significant number of high-level issues that must be considered when selecting from the various available technologies you require from your critical back up power generation system. There are the basic ones that you should expect from any supplier whilst there are other elements which are only available from a few specific vendors in the market. All these aspects need to be considered when making those critical procurement decisions.

The Supply Chain

One of the most significant things that surfaced both during and after the COVID pandemic was the relative fragility of the global supply chain. In normal times there is typically an extended period between ordering and commissioning of multi-megawatt scale diesel generators system for large hyperscale data centres. The post pandemic impact of supply chain issues and the availability of generators resulted in a significant increase in those already on long lead times. When you consider the many hundreds of points in the supply chain that could be and were impacted, from basic raw materials and logistics, to out of sequence deliveries and manufacturing delays it shouldn't be a surprise that there are problems in all parts of the production process. In many ways it has highlighted the need to work with top tier manufacturers and equipment suppliers. The more controls the manufacturer or supplier has in place with its supply chain the more accurate the product delivery dates are likely to be.

Many suppliers found it necessary to hurriedly seek alternative sourcing for key components which can lead to a reduction in the level of product quality. Companies with good relationships with their supply chain, good control of their procurement and production processes are less frequently impacted by even global disruption and as a result tend to make superior business partners.

Resilience and Uptime

When it comes to buying a diesel generating set, the adage 'you get what you pay for' still applies. High quality equipment will invariably be better built and be a more resilient product. It is often the case that the generating set is one part of a more complex package of ancillary equipment, so this rule doesn't just apply to the generating set but also to the fuel system, the attenuation or container the set is housed in too.

Buying a high-quality package and having it installed and commissioned by a team of professionals is just the first step. Regardless of the equipment, ensuring that the manufacturer's recommended maintenance regimes are adhered to is critical. Standby diesel generating sets are complex pieces of equipment made up of many parts that all need to be maintained to ensure reliability of the whole: from the coolant belts to the starting batteries.

Having a maintenance contract in place with the principal equipment provider / generating set manufacturer's dealer will ensure you have fully trained technicians who are both conversant with the products they are dealing with and more importantly have access to engine management / control system software updates. From consumables to spare parts, having access to these contacts will take away any of those unexpected operational surprises.

To ensure maximum uptime and resilience, having physical redundancy really does make sense be it N+1 or 2N. This level of redundancy can provide that extra level of security in guaranteeing a highly reliable power source. Of course, not all facilities require this level of redundancy, but if there is an expectation exist that there could be any extended outrage requiring the data centre to run on its backup power source, the adage 'one is none, two is one' clearly applies.

Whilst grid reliability in the UK is very high, local disruptions can take place. With an increase in highly disruptive weather, we need to be prepared as any organisation that has survived an extended power outage firsthand will testify. This has never been more important than now with the UK government designating data centres as "Critical National Infrastructure".

Typical Data Centre

Right sizing your generator(s) plays an important part in overall system reliability. When building a data centre, you need to select a critical backup power system that meets worst case scenario conditions or built in such a way that permits additional capacity to be added as and when needed. A system design to allow effective "scalability" adds a range of resiliency. Right sizing is also key as over provisioning your backup generation, aside from adding to cost of the build, can cause problems. Generators are rarely efficient when running at low loads, which can in turn lead to long term maintenance issues, not to mention the additional maintenance and operational costs and other Scope 2 and 3 emissions.

Sustainability and Environmental Impact

The use of diesel power standby generators in data centres is one of the most noted factors when complaining about the sustainability and environmental impact of data centre installations.

While they might be the most economically efficient solution for backup power, the complaints of both air and noise pollution from large diesel generator installations are valid ones. As viable alternatives are developed, it is unlikely that diesel power generation solutions will be replaced anytime soon, more especially so in existing installations.

During this period of transition to alternative fuels, operators will make sure they are looking for the most environmentally sound solution in the selection process for diesel backup power. Identifying the most efficient generator packages is a good place to start but equally important to ensure that all aspects of their impact on the environment is fully considered; in other words that the generator enclosures, fuel systems are factored in as they play a significant part in the decision process. From an outsider's point of view, it can be a surprise just how big a part the generator enclosure and fuel system can play in the overall package footprint.

For example, the enclosure / container not just provides a convenient housing for the generating set and associated elements, but its primary function is in reducing the noise level of operating diesel engines whilst not impacting the necessary airflow needed for efficient operation. The enclosure will be designed in such a way that any maintenance required can be fulfilled without compromising accessibility to key parts and locations. The enclosure protects the generator from the external environment particularly major weather events, when backup power will most likely be required.

Other environmental and sustainability issues encountered include the emissions of diesel generators (CO2, CO, NOx, PM etc). We now use fuel made to BS EN590 B7 and have a 7% bio element; HVO fuel is now also available. This along with other legislative changes such as the Medium Combustion Plant Directive (MCPD), low emissions zones etc have led us to the development of more fuel efficient and cleaner more sustainable diesel power production. Since backup generators are run on a regular basis to test and guarantee availability in "on demand situations", much of the environmental impact can be mitigated by a technology known as "no-load" or @low load" maintenance regimes.

Sustainability and Environmental Impact

When it comes to generator maintenance the 'gold standard' is the regime recommended by the manufacturer in the O&M manual as the requirements will vary depending on the engine type used. This applies as much to the frequency of fluid and filter changes as to load testing. Load testing regimes can differ from engine to engine but also to the specific application that the generating set is being used on i.e. healthcare or data centre where the requirements may be enhanced or diminished depending on the client ad operational constraints of the business. As there is 'no norm' and keeping in mind that the entire changeover and electrical distribution should be part of the test, it has become quite common practise for the set to be run "offline" or at low levels of load on a monthly basis (with an annual on load test or load test with a load bank once or twice per year). Off load, no load or light load testing without at least an annual load test can lead to long term reliability issues with the engine. It is important that the engine and peripherals (e.g. emissions treatment equipment) get up to full operating parameters and for a sufficiently long time to prevent the phenomena known as "wet stacking", which is when unburned fuel, soot, moisture and carbon are deposited in the exhaust system of the generator. Wet stacking reduces the efficiency and performance of the system and potentially can cause system failure or engine damage. The cause is well-known and is directly linked to not getting the engine to its optimal operating temperature and load where fuel is not fully burnt in the combustion chamber.

Diesel engines designed and put into production in the last 10 years (such as the Rehlko KD series engines) are more efficient in operation and typically run at higher engine temperatures. This can potentially prevent wet stacking and enable a maintenance regime which requires only a single, annual run to test optimal temperature and load. This has also been facilitated by new materials and key parts of the engine that have been manufactured to much tighter tolerance. Other changes in the manufacturing processes which have led to improved operating efficiencies have incorporated the minimisation of the piston ring gap, which reduces the ability of unburnt fuel and lubricating oil to escape. Less blow-by means that the engine is burning more efficiently, reducing the opportunity for stacking to occur. Better engine control and management, the use of common rail fuel delivery have improved overall efficiency of fuel delivery to the engine, allowing it to be more carefully tuned to the operation of the engine, a process known as fuel mapping.

Other changes include techniques such as charge air cooling, which allows more air delivery to each cylinder at a lower temperature, again allowing more efficient combustion. The combination of all these features combined with the use of the manufacturer's specially formulated coolant and lubricants are necessary for the no-load maintenance technique to work.

With the potential now available to reduce the frequency and scale of load testing this opens the opportunity to reduce the amount of fuel burnt and hence CO2 emitted during

system testing. This can result in as much as an 86% reduction in greenhouse gases and over 40% reduction in particulate matter (PM) (based on using a 3250kW load banking cycle). It is important to note that not all diesel generators are rated for this type of no-load / low load testing cycle, and it is critical to talk to your vendor before moving to this model as not to void any warranties. Other operational conditions may also apply.

To further reduce emissions, it is now possible to run your diesel generator on Hydrotreated Vegetable Oil or HVO fuel. HVO is a second-generation biodiesel fuel and is approved for use by the three largest global manufacturers of diesel generating sets. When made from fully recycled sources it offers a potential up to 90% reduction of CO2 over the product life cycle when compared to traditional fossil diesel. HVO has a higher cetane and hence burns more efficiently and has the potential to improve engine performance. HVO also has a longer shelf life than conventional EN590 B7 diesel products. HVO fuel is currently more expensive than traditional diesel fuel but as demand increases so will supply and prices will fall.

Combining modern engine designs with emission reduction technologies is the key to building a sustainable backup power supply.

Diesel Engine Certification

Starting back in the late 1990's the EU started to introduce a set of emissions standards for new non-road diesel engines. The aim of these standards was to reduce emissions generally but particularly CO2, nitrogen oxides (Nox) and particulate matter (PM) emissions from diesel engines used in applications other than those used on the road network. In general terms there are now two levels of emissions for non-road generating sets; one for fixed installations and another for generating sets and mobile plants typically used on construction sites such as earth moving plants and temporary generation feeding tower cranes and site cabins etc.

Rehlko (formerly Kohler) Stage V generating set

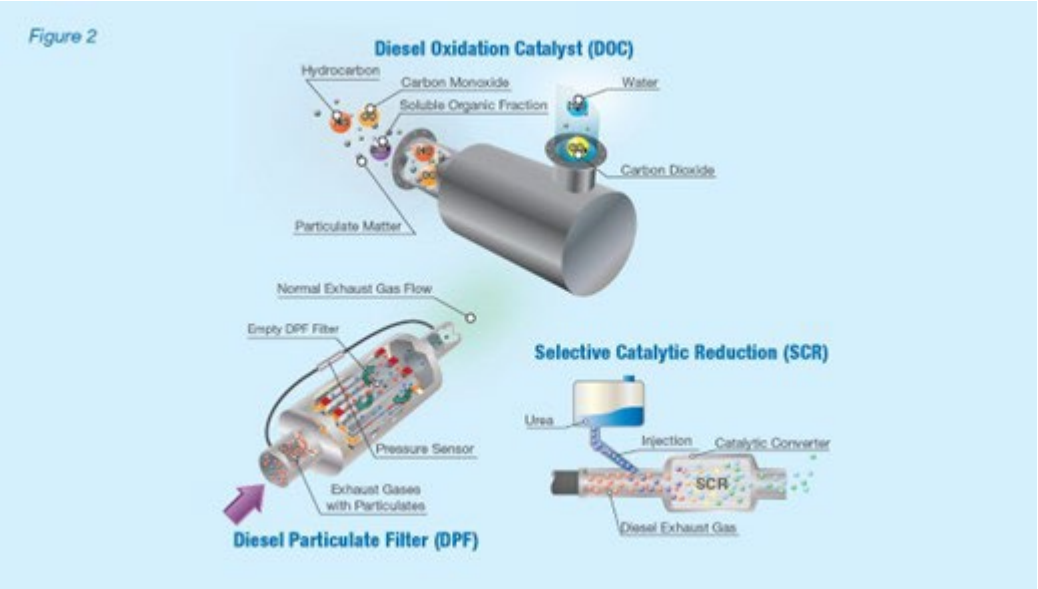
Stage V generating sets that are now being rolled out across the construction industry are being fitted with more modern engines and catalytic converters such as SCR equipment (Selective Catalytic Reduction) that are focused on reducing NOx, PM, HC, and CO.

Anyone familiar with diesel vehicles are likely to be familiar with some of these exhaust after treatments. It is now standard practice for those using newer diesel power road going vehicles to top up with 'AdBlue'. AdBlue is the liquid injected in the vehicles' SCR to reduce NOx emissions. Some may also be familiar with their diesel engine periodically running 'hot' for a short period. This is when the diesel particulate filter is cleaned.

For other fixed generator installations (which is the focus of this piece) such as those used in hospitals, Data Centres etc, engines are manufactured to meet Tier 2 standard. To supplement the Tier 2 standard various other emissions requirements are in place to ensure emissions from these standby sets are further reduced such as

- Medium Combustion Plant Directive (Adopted by the EU 2016 implemented 2019)
- Industrial Emissions Directive (IED) 2010 – for larger infrastructure such as Data Centres and industrial applications

The Diesel engine and generating set manufacturers have worked to develop engines that comply with new regulations and as a result, there have been significant advances made in recent years to reduce emissions of Particulate Matter (PM) Hydrocarbon (HC/soot). This has been achieved by the use of newer materials, common rail fuel induction systems and new manufacturing techniques ensuring engines are manufactured to much tighter tolerances. This new generation of engines, such as the Rehlko KD series engine are much less polluting than older designs, so when selecting a new standby generator it is important to review levels of engine emissions more generally to ensure any exhaust after treatment equipment isn't over specified. For older installations and engines of an older design these issues will continue to be a problem until they are replaced.



Various types of exhaust after treatment

When data is king, make sure you protect it!

A familiar saying we hear these days is that 'data is king'. This is a message that IT businesses have been sending for the last few years as we look at new ways to utilise the information that businesses collect about us as individuals. With the growth of AI applications, this will only lead to a further increase in the collection of information and the need for ever larger data centres. Making sure that data is properly protected is a significant part of maintaining the data.

Choosing the right technology for your standby power generation is an integral part of protecting the data in such facilities. When building a data centre or any significant piece of infrastructure such as a hospital (particularly as we move to all electric hospitals), power capacity planning is an essential part of that process. The information derived is one of the primary considerations for sizing the critical power train which includes the capacity of the standby generation. It isn't the only requirement though as consideration must be given to potential scalability and growth issues. Standby generators are but one component of the critical power train that should include multiple redundant power paths, uninterruptible power supplies, power conditioning, surge protection, and the transfer switching of all which is dependent on a continuous supply of power.

Many current data centres are designed to provide more power than required. From day one the standby power needs to be selected and configured in such a way that scaling that power source isn't something that ends up being a roadblock in the future development of the site. It is important to plan for higher rack densities and a greater power demand. If the design of the critical power train (along with your cooling) can't be scaled up to support the increased load, future flexibility is lost.

Redundancy is key to maintaining a high level of power availability on any site. This can be achieved using 2N or N+1 standby power sources; these also need to be scaled up with the growth of the facility.

Having planned with the likelihood of increasing power consumption over time, it is important to continually monitor power usage across the site to ensure there is insight into the power demands and consumption patterns of the data centre or hospital on a real-time basis. The information acquired will allow you to guarantee that your backup power supply meets ongoing demand.

Kohler (now Rehlko) generating set

Preparing for the future

In some quarters there is a still a tendency to think of backup power as 'put it in and forget it' technology. Once installed the maintenance and testing procedures are purely functional. While that view is easy to understand, the relentless march of technological innovation means that more efficient and sustainable options will continue to appear, even if it is something as simple as making the decision to move your standby generator from EN590 B7 white diesel to HVO fuel. It is necessary to continue to re-evaluate technology on a regular basis just as you would if it were an IT solution or new software. This is even more so as the power demands of your business operation changes. There is currently no environment changing at a faster pace than that of AI technology being introduced into the data centre space.

The first diesel engine was developed over 125 years ago, but it is safe to say it has seen its greatest advances in the last 25 years and even safer to say that technology will continue to advance and be a part of our sustainable future.

The author acknowledges the significant contribution made by David Chernicoff of Kohler Power (now Rehlko) in the preparation and writing of this article.

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Geoff Halliday started his career as an apprentice working for Square D (later part of Schneider) before moving into the critical power sector where he has now worked for over 40 years, splitting that time equally between both the UPS and standby diesel generation sectors.

During this period Geoff has held several roles ranging from Customer Service Engineer, Project Manager, Technical Director, Sales Director through to Managing Director.

The Critical Power market exposes the individual to a wide and diverse range of market sectors ranging Health Care, Life Science, Water Treatment, Banking and Finance, Military, Manufacturing, Process Control through to Data Centres of all sizes. Drawing on his management skills, product knowledge and vast application experience amassed throughout his career Geoff now enjoys sharing his knowledge with others.