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The Machine Reliability Expert

White Paper - Data center solutions

Category - EPC Projects

Data center downtime due to the malfunctioning of backup power system… whom do you blame?

CONTEXT

Demand for data in India is soaring and hence the number of data centers are increasing manifolds. The new hyperscale facilities are much more power hungry and designed with tier IV levels of uptime assurance. Unfortunately, the grid power in the country has not been keeping pace in terms of the capacity, reliability and the quality of power supplied. As a result, more than 95% of data centers in India are practically dependent on frequent use of the DG backup power system. But at times even this backup fails? Whom do you blame?

CHALLENGE

There could be no room for downtime in the data center design. In the event of a grid power outage, the emergency backup power of Diesel Gensets should start in less than 25 seconds to avoid interruptions in operations. However, at times these gensets may just refuse to respond as expected, causing the worst nightmare for the data center operating team. The standard design practice of n+1 redundancy also can't avoid this possibility.

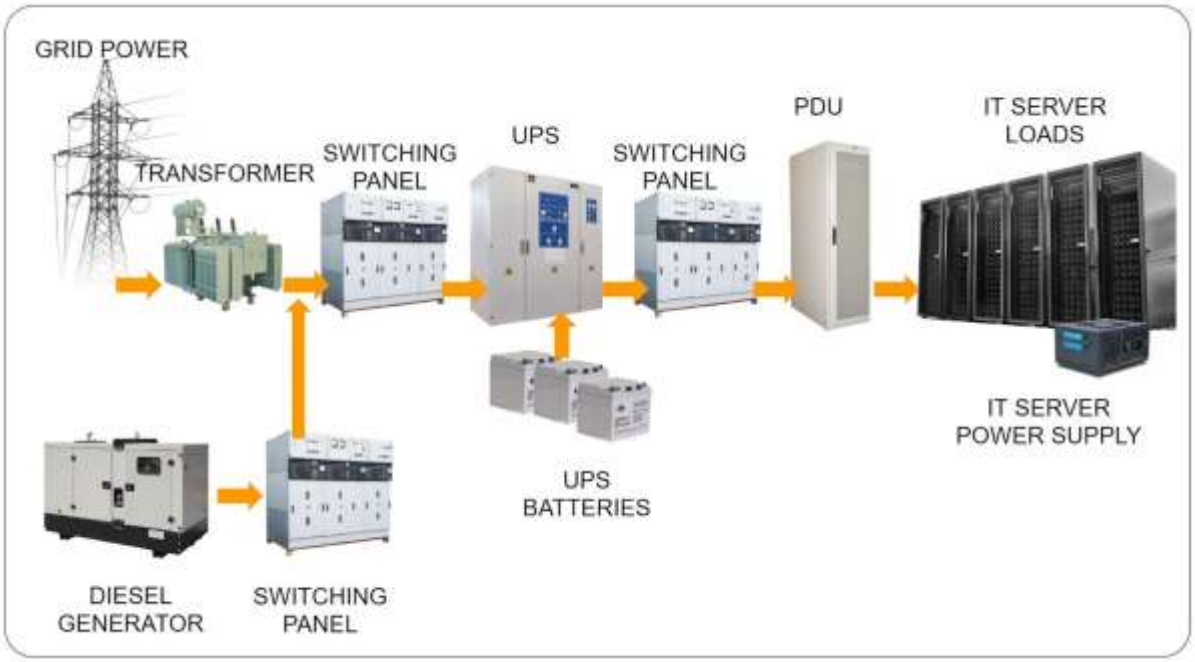
SOLUTION

The delay in start-up or scaling-up is not due to the DG set itself, but is often a result of inadequate 'fuel management system'. Unfortunately, this aspect may get ignored or underplayed during the project design and execution where the focus remains on high-side and high cost elements like the DG set itself.

This paper discusses the fuel management system in detail including its objectives, components, design and value in avoiding costly downtime. It can also be retrofitted in an existing data center facility.

Power supply architecture & utilities for data centers

Figure 1 below shows a power supply system schematic for a typical data center.



The primary source of power at the data center is typically the local power grid. In case of a grid power interruption (which is not so uncommon in India), a provision of backup power source is mandatory. This is

fulfilled through a DG power plant set-up within the data center premises. This also includes on-site storage and handling of fuel (diesel) with underground tanks and network of pipelines connected to the DG room.

In the event of grid outage, an automatic switching mechanism is provided to seamlessly switch the connectivity from grid power to DG power. An intermediate emergency power backup is provided with battery operated UPS system for IT load. But no direct backup is available for the CRAH and chillers units in server room, hence the DG backup power needs to start and ramp-up at the earliest so as to take over the entire load.

Need for fuel management system

The malfunctioning of DG sets by way of failure to start or to synchronize quickly can be traced to an inadequately designed fuel management system. By nature, diesel deteriorates over time, and the longer it is kept idle either in storage tank or inside the diesel generator, the rate of degradation is faster. If such diesel is fed into the DG set, it will lead to sludge formation, clogging of filters and several other problems.

In many markets including India, there is a trend towards the use of 'clean fuel' which has lesser sulphur content, is sometimes blended with biodiesel and other additives to ensure clean burning and less harmful emissions. While it's a good move in general, it is also a cause of potential trouble because, compared to earlier grade, this cleaner grade of diesel is prone to faster decomposition and sedimentation when stored for a longer time in the tank.

Other factors that drive the need for the fuel management system are critical controls involved at various stages of fuel handling, right from the intake at the tanker unloading bay to intermediate movement between the storage tanks, supply through a network of pipelines, day tank and final supply into the DG set. Leaving this handling operations to manual judgement can be prone to errors. The automated measurement, and control of fuel quality & transfers help in enhancing efficiency, reliability and cost optimization.

Can it be retrofitted into the existing data center?

For all new generation data centers with hyperscale capacities and tier IV reliability, use of full fledged Fuel Management System is mandatory. But even for the older data centers, it is a worthy upgrade to consider so as to stay competitive and avoid costly downtime in the future. Some of the reasons why older data center should go for the upgraded fuel management system are listed below;

1. For the data centers which have been in operation for some years now pollutants and impurities would have got collected in the fuel tank and can be a cause of DG set failure in future.
2. Older manually operated systems are prone to errors in terms of valve operations & safety lapses. Also these will not detect the fuel leaks leading to fuel wastage and higher operational costs

3. Older systems only provided for one direct connection between fuel tank yard and DG set. This has the single point failure risk, that can be avoided with the upgraded fuel management system
4. Inadequate fuel management system can be a hindrance for the future capacity expansion and getting uptime certification etc.

Design considerations of the fuel management system

Fuel management at the data center site involves management of:

- **Quality:**
  Maintaining the right quality is crucial across the life cycle of diesel from the moment it enters the storage tank till its consumed in the DG set.
- **Capacity:**
  This largely depends upon factors like how long the DG backup power is required to run and the overall space available.
- **Other Factors:**
  There are also some regulatory guidelines (example CCoE, CPCB etc.) that govern the design. Other key factors include; automation for monitoring the fuel levels, detection of leak and theft, measurement of fuel consumption and providing real time insights of the same

Points to ponder upon while designing the Fuel Management System

1. Ensuring availability of clean filtered fuel throughout the system, from storage tank to the day tanks is one of the key objectives of the fuel management system. This is achieved by the fuel polishing unit that helps filter out impurities like solid particles, water ingrace, sludge, sedimentation etc. It not only clean the fuel at the intake/ entry point but also during circulation of fuel across the tanks. The key benefits of using the Fuel Polishing System are as follows;
   • Reduction in DG maintenance expenses
   • Less likelihood of failure of fuel injectors
   • Lesser buildup of sludge (sediment, rust, water, etc...)
   • Reduced noise and smoke during DG set operations
2. Sometimes, additional fine filtration system between day tank and engine is included in the fuel management system to prevent injectors of DG set from choking
3. By design, the fuel management system provides for redundancy in fuel supply piping network between the storage tank and day tank in the DG room. Two routes of piping ensures that there is no single point of failure. Automation is incorporated to switch the alternate route in case the primary one can’t be used.

4. Diesel is a costly fuel and any pilferage can be quite costly. The fuel management system incorporates multiple check-points and metering to maintain an accurate accounting of fuel consumption. This is also helpful in measuring the efficiency of DG sets if required.

5. By design the storage tank holds upto 48 hours of running stock of diesel. However, anticipating situations where this storage may not suffice, the fuel management system has provision for the rapid bunkering of the tanks in case of prolonged shutdowns.
6. From the safety viewpoint, the fuel management system incorporates technologies like fusible link valves that help in quicker evacuation of the day tanks in case of fire in the DG Power House. Fitment of spillage tank arrangement under the pipe trench inside DG room will avoid the fire incidence.
7. Provision of a leak detection system across the fuel pipeline helps detect oil pilferage. It can be connected to the central Building Management System (BMS) to raise alarms.
8. Finally, the fuel management system is also required to provide adequate security and protection of the sensitive fuel storage and handling areas through fencing and secured access control.

Key components of the fuel management system

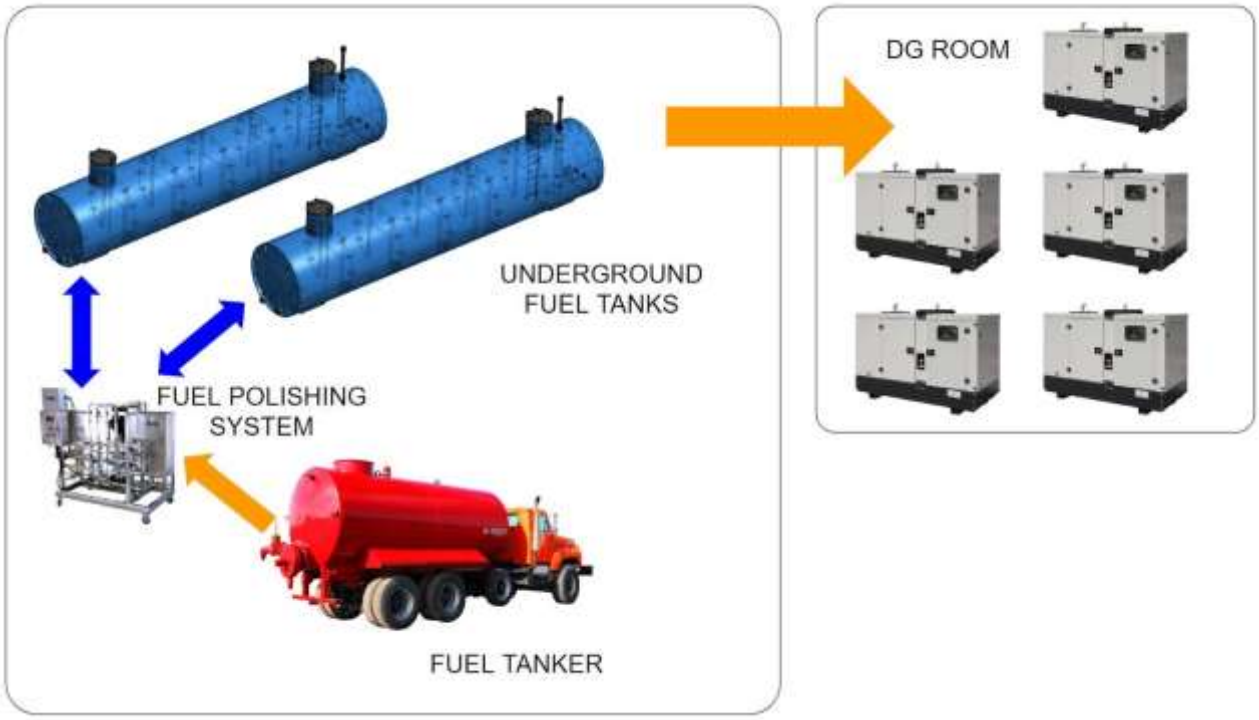


FIGURE 2 : Fuel Management System Layout & Key Components

1) Tank Yard

a) Underground tanks preferred due to better safety
b) Tank capacity (std. 90kL - IS10978 std or usage requirement/ space constraint)

c) Tank size 13-14 m length x 3.15-3.45 m height
d) Tanks redundancy N+1

e) Space considerations
    i) Provide for turning radius of the oil tanker
    ii) Provision of “dike wall” around each tank
f) Fire protection & fighting system
g) Proper earthing system to provide to the underground tanks

2) Fuel polishing unit

i) 1 running 1 standby : (n+n)
ii) Pump + filter assembly

3) Fuel transfer pump

i) n+n or n+1 redundancy
ii) Canopy with Electrical panel

b) Fuel input flow meter
c) Instrumentation + earthing needed for each tank in the DG room
d) Leak detection system - High resistance leak detection to give alarm

4) Related to the DG Room

a) Spillage/settling tank fitted in DG room
b) Fuel transfer pump - from storage tank to day tank
c) Max limit for the day tank is 990 L / DG set as per the CCoE norms
d) Automation - valves, instrumentation - connected to fuel automation system
e) Panels + PLC for control purpose

5) Fuel Fire safety system

a) Piping design
b) Tank isolation / Dike walls between two tanks
c) Fire hydrant system for tank yard
d) Fire alarm system and sprinkler system
e) Fire cortons between bays inside DG room
f) Explosion proof electrical equipment inside tank yard - Light. Switches
g) Minimise downtime

CONCLUSION

Cost of a downtime is far more expensive in a data center than in any other industry. The DG backup power system is prone to failure if it is not shielded with an adequate and automated fuel management system. Sedimentation, impurities, decomposition as well as water ingrace are the main factors causing degradation of diesel that can cause malfunctioning of diesel generators. This was experienced in the USA. During the Hurricane's Sandy and Katrina, there were numerous instances of downtime reported by the data centers and other infrastructure due to failure of backup power to kick-off when needed.

A robust and well designed Fuel Management System ensures that the DG backup power solution will be able to operate with very high reliability, responsiveness and at a lower operating cost. This not only applies to new projects, but can also be retrofitted into existing data center facilities.

Domain experts such as the Uptime Institute and The Society of Automotive Engineers (SAE) place a high degree of importance on fuel cleaning and polishing to ensure reliable operation of the DG set. From fuel capacity planning & automation perspective as well there are norms that guide designing of an efficient, reliable and intelligent Fuel Management System.

Data center establishments spend millions of dollars in erecting the sophisticated backup power infrastructure for ensuring power reliability and this investment can be justified by caring for the fuel that goes inside by incorporating fuel management system.

Neptunus combines 23+ years of experience in engines and generators to design and deliver solutions that work. We serve customers from 25 countries in marine, oil & gas, industrial and data center segments. We offer reliable solutions in "advanced predictive maintenance" and "turnkey project engineering". We undertake a complete EPC package comprising of the backup power plant, associated fuel storage & management, HVAC, MEP and the Fire Protection System.

Website: www.neptunus-power.com, Email: info@neptunus-power.com

About the authors

Author : Uday Purohit, Founder and Managing Director

Tel: +91 98200 75933; Email: uday@neptunus-power.com

Co-author : Satish Kane, Sr. Manager - Project Management

Tel: +91 98894 77269; Email: satish.kane@neptunus-power.com