Backup Generator Sets and Disaster Planning / Recovery

MTU Onsite Energy

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Based in Mankato, Minnesota, MTU Onsite Energy is a leading producer of diesel-powered generator sets from 30 to 3,250 kW and natural gas-powered generator sets from 30 to 400 kW for standby, prime power and cogeneration applications. The company also provides automatic transfer switches, paralleling switchgear, controls and accessories for complete power system solutions. MTU Onsite Energy is a subsidiary of Tognum America Inc., part of the Germany-based Tognum Group.
Emergency and Standby Technologies

- **Diesel Reciprocating Engine based generators** - Compression Ignition (CI) or Reciprocating Internal Combustion Engine (RICE); engine used in trucks, large industrial equipment, etc.
- **Gas Reciprocating Engine based generators** - Spark Ignition (SI). From small vehicle engines to large industrial engines fueled by LP and/or NG for example.
- **Gasoline Engine generators (SI)** - typically smaller generators for home standby, etc. Equivalent to car engines.
- **Gas Turbine** based generators
- All others such as SEPSS-Stored Emergency Power Supply Systems; UPS, Solar and Wind based; Nuclear (NFPA 111)
Emergency and Standby Technologies

• **Emergency Power** is primarily intended to indicate where a back-up source of power is mandated by code or law; Life safety and security are essential mission of the facility or application. Hospitals, hazardous material handling, water and waste water facilities, or other Critical Operations such as, security, military, civil defense, flood control, etc.

• **Standby Power** is primarily intended to indicate where back-up power is discretionary; continued process for commerce and e-commerce, food storage, convenience, etc.

• **ESP-ISO-8528 Definition Follows:** Basis of EPA and other codes and standards. All manufactures use this standard.
ESP is the maximum power that a generator set is capable of delivering

- Variable power sequence (70-85% Load Factor)
- Stated operating conditions
- Utility power outage or testing – up to 200 hours/year

ESP rating is typically applied to maintain building function in the event of an outage of a normally reliable utility
ESP – Permissible *Average* Power Output

**Based on 24 hour period of operation**

- Shall not exceed 70% of ESP rating
  - Unless agreed by RIC (reciprocating internal combustion) engine manufacturer

- **MTU approves 85% average power output**
  - Products ranging from 230 - 3,250kW
Considerations in Application of ESP rating

Utility
- Considered normally reliable?
- A sustained outage; outage lasting longer than 1 minute

Estimated Annual Usage
- Typically anticipated to be 200 hour per year or less, including maintenance requirements (Note EPA has limited it to 100 hours per year for all non-emergency related operation for testing or other approved mitigation activities)

Peak Demand
- Typically sized to no more than 80-90% of maximum standby rating but capable to full nameplate.

Average Demand - 24 hour average of variable load
- Typically sized to 60-80% of standby rating
Technology Comparisons

CI vs. SI
Compression Ignition (CI), primarily Diesel fueled units are the preferred and main technology used in emergency power generation.

- Quick start; NFPA 110, Type 10 for 10s to accept load.
- Transient performance; accept up to 100% of nameplate in a single step.
- Relative ease of maintenance and operation
- Long history of reliable support in emergency conditions
- Ability to fumigate with Natural Gas for longer run-times and cheaper fuel cost for extended runs-careful with emissions however!
- Emissions is a huge issue confronting diesel generators
Technology Comparisons

CI vs. SI

Spark Ignition (SI), primarily gaseous fueled units, are an increasingly popular alternative to Diesel engines.

- Fuel Storage benefit when NG is the fuel; no large Diesel tanks requiring polishing and filtering.
- Abundance of NG and cost of fuel.
- General benefits from exhaust gas emissions mitigation, Application of control technology cheaper for Rich-burn engines with three-way-catalyst for example. Lean burn more complicated due to need for SCR/DPF/DOC.
Technology Comparisons

CI vs. SI
Spark Ignition (SI); cont.

- First cost is generally higher due to the need for more displacement; NG has lower BTU content compared to Diesel. Need more engine for equivalent kW.
- Time to start and accept load could be limited.
- Public directive to use wherever possible.
Technology Comparisons

Gas Turbines

Where large need for power and possible Combined Heat and Power (CHP) are needed, a Turbine has a very high power density to space claim. These systems are traditionally very complicated and require a fairly sophisticated installation and facility management approach.

Time to start and accept load would not fit a traditional emergency application.

Additionally, storage of diesel would not be practical for a very large turbine generator, so it would rely on Natural Gas, if that supply of fuel were interrupted for some reason, the mission of the power supply would be compromised.
Technology Comparisons

SEPSS - Stored Emergency Power Supply Systems

- **UPS** is quite common - requires some kind of storage, typically batteries, rotary, fly-wheel, etc. Limited time 15s-15m, complicated installations and service demands. Quite often used in conjunction with Diesel Generators when outage to critical equipment cannot be tolerated but extended run time is necessary.

- **Solar or wind based** obviously have limitations, day-night for solar, and wind needs to blow. Need some kind of storage. Limited use in emergency applications due to reliability as on-demand need can be compromised. Some hybrid Solar with DC generators through invertors are available. Cost vs power density still an issue.
Fuels

Diesel

- Highest BTU content for the volume
- Combustible, but not volatile. Safer than flammable liquids
- Readily available.
Fuels

Diesel

• Very specific regulations to the supply, low sulfur for example. Major influence of exhaust emissions and major impact to generator performance.
• Storage and shelf life are problematic. Certain codes, in a seismically active areas for example, may require as much as 96 hours of fuel storage on site for those generators with a special seismic performance certification. May require additives, polishing, and in extreme climates heating or cooling.
• Spill containment and hazardous material handling needs. Limitations on quantity in enclosed areas. 660g in defensible fire fighting area;
Fuels

Diesel

- Availability of fuel after an event, man or nature made. Need to have contingency plans for the continued supply of fuel.
- Special consideration for the design of fuel storage (no basements); delivery (power for pumps on emergency power); and conditioning (filtration and water removal as well as polishing for long term storage conditions); and ease of access for replenishing fuel supplies.
Fuels

Natural Gas
- Abundant supply and currently inexpensive
- Benefits to exhaust emissions
- Fuel storage not a concern
- Some concerns during natural disasters affecting fuel supply, earthquakes and severe storms or fires.
- Power density is much less than Diesel, requiring larger engines to supply similar output (kW).

Dual Fuel-NG and Propane
- Allows benefits of NG with on-site storage of Propane
- Usually a de-rate for propane use.
- Correct tank installation and design details for delivery.
Bi-Fuel-not yet widely accepted but many inquiries!

• Benefits of Diesel application;
  ✓ Start and accept load on Diesel, then introduce NG once load is stable.
  ✓ Seamless transition of NG supply is removed.
  ✓ Extended run time of 3X of on-site fuel storage.

• De-rate of 15-20% from Diesel rating.

• EPA has recently provided guidance on this technology. Site stack testing may be required to ensure that the original Tier certification is met. PM benefit, slight benefit to CO, NOx may actually increase. If installed, EPA considers original manufacturers Tier certification invalid until proper stack testing is done and verified to Local/State/Federal compliance requirements.
Fuels

Bio-Fuel

• Not to be confused with Bi-Fuel, Bio-fuel is a non-petroleum based fuel oil. Typically Vegetable oils and animal fats.
• B5 (5%) to B20 (20%) used in generator applications
• Some states have mandates, e.g. Minnesota has a B5 blend requirement.
• Some reduction of PM, CO and Hydrocarbons for exhaust emissions.
• Considerable maintenance requirements.
• Storage environment and shelf life limited.
• Not a good fuel for emergency standby generators in my opinion. MTU OE soon will have a white paper on the use of Bio Fuel content in Diesel Engines.
Emissions

- EPA allows for certain exemptions for emergency standby application; Current level emissions allowed, e.g. T2 for >560kW. Typically no additional after treatment. Limits to run time of 100 hours per year of non-emergency use; maintenance and testing and:
  - 15 hours for non-revenue related demand response
  - Energy Emergency Alert Level 2 situations
  - Potential voltage sags, collapse or line overloads that could result in regional power disruption
  - Storm avoidance; hurricanes, ice storm or other similar emergency.
Emissions

• Revenue generating demand response will result in the need for a Prime rated unit, and thus T4i certified for larger units.
• Non-emergency related runtime; base load; CHP applications, etc. will require that you meet emissions regulations.
• EPA is the minimum criteria, local, state and other criteria may dictate some other scope of supply, including after treatment. DPF is a common device for Ca. for example.
Application Details from Lessons Learned

• Wind ratings or housing; 100MPH; 150MPH
• Seismic ratings; IBC/OSHPD Is the equipment needed to perform after a seismic event?
• Fuel storage and delivery-Major consideration!
• Fuel quality and maintenance
• Redundancy of power supply and distribution
• Specifying the correct codes and standards for the proper application; NFPA 110; NEC; IBC; UL; etc.
• The proper rating to meet the Federal and local air permit needs.