DESIGN GUIDELINE 263000
ENGINE-GENERATOR SYSTEM AND ROOM

Scope:

This guideline defines the requirements and standards for design of engine-generators and associated system components. The guideline covers basic requirements for design, system components, controls, natural gas fuel systems, exhaust systems, automatic transfer switches (ATSs), room construction, outdoor enclosures and installation.

Related Sections:

U-M Design Guideline Sections

5.11 DG – Fire Command Center
6.2 DG 210000 – Fire Protection
6.2 DG 230060 - Mechanical Sound and Vibration Control
6.2 DG 230900 – Mechanical Systems Controls
6.3 DG 260526 – Grounding and Bonding for Electrical
6.3 DG 260533 - Electrical Materials and Methods
6.3 DG 260800 - Electrical Acceptance Tests
6.3 DG 262000 - Low Voltage Electrical Distribution
6.3 DG 283100 - Fire Detection and Alarm

U-M Master Specification Sections

7.2MS 231123 – Natural Gas Systems
7.3MS 263000 – Engine-Generator System

U-M Standard Details

26000000 - Series Details

Reference Documents

- Environmental Protection Agency (EPA) emissions standards for stationary internal combustion engines.
- NFPA 37, "Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines"
- NFPA-110, “Standard for Emergency and Standby Power Systems”
- UL 1008, "Standard for Automatic Transfer Switches"
- UL 2200, "Standard for Stationary Engine Generator Assemblies"
- International Fuel Gas Code
- Ann Arbor City Code, Chapter 119 Noise Control

Design Requirements:

Use U-M Master Specification 263000 Engine-Generator System as basis for design and specifying Emergency Power Supply Systems (EPSS) comprised of engine-generator units (Emergency Power Supply - EPS), ATSs and associated accessories. Edit the specifications to make them project specific. When editing the specification, turn on hidden text and follow the Spec Editor notes.

Locating EPSs outdoors, on grade level in an accessible location is preferred (see UMHS Design Guideline 263000-H for healthcare related projects). Evaluate and compare locating the EPS in a room versus locating it in an outdoor enclosure.

- Consider initial cost, ease of maintenance, load bank testing, ease of major component replacement, fuel and exhaust piping routes, fuel tank placement, heat rejection, feeder cable lengths, sound, vibration, exhaust re-entrainment, etc.
- For non-Regental projects, obtain Exterior Elements Design Review Committee (EEDR) approval before locating a unit or exhaust stack outdoors where visible to the public.

Provide studies to determine how the EPS's sound, vibration and exhaust re-entrainment will impact the building and surrounding buildings. Perform these studies in the schematic design phase to avoid last minute design changes. See Design Guideline 230060 for applicable sound and vibration limits.

During the schematic design phase, contact the U-M OSEH Air Quality Specialist regarding Michigan Department of Environmental Quality regulations, EPA air permit requirements and estimated EPS kW rating. At completion of EPS submittal reviews, provide the OSEH Air Quality Specialist finalized EPS kW rating. Also notify the OSEH Air Quality Specialist when EPSs are relocated or removed from service.

System Requirements:

Provide a stationary natural gas fueled EPS with ATSs, load testing means, and associated accessories in compliance with NFPA 110, Level 1, EPSS requirements. The University considers the probability of a simultaneous failure of both the natural gas utility delivery system and power from the Ann Arbor campus outside electrical utility to be low. Provide a diesel engine-generator system only when on site fuel storage is required or the EPS performance requirements cannot be met using a natural gas fueled system. Off Campus installations will require analysis and coordination with the local authority having jurisdiction for determination if a natural gas utility delivery system will be acceptable.

Provide generator main circuit breakers located in the unit mounted generator connection panel. Provide circuit breakers for emergency power, standby power, fire pump and load bank circuits. Provide barriers between emergency, standby and load bank circuit breakers. Load bank circuit breaker shall be rated for 100 percent of EPS capacity.

When the EPSS includes multiple accessories requiring power, provide a 208Y/120 volt, three phase load center panel to feed lube oil pumps, electric fuel pumps, cooling water pumps, electric motorized dampers, exhaust fans, lights, and receptacles. Feed the panel with emergency power.

Provide emergency power to the controls associated with combustion air, ventilation air and other systems that must operate when the engine-generator is operating.

Edit the specifications to include the EPS's maximum physical size, maximum allowable sound levels (including the load bank) and maximum allowable vibration levels. Sound and vibration requirements shall be based upon sound and vibration studies.

When multiple units are operated in parallel, the units shall be the same manufacturer and model, have the same kVA ratings, the engines shall utilize the same fuel type and the generators shall be wound with a 2/3 pitch. The loads served by multiple units operated in parallel shall be divided into multiple blocks, prioritized (emergency, legally required standby, optional standby) and controlled so the highest priority blocks receive power even if one unit fails. Emergency loads shall not be shed.

EPA Certification
Engine shall be factory EPA Certified and meet the current EPA exhaust emissions standards for engine-generators operated no more than 500 hours per year and no more than 100 hours per year in a maintenance/test mode. When a factory EPA Certified engine is not available, the engine shall be EPA Compliant Capable and the supplier shall provide the first field certification of EPA emissions compliance as part of the field start-up and performance testing.

EPS Sizing
Design of EPS sets shall be based upon the unit's code defined standby rating.

Size the unit using generator sizing software from one of the specified manufacturers and submit report to Design Manager. Provide sufficient capacity to start the unit's largest block of load while all other loads are running, without exceeding the specified maximum voltage or frequency drop.

Specify minimum required starting KVA, corresponding voltage dip percentage and temperature rise of alternators.

Provide 25 percent spare capacity above the peak projected load to feed future growth.

Automatic Transfer Switches
Specify ATSs to be provided as part of the EPS package and supplied by the EPS vendor. Do not specify them separately. ATSs shall be approved by the EPS manufacturer. ATSs shall be from the same manufacturer.

Provide 3 pole ATSs rather than 4 pole except where the generator neutral is grounded, the generator feeds multiple buildings, or 4 pole ATSs are required by code.

Provide open transition ATSs to feed loads which can withstand interruptions and will restart automatically after transfer to and retransfer from the EPS. Provide closed transition ATSs to feed loads, including elevators, which cannot withstand interruptions and will not restart automatically after transfer to and retransfer from the EPS.

Verify ATSs are adequately rated for the available fault current either from the EPSS or normal power system, whichever is greater. Closed transition ATSs shall be rated for the combined fault current contributions from the EPSS and the normal power system if the two power sources are paralleled for more than 100ms.

ATSs shall include full maintenance bypass and transfer switch isolation sections.

ATSs shall include a microprocessor based control panel. One ATS shall include a programmable generator exerciser time clock.

EPS Load Banks
EPS unit load testing shall be performed using a resistive load bank.

For EPS units located in an accessible location on grade (indoor or outside), provide a means to connect a portable load bank. Load bank staging locations shall be within 80'-0 of the EPS connection point.

For EPS units not located in an accessible location, provide a permanent, 100 percent rated, resistive load bank with integral control panel. Load bank design shall include the following:

- Master load on-off switch and load on-off step switches.
- Load dump circuit and associated components to immediately disconnect the load bank if a loss of normal power occurs during a load test. Show the control wiring on the drawings.
- Digital monitoring system with memory to display and log generator volts, amps, kW and frequency.
- Indicate the direction of heat discharge on the drawings.

Controls and Monitoring
Provide an NFPA 110 compliant control panel mounted on the EPS no more than 78 inches above the finished floor to the top of the panel, including the concrete housekeeping pad and vibration isolators.

Provide a guarded, remote manual stop station in accordance with NFPA 110. Locate it on the outside of the generator room or enclosure. Label it with a laminated plastic nameplate, white letters on a red background.

Provide a remote generator annunciator panel in the fire command center. For buildings without a fire command center, provide a remote annunciator panel in a location where it will be readily visible to maintenance personnel. The remote annunciator panel shall mirror all status indicators and alarms contained on the EPS control panel. Coordinate remote annunciator panel locations with U-M Division of Public Safety & Security, Facilities Maintenance and Utilities & Plant Engineering Department (UPE).

In fire command centers provide a generator remote “Auto-Run” switch and ATS status indicators in accordance with Design Guideline DG 5.11.

In addition to connections to remote annunciator panels, connect auxiliary “generator running” and “generator trouble” output contacts to separate points in the Building Automation System (BAS) DDC panel.

Connect an “on generator power” auxiliary contact in each ATS to a single point in a DDC panel for notification if any ATS transfers to generator power. Show these DDC points on the temperature control drawings.

Do not connect any EPS or ATS output contacts to MOSCAD or to the fire alarm system.

EPS control panel contacts shall be used for control of mechanical equipment required for EPS operation. Do not use ATS auxiliary contacts to control mechanical systems because false mechanical system operation can occur during ATS testing and maintenance.

Natural Gas Fuel System
Coordinate with DTEEnergy to ascertain the range of natural gas pressure available at the outlet of the DTEEnergy regulator and development of an engineered solution. Submit a Service Request form to UPE for new NG service arrangements. Edit Specification 263000 to specify this gas pressure range and update the basis of design with this information.

Obtain the approximate dimensions of the DTEEnergy gas meter train (often 12 feet or more in length) and locate the meter train where it won't detract from the building's appearance (include meter train in any EEDR efforts). Provide protection against vehicle impact where appropriate, such as concrete-filled steel pipe bollards with yellow PVC jackets.

Provide gas piping in accordance with NFPA 37, a second gas regulator at the engine in compliance with the EPS manufacturer's recommendations, and a gas pressure gauge downstream of the second gas regulator.

A frequent cause of EPS problems is low gas pressure caused by undersized gas piping resulting in excessive pressure drop. Size the gas piping system based on maximum gas flow of the EPS and other connected loads.

Engine Exhaust System
Design the exhaust system in accordance with the results of the exhaust re-entrainment study and in accordance with EPS manufacturers' instructions.

Calculate the exhaust system's expansion and contraction with temperature, and provide supports, slides and restraints as required.

Exhaust system piping in direct contact with the earth shall be stainless steel or otherwise protected from corrosion.

Direct the exhaust upward rather than horizontal, and away from buildings, trees, plants and anything else that is combustible.

Exhaust system design shall include the following:
- Flexible section to isolate the exhaust system from engine vibration.
- Hinged 90 degree, flapper style rain cap at the top of the exhaust stack. Do not provide a stack termination that deflects exhaust horizontally, including an inverted cone style cap.
- Manual blowdown valve in a pipe tapped into the lowest point of the exhaust system, and piped down to 24" above the floor for discharge into a bucket in an accessible location.

Provide a silencer with 35 dBA minimum attenuation when the EPS is located in or near an occupied building. Provide a silencer with 25 dBA minimum attenuation when the EPS is located

remote from occupied buildings. Provide a higher attenuation silencer when required by the results of the sound study. Refer to Design Guideline 230060 for additional sound control requirements.

A natural gas unit will require a 3-way catalytic converter. A diesel unit may require a catalytic converter or at least a particulate filter. Provide access for maintenance of the catalyst or filter.

EPS Room Requirements:

Architectural

Space and room requirements for EPSs shall be determined and accounted for during the Schematic Design Phase. Locating the room above the lowest level of the building is preferred.

Separate the generator room from occupied areas or provide sound-proofing and vibration isolation so the EPS will have minimal impact on surrounding areas. Generator room designs should maintain the sound criteria of the surrounding areas.

Per NFPA 110, generator rooms shall have a minimum two hour fire rating including rated walls and doors. Extend the walls from the floor to the deck above. CMU block walls are recommended for noise mitigation and safety. Obtain permission through the Design Manager before providing stud and wallboard construction. Expanded metal mesh, woven wire mesh or chain link fence are not acceptable for EPS rooms unless used to segregate spaces within the room.

Exit doors shall swing outward from the room.

- Exit doors shall be equipped with listed fire exit devices. Door locks shall be keyed with Best "BDM" cores.
- Provide an opening large enough for the passage of the largest shipping section of the EPS. Typically, this means a minimum 8 foot tall by 7 foot wide double door with a removable mullion.
- Personnel doors should be a minimum 36 inches wide.

Provide a 4 inch minimum housekeeping pad under each piece of floor-mounted equipment.

- Pads shall be smooth and level.
- Pads shall conform to the footprint of the equipment and shall be the full width and depth of the equipment, but shall not extend beyond the equipment by more than 4 inches. Pad edges shall be chamfered.
- The EPS housekeeping pad shall be steel reinforced in accordance with the EPS manufacturer's instructions.

Provide 2 coats of water-borne epoxy paint over a compatible primer on the concrete floor. Provide paint on the walls and ceiling.

Provide a 10 pound Type ABC fire extinguisher at each exit door.

Provide an unobstructed route to the building exterior to permit replacement of the largest shipping section of the EPS. Entire equipment access pathway, including egress route exterior door, and all intervening doors shall have free and clear area that complies with

requirements for EPS room listed above. Interior intervening doors/frames and other secondary systems constructed to be easily removable are an acceptable alternative. Design the floor of the entire route for the weight of the EPS. Provide a route and means to move drums of oil and other large maintenance items to the EPS (i.e. roof mounted units).

Mechanical

Avoid installing ductwork, piping, clean-outs, and other mechanical system components in the room unless they serve the room or EPSS. When there is no alternative to installing foreign ductwork or piping in the room, they should be installed over aisle ways and not over footprint of EPSS equipment.

Provide dry horizontal sidewall fire protection sprinklers. Sidewall sprinklers shall be supplied by the building wet sprinkler system from adjacent heated spaces. See Design Guideline 210000, for additional requirements.

- Do not locate the sprinkler heads over the EPSS equipment.
- Provide wire guards on the sprinkler heads.

When the EPS room will be located on the lowest level of the building and/or below-grade evaluate the risk from flooding and the resulting associated water damage to the EPSS equipment. Based on the risk analysis, determine if a floor drain with a backwater check valve should be installed. If required the backwater check valve shall be located outside of the room.

Provide sound attenuation at intake and exhaust dampers when required by the results of the sound study.

Provide motorized dampers, fed by emergency power, for combustion and cooling air in accordance with EPS manufacturer's instructions. Provide louvers exterior to the dampers when the dampers are visible to the public. Louvers shall be sized to avoid rain and snow intrusion and so as not to reduce design air flow rates of associated duct work and dampers.

Provide ventilation to remove equipment heat (in addition to EPS unit mounted radiator fan) and maintain equipment within their ambient temperature ratings under all weather and electrical load conditions.

Provide heat to maintain room temperature above 45 degrees F when the unit isn’t running.

Electrical

Unless part of the EPSS, do not locate electrical equipment in the EPS room, including lighting and receptacle panels, central UPS systems, Building Automation System DDC panels, fire alarm control panels, security panels, or MOSCAD panels.

Provide manually-switched LED lighting in front of each EPS control panel, along either side of each EPS, in front of ATSs and in front of other electrical equipment. Connect this lighting to emergency power. Provide a battery-backed lighting fixture or an emergency lighting battery pack in front of each EPS control panel, ATS and paralleling switchgear if provided.

Provide exit signs above the exit doors.

Provide two quad receptacles, each on a dedicated circuit, and connect them to emergency power. Receptacles shall be located on opposite sides of the room.

To protect EPSS equipment from water damage by activation of the fire protection sprinkler system, provide fire alarm system, multi-sensor, smoke/heat detectors to give an early warning of a possible fire. Also provide minimum of one combination audible/visual appliance. Fire alarm system devices shall be installed in accordance with Design Guideline 283100.

Indicate EPSS equipment working clearances on plan view drawings.

Provide full size copies of the building's EPSS One Line Diagrams and Riser Diagrams on the wall in front of the EPS. Drawings shall be minimum 24"x36", installed in wooden frames and protected by glass.

Outdoor Enclosure Requirements:

Provide the EPS manufacturer's standard weather-protective, non-walk-in outdoor enclosure for most projects. When recommended by the results of the sound study or when the EPS is adjacent to occupied buildings, provide an appropriately rated sound-attenuating enclosure.

- Provide a floor unless the enclosure will be fastened down to a level concrete pad. Enclosures that are open on the bottom to air or grating are not acceptable.
- Provide clearance above the radiator cap to permit viewing down into the radiator without using a mirror, and to permit adding coolant without using a pump.
- Provide access and clearance around the engine and generator for routine maintenance.

Back Feed Tap Box:

Evaluate the need for a back feed tap box for connection of a temporary portable EPS to a unit substation feeder breaker. Temporary portable EPSs are used during unit substation maintenance, generator maintenance and for support of designated loads during a prolonged power shutdown (i.e.: freezers, general building HVAC, etc.).

A generator back feed tap box may be required for buildings under the following scenarios:

- A permanently installed EPS is not required by code.
- To satisfy special program load requirements.
- For buildings with an EPS sized only for small emergency and legally required standby loads.

Design the tap box in accordance with Standard Detail 26110004. The tap box shall also include a phase rotation monitor with indicating light to signal correct phase sequence. Install phase rotation monitor label reading 'LIGHT INDICATES CORRECT PHASE ROTATION. IF NO LIGHT REVERSE ANY TWO LEADS'. Locate the tap box at the loading dock or where a portable generator can be parked adjacent to it.

Installation Requirements

The EPS, automatic transfer switches, load bank, accessories and supporting systems shall be shall be installed, adjusted and tested in accordance with Specification 263000 and the other Division 23 and 26 specifications.