EMERGENCY ENGINE MAINTENANCE

INTRODUCTION

Maintaining engine-driven emergency units, such as power generators and fire pumps, presents several challenges. Unlike most equipment, which operates regularly or continuously, emergency units may not operate until an emergency occurs. When emergency units are not operating, they do not appear to require attention and can deteriorate without showing signs of distress. Discovering there is a problem when the unit is needed most is never a good experience especially when just a little planning would have corrected the problem.

Emergency equipment startup failures can have catastrophic consequences. A fire pump failure may cut off the water supply when a strong supply is most needed. A generator failure may prevent emergency shutdown systems from working, possibly leaving operators to perform complex manual shutdown procedures in the dark. Communication can be completely lost when a computer server loses power and the emergency power system fails to transfer over.

Most maintenance philosophies and guidelines are oriented toward the needs of regular service equipment. Maintenance programs are designed to minimize in-service failures by detecting distress and allowing timely repair. Emergency equipment maintenance programs must ensure that idle equipment is always ready to start immediately and perform to capacity. Also, special precautions to protect the facility may be needed during emergency equipment maintenance. A complete tracking method for the routine maintenance is a must for a properly working system.

Even when owners commit to properly maintaining emergency equipment, they may have difficulty finding appropriate guidelines. Sometimes the manufacturer's recommendations are misleading. For example, manufacturers of emergency engine-generator sets often assemble their units from components built by others. As a result, buyers may be consulting maintenance guidelines from three sources: the engine manufacturer, the generator manufacturer and the unit assembler.

Guidelines for the engine may be based on operating hours or, worse yet, on road miles. Guidelines for the generator and the unit will probably be based on operating hours. However, an engine in emergency service receives more wear and tear from frequent starts and stops than it does from running continuously, yet there may be no maintenance guidelines based upon the number of starts.

Emergency engines are started and run under load periodically to verify fitness for service and may have to start in response to a utility power outage or a fire. Most units never run longer than is necessary for maintenance and operability tests. In fact, it would take more than 200 years for most emergency engines to accumulate the 20,000 hours of operating time which is often used as an overhaul guideline.

This section suggests maintenance activities and intervals for internal combustion engines that drive emergency equipment. These guidelines, which are minimum standards primarily intended for

equipment lacking appropriate standards, do not supersede instructions required by the listing agency for listed fire pump engines. Some engine units may include equipment not covered by this section; other engines may require more frequent attention than is suggested. Since the engine is normally the limiting component of an emergency service unit, this section does not include specific maintenance guidelines for attached equipment.

POSITION

Maintain engines used to drive emergency equipment following manufacturer guidelines using a formal management program as described in Section 3 of *OVERVIEW*. A Computerized Management System (CMS) can aid to set up frequencies and provide reminders of work needing to be completed.

Maintain a written operating and maintenance log to monitor actual service of a unit. Trending can be a very useful tool to see a slow change over time. Keep the operating instructions posted at the unit.

Maintain driven equipment and accessories in accordance with the manufacturer's recommendations. Ensure that all service is performed by personnel properly qualified to work on stationary engines.

Personnel should attend all starts for maintenance purposes, including those for exercise. By attending the scheduled start, personnel can notice a problem before it becomes critical. This can be visual noticing of drips/leaks or hearing a change in the sound of the operating unit.

Use a management program, such as RSVP described in Section 1 of *OVERVIEW*, to control any fire protection or emergency service impairment. Consider rented equipment for standby service during extended outages.

Weekly and Prior to Scheduled Starts

Check the lubricating oil sump for proper level. Look for any obvious contamination. Investigate any change in oil level. A low oil level may indicate leakage; a high level may mean moisture is condensing, or coolant or fuel is leaking into the sump. Also check the governor oil level, if applicable.

Check the coolant level in engines having closed cooling systems. If coolant needs to be added, check the cooling jacket, pump, heat exchanger or radiator, and the rest of the system for leakage.

Verify water availability and water quality in engines having once-through cooling systems. If water inlet strainer or filter bypass valves are open, investigate and correct the condition. A prefilter or settling tank may be needed.

Examine the radiator or heat exchanger for fouling. Verify that louvers or fans used in cooling air systems or pumps used in secondary cooling water systems operate.

Visually inspect the unit:

- The routine inspection helps to establish a baseline for reference. Any exercise of the equipment can help to notice a 'change' from the normal operation. Often it is change over a long period of time that can be the most useful.
- Pay particular attention to cooling water hoses and accessory drive belts. Look for cracks or deterioration and leaks in hoses and for cracks and proper tension in belts.
- Look for any debris or foreign objects, animal or malicious damage, and loose or broken fittings, guards or other parts. Inspect all instruments and gauges.
- Check the air intake for obvious problems, such as ice, debris or animal intrusion.
- Check the fuel supply and piping. Drain the water trap, if one is provided.
- Inspect the starting system. Maintain batteries in accordance with PRC.5.7.4. Drain moisture from units with air starting systems, and ensure that the air cylinders are fully charged.
- Verify that the block, generator, oil and battery heaters are adequate and operate correctly. NFPA 110 requires keeping jacket water temperature above 90°F (32°C) for Level 1 equipment, unless the equipment room is at least 70°F (21°C). The standard further requires

keeping battery temperatures above 50°F (10°C) unless the equipment room is at least 32°F (0°C). Generator and oil heaters may be needed to prevent condensation and ensure proper oil viscosity. For further guidance and for equipment other than NFPA 110 Level 1, consult the manufacturer's instructions.

Before leaving the engine, verify that all manual system valves are properly positioned and all controls are set for automatic operation.

Starting or Running the Engine

Except for periodic load acceptance tests, start the engine without load and bring it up to operating temperature before loading. Any time the engine is started, it should run long enough for warm-up, normally at least 20 min – 30 min, whether it is to be loaded or not. NFPA 20, NFPA 25 and PRC.14.2.1 describe the weekly test for fire pumps and require running them at least 30 min. NFPA 110 requires a monthly load test of emergency generators at least 30 min long at no less than 50% of the connected load. Some engines must be loaded if they run longer than 30 minutes. Be sure to consult the manufacturer's instructions.

Attend the engine as soon as possible after an emergency start and at all times during operation. Check the oil pressure and temperature, fuel pressure and engine speed. Inspect the engine and all systems for leaks, abnormal noises or other signs of distress. Make any needed adjustments, and inform management of any problems, but do not allow the engine to shut down after an emergency start for any reason unless authorized by a responsible manager.

Except for fire pumps, allow a running cool down period after removing the load from the engine and before shutting it down.

After running the engine, ensure that the controls are set for automatic operation. Replenish the fuel supply.

After an emergency start, thoroughly inspect the engine for any damage. Include a complete lubricating oil analysis, a load test under normal conditions and any other inspections or tests suggested by the manufacturer.

Report and correct any problems.

Monthly

Service air and fuel filters in accordance with the manufacturer's instructions. Verify adequate freeze protection in all associated water systems.

Quarterly

Submit a lubricating oil sample for wear particle analysis. Collect the sample as directed by the laboratory that will analyze it. Wear particle analysis can flag many adverse conditions, particularly abnormal wear. Analysis results also provide excellent control of oil condition. See PRC.6.0.8.3 for more information.

Use an infrared thermometer to examine the unit for obvious problems during operation, such as fouled heat exchangers, cylinder imbalance and overheated bearings or windings. Investigate temperature variation among cylinders exceeding 50°F (28°C).

Check the engine governor where appropriate for proper set point at no load and full load.

Inspect and exercise generator circuit breakers and transfer switches.

Annually

Test the engine overspeed trip in accordance with the manufacturer's recommendations. Test or calibrate all other safety devices, instruments and gauges.

Change the oil and filter.

Clean any cooling water strainers.

Inspect crankcase ventilation systems for proper operation. Clear as needed.

Tune up the engine; test and recalibrate all controls. Perform a compression check and cylinder balance test on spark-ignition engines and compression and cylinder load tests on diesels. Service the ignition and fuel injection systems or both.

Inspect and service the supercharger or turbocharger, if either one is provided.

For generators, test the system, including transfer switch function, by actual or simulated power loss.

Every Five Years

Overhaul the engine, unless:

- All maintenance, including lubricating oil and wear particle analysis, has been properly performed and results were positive without incident.
- Operation has been restricted to operation required for maintenance and a minimum number of starts under emergency conditions.
- Abnormal operating conditions, such as overload, overheating or other undue stress, have not occurred.
- Adverse conditions are not indicated by any maintenance or inspection program.

If all these criteria are met, the overhaul interval may be extended to seven years.

Repairs

Select repair parts for stationary engines with caution, particularly refurbished parts such as crankshafts. A 100,000 mile (160,000 km) guarantee may seem impressive, but stationary service may be more severe than road service. Use parts for listed engines that will not invalidate the listing.

Other Considerations

Emergency equipment is sometimes pressed into non-emergency service. For example, emergency generators are occasionally used for “peak shaving.” Approach this cautiously. Fire pumps, specifically, should have no function other than fire protection. Review the facility hazard analysis described in *OVERVIEW*, Section 13, and specific AXA XL Risk Consulting recommendations that apply to avoid compromising safety services. NFPA 110 restricts using emergency generators for nonemergency service. If a decision is reached to proceed with the change in service, the maintenance needs of the machine change. The following recommendations apply:

- Make sure the equipment is rated for the intended service. Long-term ratings may be considerably lower than emergency service ratings.
- Overhaul the equipment to ensure that it will operate satisfactorily in its new service.
- Adjust the maintenance intervals. The equipment will have many more hours under load than an emergency unit and many more startups and shutdowns than a base-loaded unit.
- A complete Management of Change review should be completed as to the impact of changing the use of the equipment. It may be determined that the change is too risky for the site to undertake and plans should be put in place to install a duplicate unit.