

Insight: Turbine Generator Lube Oil Fires

Turbine Generator Lube Oil Fires Represent the Highest Electric Generating Facility Fire Risk

Recognizing the Risk

Steam turbine and gas turbine generators may use upwards of 20,000 gallons (75,700 liters) of oil for lubrication, control, and cooling. The most popular lubrication products are mineral oil based fluids with a relatively low flash point (flash point 400°F. (204°C.) and an auto-ignition temperature near 700°F. (371°C.). This represents a significant hazard since these are well below the operating temperature of the equipment.

During 2014, fire was a significant contributor in many of AIG's largest claims in the power generation segment. The auto ignition and uncontrolled combustion of lubrication oil caused (6) of these (8) fire losses. These fires were caused by uncontrolled oil release from system bearings and/or piping due to either maintenance errors or machinery breakdown. Power plant fires can occur even when the best tools, practices, and training are all in place. Even the very best power plant operators are not immune from this type of failure. Over the last five years about 75% of major electric generating plant fires involved the uncontrolled combustion of lube oil. For electric generating facilities a lube oil fire is 6 times more likely than any other type of fire.

An Electric Power Research Institute (EPRI) study concludes that based on a 30-year plant life there has been one fire in roughly 200 unit-years. This means that one out of seven turbine generators in operation will experience a fire at some time during its operational life.

As steam turbine lube oil fires are the highest probability fire event, and the damage is always severe, it is essential that plant owner/operators have proper protective systems, procedures, training, and plans in place to mitigate this risk.

Risk

Most often lube oil fire occur as the result of other turbine damage. A common example is the unexpected and sudden loss of several large turbine rotating blades while the unit is spinning at operating speed. Large blade loss will cause severe imbalances within the machine with the consequent vibratory energy resulting in extensive shock damage to the bearings and pipes supplying pressurized lube oil. A spray of lube oil from a damaged bearing or pipe will auto ignite when it comes in contact with any hot metal surface in the vicinity. This type of spray fire is difficult to extinguish with water alone and often not controlled until the flow of oil can be interrupted by shutting down the oil pump.

The second leading cause of lube oil fires is via oil issuing from damaged hydraulic fittings, piping, or a leaking flange. Typical causes would be a flange left loose after maintenance work, or an improperly supported line that has vibrated to a point where a crack forms. The EPRI report on fires notes:

"Of the 119 fires involving lube oil, 39 fires occurred at the turbine bearings, 16 fires involved lube oil piping, 14 fires occurred below the turbine deck, and seven fires involved the lube oil reservoir. The exciter has also been identified as both lube oil and an electrical hazard (seven electrical fires and two oil fires). Thus, it can be said that the greatest fire hazard for turbine generators is from lube oil."

Risk Mitigation

National Fire Protection Association (NFPA) 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations provides an excellent basis for mitigating the risk of lube oil fires. These

standards provide guidelines on assessing the risk, carrying out a gap analysis, and how to ensure an appropriate follow-up plan is in place – all critical steps in mitigating the risk of major steam turbine or gas turbine generator fire.

Recommendation

A thorough risk assessment of your electric generating facility focusing on potential lubrication and hydraulic oil fire risks is therefore highly recommended. Critical areas of assessment are:

Protection System Assessment

Assess the extent and condition of your current fire protection systems. In most cases a lubrication oil fire is caused by an unpredictable machinery breakdown or failure that ruptures an oil line. The best defense against this event is a permanently installed fire suppression system that initiates without human intervention. Such systems should include coverage of the lube oil reservoir, hydrogen seal oil skid (if the generator is hydrogen cooled), the bearings, and the under deck area where oil is likely to flow and accumulate. The adequacy of your plant's protection system should be assessed for completeness in accordance with NFPA 850. This system should include reliable automatic notification via a central station to the local fire emergency response agency.

Existing systems should be tested and verified that they perform as per the NFPA standards. If a system is not maintained and tested, it may not function when required.

Fire suppression systems have demonstrated improved effectiveness with the use of water additives (Micell Encapsulators) or foam-water systems. Facilities should consider the use of these types of additives in their fire protection systems.

Lube Oil System Condition Assessment

Assessment of the current condition of the lubrication system, including reservoirs, pumps, piping, connections, flanges, and turbine bearing areas should be conducted with the specific goal of identifying the fire potential. Where leakage is possible such as flanges or piping connections evaluate what might happen if a leak occurred and identify ways to keep oil drips or sprays from hot surfaces or areas. Some specifics to check for:

- Installing flange guards, catchments, or spray shields on vulnerable areas.
- Housekeeping, oil storage, accumulated oily debris, flammable storage.
- Bunding or curbing will contain leaking oil to an area of a particular unit so that the potential of fire spreading to adjacent units is minimized.
- Covering cable trays below the bearing centerline where oil may accumulate to limit the spread of oil and fire to other units. Ensure wall penetrations are sealed.
- The entire lube oil system is inspected for damaged or compromised piping that may lead to leaks. Double piping is recommended.
- Reservoirs are properly located and protected.

Plant Management, Procedures and Training Assessment

Many plants consider the boiler burner fronts, coal conveyors or oil storage tanks as the most critical areas when planning on how to respond to fire incident. While this is important, a lube oil fire is more likely to occur and is sometimes overlooked in discussions with local fire departments and in plant personnel training. The lube oil fire scenario must be included in emergency planning, response coordination, and in training exercises. Consider having a table top exercise where participants run through how response personnel would respond to lube oil fire.

The following are effective measures that plant management can stress and put into practice to help mitigate damage that can occur should a lube oil fire occur:

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- Institute a directive that should an oil leak occur, immediate action must be taken to stop the leak, or the unit should be removed from service immediately. In a number of losses, an oil leak was noted but operators keep the unit on line with the thought of containing the leak. This proved to be a poor choice.
- Ensure that procedures are written documenting test and inspection requirements, intervals etc. for protection systems.
- Park your turbine hall crane in an area of low damage potential. Never leave your turbine hall crane parked over a turbine generator. Delays of up to 3 months have been experienced to repair fire damaged cranes prior to turbine disassembly.
- Train operators to speed shut down of the turbine and to secure the lube oil pumps as quickly as possible in response to a fire. Breaking vacuum will speed the roll down. A protected kill button for the lube oil pumps might be considered. If a spray fire develops the most effective control to put it out is to cut the fuel supply.
- Train operators in the proper procedures for notification of the nearest fire emergency response agency, orderly evacuation, assembly locations, personnel accounting and reporting. It is recommended that exit paths are not directed through the immediate vicinity of the turbine generator.
- If the plant has hydrogen cooled generators, develop procedures and train operators to evacuate the hydrogen from the generator as quickly as possible.
- Conduct a table top exercise for the turbine lube oil scenario with the local fire emergency response agency. Developing solid working relationships with fire emergency response agency at site familiarization tours, table top and field exercises is instrumental in successful management of emergencies. This provides opportunity to practice rapid set up of an "Incident Command System" structure.
- Automatic notification by auto call or radio to the local fire emergency response agency with responsibility to respond should be put in place. "Pull" stations should be properly located.
- If an incident occurs ensure that a thorough Root Cause Analysis (RCA) is performed along with corrective actions.

Resources / Standards

The references are:

Power2013-98303 American Society of Mechanical Engineers (ASME) Power Conference 2013 W. Ebner

Turbine Generator Fire Protection by Sprinkler System, Electric Power Research Institute, 1985

NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

NFPA 1620, Standard for Pre-Incident Planning

For more information, contact your local AIG Property Risk Control Representative.

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