Designation: D 4241 – 98 (Reapproved 2003)

An American National Standard

Standard Practice for Design of Gas Turbine Generator Lubricating Oil Systems[1]

This standard is issued under the fixed designation D 4241; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This practice has resulted from a culmination of the experiences of the turbine builders, the erectors, the oil suppliers, and the operators. Out of necessity, it is a generalized and minimal standard. Previous issues of this practice have been used in specifications to aid in obtaining satisfactory performance of the lubricating oil system.

1. Scope

1.1 This practice covers the design of lubricating oil systems for gas turbine driven generator units 1000 kW and larger.

1.1.1 The lubricating oil system is defined as that assembly which utilizes and circulates the turbine generator lubricating oil and furnishes pressurized oil for control and seal functions.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ISO Standard:*

ISO 4572 Hydraulic fluid power-fillers-multi-pass method for evaluating filtration performance[2]

3. Significance and Use

3.1 This practice establishes minimum recommended design practices for gas turbine generator lubricating oil systems to ensure that:

3.1.1 Lubrication, control, and seal functions will be performed satisfactorily by the oil mutually acceptable to the parties concerned.

3.1.2 Installation, cleaning, and flushing will be facilitated.

3.1.3 Satisfactory system cleanliness can be maintained.

3.1.4 Safe practices are observed.

4. System

4.1 The operation of the gas turbine generator depends upon a satisfactory supply of lubricating oil at the proper places. Thus, a highly reliable system must be supplied.

4.2 The system flow requirements include the summation of the individual requirements for lubrication of all the bearings, gear meshes, couplings supplied by the system, and the steady state and transient control oil requirements. A margin should be added for flow changes with use.

4.3 The system pressure must be sufficient to overcome piping and equipment pressure drop, overcome elevation head difference, provide margin for regulation, and ensure proper distribution of lube oil to the required areas of the machinery.

4.3.1 The control and seal oil function may require higher pressure levels than the lubrication. For these cases, the total system pressures may increase to where reasonable or separate control or seal oil pumps, or both, can be required.

4.4 The designer should specify the maximum allowable oil viscosity for cold start. With reduced temperatures the increased lube oil viscosity can have a significant affect upon the reliable distribution of the oil throughout the system and upon the reliable operation of the controls.

4.5 Heat is rejected from a number of sources to the lubricating oil.

4.5.1 Bearing shearing and pumping losses are transferred to the lubricating oil.

4.5.2 When accessory or load gearing are used, a major portion of their losses is transferred to the lubricating oil.

4.5.3 Lubricated couplings add heat to the oil.

4.5.4 Because of the proximity of hot gas turbine parts, some heat is transferred to the lube oil. This is especially true with buried bearings.

[1] This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.C0 on Turbine Oils.

All previous recommended practices have been published by ASME as joint ASTM-ASME-NEMA standards. With the issuance of this document all standards under the auspices of Technical Division C of ASTM Committee D02 will be published by ASTM, solely as ASTM standards. This standard replaces ASME Standard No. 120.

Current edition approved Nov. 1, 2003. Published November 2003. Originally approved in 1992. Last previous edition approved in 1998 as D 4241–98.

[2] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

4.5.5 Pumping and throttling result in heat being added to the oil.

4.6 Failure of the system to distribute lubricating oil to the required areas can result in significant damage to machinery. Annunciating or machine tripping, or both, should be provided for the following:

4.6.1 Trip with low lube oil pressure.

4.6.2 Alarm for high oil temperature at the bearing header.

4.6.3 Alarm for high- or low-reservoir level, or both, depending upon the system design.

5. Materials

5.1 Exposed devices and piping containing pressurized lubricating oil should be of rugged construction and made of high melting point materials.

5.1.1 Steel piping, tubing, valve bodies, fittings, and fabrications are acceptable and recommended. Valve and pump bodies of cast iron can be used within the oil tank.

5.2 The use of copper, cadmium, zinc, and lead in systems should be avoided due to the poor resistance to corrosion by oil oxidation products. In addition, these metals can serve as catalysts for accelerating oil oxidation processes.

5.2.1 Make sleeve bearing linings of high-tin base babbitt with a minimum of 80 % tin.

5.3 All materials used in system construction, including gaskets, seals, diaphragms, interior surface coatings, and hoses, should be resistant to turbine lube oils and maintain adequate physical and chemical properties at maximum and minimum expected operating temperatures.

5.4 Interior surfaces of steel reservoirs and major fabrications should be coated for rust protection with a material impervious to oil and water at the maximum expected temperature. If corrosion resistant materials are used, no coating is needed.

6. Oil Reservoirs

6.1 The lubricating oil is stored in the reservoir. The several components frequently mount from or within the reservoir. Oil distribution and return piping originate and terminate respectively from this assembly.

6.2 The capacity of the reservoir is affected by the necessary dwell time and the total system capacity.

6.2.1 To allow for the separation of entrained air, the normal operating oil volume should not be less than four times the flow per minute to the bearings. The exposed oil surface and oil depth affect the air separation.

6.2.1.1 As an alternative, air separation may also be accomplished through incorporation of mechanical separators, mounted internally to the reservoir, on each return connection. Reservoir size shall then be determined by the separator space requirements and flow paths to limit short circuiting flow, together with the provisions of 6.2.2.

6.2.2 The capacity of the reservoir should be sufficient to hold the operating oil level volume, plus the volume that will drain from the remainder of the system when the gas turbine generator unit is shut down.

6.3 Numerous factors contribute to the arrangement of the reservoir, including the following:

6.3.1 The entire inside of the reservoir should be accessible.

6.3.2 All connections and openings should be sealed to minimize air leakage and the entrance of atmospheric contaminants into the reservoir.

6.3.3 Access openings and device mounting pads on horizontal surfaces should be raised from the normal surface to reduce the entrance of contaminants into the reservoir.

6.3.4 Flanged submerged connections should be kept to a minimum.

6.3.5 Oil reservoir connections for major drain lines from bearings should be as far from the pump suction as practical or baffled to prevent return oil from flowing directly to pump suction, thereby providing a maximum oil rest period. Drains should be arranged to provide for maximum deaeration and minimum oil agitation.

6.3.6 The discharge of relief or regulating valves should be arranged to minimize air entrainment by discharge below oil level or over a deaeration tray.

6.3.7 The reservoir and the oil system should be arranged such that the entire system can be drained.

6.4 The reservoir should be drainable.

6.4.1 The bottom of the reservoir should slope towards the drain connections. For rectangular reservoirs, the slope should be 20 mm/m (¼ in./ft) or greater. Small easily cleanable reservoirs may not need the sloping bottom.

6.4.2 Drain connections should be provided at the reservoir low points. Precautions must be taken to prevent accidental draining of the oil. If drain valves are used, they should be locked closed or have blanks in the drain lines immediately downstream.

6.4.3 If connections for an external oil purification system are provided, they must be arranged and located so that siphoning of the reservoir below a safe level is not possible.

6.5 Forced ventilation of the lube oil system vapor space should be provided.

6.5.1 One method produces a vacuum for removal of gases and vapors. This may use a vapor extractor or an air–operated eductor. Internal baffles should have openings above the oil level to equalize the vacuum within the reservoir. The vacuum produced in the bearing housing should not average more than approximately 0.5 KPa (2 in. water) to minimize the entrance of atmospheric contaminants into the oil system.

6.5.2 Another method uses air pressurized seals in the bearing housings. This air circulates through the vapor spaces of the oil system and discharges through a vent.

6.5.3 The reservoir extractor or vent connection should be located to minimize oil vapor entrainment.

6.5.4 Care must be taken in location of the reservoir ventilation discharge so that any oil vapors do not become entrained with the gas turbine inlet air.

6.5.5 The external vent outlet should be screened and covered.

6.5.6 For hydrogen cooled generator application, the reservoir should contain an explosion door or blowout diaphragm capable of maintaining the reservoir internal pressure at a safe level at all times.

7. Pumps

7.1 Pumps must circulate lubricating oil from the reservoir to the bearings, controls, and other points of use. The pressure