Chapter 12
Oil Systems

12-1. General

Installed systems for two types of oil, governor-lubrication oil (governor-lube) and insulating oil, are required in most powerhouses. The systems are based on the use of a common oil for unit lubrication and governor-systems and for transformers and circuit breakers. Should there be uncertainty regarding the common use of these oils, predesign discussion with review offices is recommended. Other powerhouse oils which may be necessary are handled in portable containers and are not covered in this chapter. The storage, pumping, purification, and piping facilities for governor-lube oil and insulating oil are similar, but the design must be based on maintaining complete separation of the two oils through the use of separate facilities due to the special purification requirements of insulating oil. Separation is not necessary in disposal. Design emphasis should provide maximum protection against misrouting and mixing of oils and fire hazards resulting from spillage (see paragraph 15-2). Separate piping systems should be provided insofar as possible for insulating oil for the transformers and circuit breakers to minimize the chance of mixing these oils. Additional guidance can be found in Guide Specifications CW-15487 for turbine lubricating oil and CW-16321 for electrical insulating mineral oil.

12-2. System Requirements

a. Governor-lube oil. The following operations are normal system requirements:

(1) Filling dirty oil storage tank from tank car or truck.

(2) Moving oil from clean oil storage tank by either the purifier or transfer pump to the generator-turbine unit.

(3) Draining or returning overflow oil from the generator-turbine unit to the dirty oil storage tank.

(4) Moving oil from either storage tank to a tank car or truck for disposal.

(5) Flushing of any supply line to generator-turbine units.

(6) Recirculating oil in any equipment on generator-turbine unit through purifier and back to equipment.

(7) Recirculating oil from any storage tank through purifier and back to tank.

b. Transil oil. The system requirements for insulating oil are essentially as for governor-lube oil in 12-2*a* with each operation relative to transformers or circuit breakers instead of generator-turbine units.

12-3. Oil Storage Room

The oil storage room should be located at a low elevation in the powerhouse. A depressed area in concrete should be provided below all openings in the room of sufficient volume to contain all oil stored in the room. Space for purification equipment in the same room is desirable to simplify CO_2 fire protection. The room should be in mass concrete but, in any case, should be of fire resistant construction and have automatic closing fire doors. The floor should slope to a sump to collect small oil spills for removal. A valved, inverted outflow line should drain water from the bottom of the sump. A personnel emergency escape door or hatch should be provided in a desirable location away from the main door. If separate oil storage and purification rooms are provided, the room requirements are similar.

12-4. Oil Storage Tanks

a. Capacity. Clean and dirty insulating oil tanks should each hold a minimum of 110 percent of the oil required to fill the largest transformer on the system. Clean and dirty governor-lube oil tanks should each hold a minimum of 110 percent of the oil required to fill the governor system and all the bearings of the largest generator-turbine unit.

b. Design. Storage tank design should conform to the applicable requirements of American Petroleum Institute (API) Standard 650, Underwriters Laboratories (UL) Standard 142, or ASME “Boiler and Pressure Vessel Code” (design pressures 15 psi and over). Minimum wall thickness should be 6.4 mm (1/4 in.). To determine the type and configuration of tanks, the following factors should not be overlooked:

(1) Shipping limitations.

(2) Shipping costs.

(3) Space and scheduling for field erection.

(4) Testing of field-erected tanks.

(5) Limitations on oil room configuration.

Tanks should be provided with direct reading liquid-level gauges and the interior finish should be an epoxy-based paint system.

12-5. Pumps

a. General. Oil system pumps should be the positive displacement type and should be provided with safety relief valves and high temperature shutdown. Suction lift should not exceed 4.5 m (15 ft), and pump speed should be limited to 1,200 rpm. Control should be manual, but timer switches should be used to prevent continuous pump operation beyond the normal time required for each oil transfer. Pump capacity may be provided in single or duplex units, but if single, a standby pump for convenient exchange should be available.

b. Dirty oil pumps.

(1) Waste oil. A pump should be provided to pump waste oil to a deck waste valve. Capacity should permit emptying the largest tank in approximately 8 hr or less. The pump should have a hose valve suction connection for the hose connecting to the insulating oil tank, governor-lube oil tank, or floor sump. A suction line filter is required to protect the pump from foreign material. Manual-timer switches should be located in the oil room and at the deck valve.

(2) Nongravity return oil. Projects where it is not feasible to return oil from generator-turbine bearings and governor to the dirty oil tank by gravity should be provided with pumps for this service. The location will usually be in the turbine pit at each unit.

c. Clean oil pumps.

(1) Governor-lube oil. A governor-lube oil pump sized to fill the bearings and governor of the largest unit in approximately 8 hr or less should be installed in the oil storage room. An adjustable back pressure valve and the safety relief valve should bypass excess oil back to the clean governor-lube oil tank. The safety relief valve should be set to maximum system operating pressure, and the adjustable back pressure valve to pump rating but not higher than 95 percent of the safety relief valve setting. Manual-timer switches should be located in the oil room and at each unit.

(2) Insulating oil. The insulating oil pump should have approximately 105-110 percent of the capacity of the purifier to be used at the transformers. Back pressure and relief valve provisions should be as noted in 12-5*c*(1). Manual-timer switches should be located in the oil room and at each deck valve.

12-6. Oil Piping

a. General. Refer to Chapter 17 for general piping considerations. Figures B-11 and B-12 show typical oil systems. Appendix B specification, "Powerhouse Piping," provides flow losses for oil in tubing (see paragraph B-3).

b. Special provisions.

(1) Supply piping should be sized to deliver full pump flow to the most remote outlet without exceeding allowable tubing pressure.

(2) Return piping should be sized to drain the most remote transformer or generator-turbine-governor within 8 hr.

(3) Return lines should be routed to avoid air traps. Loops discharging to the bottom of tanks should be vented to the top of the tank.

(4) Flushing connections are required between ends of each supply line and return line. Connection should include a check valve.

(5) Normal overflows and leakage should generally drain by gravity to the dirty oil tank. Where this is not possible, an automatic float-operated pump and sump should be provided.

(6) The piping layout should provide for pipe drainage back to the tank wherever practicable.

(7) Pressure gauges with isolating cocks should be provided on the suction and discharge of each pump.

(8) Sampling cocks should be provided at bottom of tanks and at one-fourth points up to the top.

(9) Fixed piping connections are used for generator and turbine bearing sumps and governor tanks.

(10) Hose valves and hoses are used for connections to transformers and circuit breakers.

(11) The piping material schedule, Figure B-13, provides for type K hard drawn copper tubing for oil system piping. Soft solder connections are normally satisfactory.

(12) Overflow drains to the dirty oil tank should be installed without valves.

(13) Purifier hose connections should be provided in the oil storage room, transformer locations, and at generator-turbine units.

12-7. Oil Purifiers

a. General. Each powerhouse should be provided with a governor-lube oil purifier and with, or have convenient access to, an insulating oil purifier. Portable purifiers are preferred. Overall purifier dimensions, access doors and ramps, and elevator sizes must be coordinated in the early powerhouse planning to permit purifier access to the oil storage room, transformer locations, and purifier connections at generator-turbine units. For additional guidance, refer to ETL 1110-8-12.

b. Governor-lube oil purifier. The governor-lube oil purifier should be either a centrifuge or coalescent type. A low-vacuum purifier may be added to remove excess water and dissolved gases. The purifier should be capable of processing oil with up to 1 percent water and 0.5 percent solids by volume to no more than 0.25 percent water and 0.02 percent solids and remaining solids not exceeding 40 microns in size. The separated water should not contain more than 0.5 percent oil by volume. Purification should be attained in one pass. The purifier rating should normally provide for purification of the dirty oil tank capacity within 8 hr. However, in the case of very large tank requirements, reasonable access for the portable purifier may limit its size and justify longer periods. Purifier units should include required pumps, oil heaters, controls, and wheeler carriage.

c. Insulating oil purifier. The insulating oil purifier must be designed so that the processed oil meets the transformer oil purity requirements. This normally consists of a filtration system and a high-vacuum purifier.

12-8. Alternate Systems

For small powerhouses with reasonable availability of insulating oil supply via tank truck to source, it can be practicable to omit the installed insulating oil storage facilities and service the transformers directly from the truck via the purifier.