



**US Army Corps  
of Engineers®**

# ENGINEERING AND CONSTRUCTION BULLETIN

No. 2003-17 Issuing Office: CECW-EIS Issued: 25 Aug 2003

**Subject:** Potential Performance Problems Caused By Mixing Different Types Of Turbine Oils

**Applicability:** Information

1. Purpose: To inform personnel at the Corps of Engineers hydropower facilities of the potential operational problems as a result of mixing different types of turbine oil.
2. Background: Historically most turbine oils used in hydropower applications have been formulated from naphthenic base oils with additives for performance enhancement. These base oils are known as Group-1 oils and were purified by a solvent refining process that resulted in good solvency characteristics with up to 35% aromatic content. In recent years, oil companies have discontinued the manufacture of Group-1 oils, changing their manufacturing practices to produce what is known as Group-2 oils. These oils use paraffinic base stocks and either a hydrocracking and/or hydrotreating process to produce purer oils with improved thermal and oxidation stability. New rust and oxidation (R&O) prevention additives were developed for use in higher temperature applications. Although Group-1 and Group-2 base oils are compatible, Group-2 oils have lower solvency characteristics and the additives used have been found incompatible with the Group-1 additives. Mixing oils with incompatible additives can cause cross-contamination of the entire oil stock with resulting sludge formation and additive dropout. Adding to the problem is the fact that as manufacturers changed to the Group-2 products, they retained the same commercial names and designations as the discontinued Group-1 products. Consequences of undetected incompatibility can be detrimental to the equipment and will disrupt the normal operations.
3. Corps Experience: Three Corps powerhouses (total of 40 generating units) recently replaced Group-1 turbine oil with the new Group-2 oil. Shortly after the replacement, all showed excessive foaming with an increased amount of entrained air in the oil. Approximately six months later operational difficulties were experienced due to sticking of governor proportional valves and plugging of governor in-line filters. The disruptions of the operation in one powerhouse were so extensive that all units had to be disassembled to physically clean accumulated sludge. The oil was completely replaced with a new oil (again Group-2), which in turn is beginning to show the same pattern of performance as the replaced one. Currently, the majority of oils used in Corps powerhouses are Group-1. The average age is approximately 25 years and many are approaching the end of their service life. As powerhouses are scheduling oils replacement, more operational problems and unscheduled downtime will be imminent if this problem is not solved. A similar problem also occurred at a Bureau of Reclamation facility.

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4. Corps Approach: In addition to issuing this bulletin, an R&D work unit under the Infrastructure Technology Program has been initiated to find a long-term solution. The objectives are:

- a. Investigate and document the extent of problems related to the usage of Group-2 oils and oil contamination control practices in Corps powerhouses.
- b. Identify, verify, and document the root cause of the problems being experienced with Group-2 oils.
- c. Survey the oil market for possible long-term suppliers of Group-1 oils.
- d. Consult with oil suppliers, independent testing laboratories, standards development organizations, and other agencies for an effective and standardized oil compatibility test.
- e. Develop guidance and procedures necessary for oil replacement at Corps hydropower facilities.

It is anticipated that R&D will be completed in FY05. Point of contact for the Infrastructure Technology Program work unit is Al Beitelman, CEERD-FL-M, 217-373-7237

5. Recommendations:

- a. The Group-1 and Group-2 oils should not be mixed until the R&D work unit is completed and a new guidance is issued.
- b. The exact same type of oil should be procured for the make-up oil. If the existing oil is unknown and the needed quantity is relatively small, the best option is a total replacement. Shutting down for cleaning and repairing of the damaged equipment due to incompatibility could cost more than the new oil.
- c. Before new make-up oil or replacement oil is acquired, it must be tested for compatibility with in-service oil. Test results and data must be requested from the oil supplier. In addition, an independent testing is recommended.
- d. When the oil is at the end of its service life and needs total replacement, the Hydroelectric Design Center (HDC) should be contacted for assistance. Short-term solutions will be accomplished on a case-by-case basis.
- e. Questions regarding the evaluation of turbine oils and additives, including service life, characteristics, compatibility testing, and contamination control, as well as current replacement guidance, should be directed to the HDC. Point of contact at the HDC is John Micetic, CENWP-HDC-T, 503-808-4216.

6. Point of contact for this bulletin is Andy Wu, CECW-EI, 202-761-0327.



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