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Preparing Activity: USACE

## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2008

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11/08

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### SECTION 48 13 19.00 10

#### TURBINE OIL 11/08

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NOTE: This guide specification covers the requirements for turbine oil for hydroelectric power plants.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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#### PART 1 GENERAL

This specification covers zinc and chlorine-free rust and oxidation inhibited (R&O) mineral oils for use in hydraulic turbine and generator bearings, Kaplan turbine hubs, hydraulic-turbine governors, and other applications, where high grade turbine oil having anti-corrosion, anti oxidation, and anti foaming properties is required.

##### 1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's

Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 130	(2004; E 2005) Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test - IP Designation: 154/93
ASTM D 1401	(2002) Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids
ASTM D 2270	(2004) Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C - IP Designation: 226/91 (95); British Standard 4459
ASTM D 2272	(2002) Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel
ASTM D 3427	(2007) Standard Test Method for Air Release Properties of Petroleum Oils
ASTM D 4057	(2006) Standard Practice for Manual Sampling of Petroleum and Petroleum Products
ASTM D 4177	(1995; R 2005) Standard Practice for Automatic Sampling of Petroleum and Petroleum Products
ASTM D 445	(2006) Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
ASTM D 6304	(2007) Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
ASTM D 664	(2007) Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration

ASTM D 665	(2006) Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water - IP Designation: 135/93
ASTM D 7155	(2006) Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils
ASTM D 892	(2006; E 2007) Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D 92	(2005a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D 943	(2004) Standard Test Method for Oxidation Characteristics of Inhibited Mineral Oils - British Standard 4388
ASTM D 97	(2008) Pour Point of Petroleum Products

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 11171	(1999; Corrigendum 1 2001) Hydraulic Fluid Power - Calibration of Automatic Particle Counters for Liquids - First Edition
ISO 4406	(1999) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles - Second Edition

## 1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the

District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Chemical and Physical Characteristics of Oil[; G][; G, [\_\_\_\_]]

Furnish [\_\_\_\_] copies of certified test data, which show that the oil meets or exceeds characteristics values specified in TABLE 1. The certified test data shall be submitted for approval 30 days before the oil delivery.

#### SD-04 Samples

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NOTE: Delete bracketed part of paragraph for new construction. When soliciting for new contracts or orders using this specification for purchase of turbine oil that will be mixed with the in-service oil or as a replacement oil, the government should require all offerors to provide a 4-liter (1-gallon) sample of the proposed oil, which must meet the requirements of this specification in order to be eligible for award. The Government may test this oil for compatibility with the in-service oil by sending a portion (1 qt) of new oil in an unmarked container, and a sample of in-service oil to a lab. Prior to awarding the Contract, the compatibility of new oil must be verified by the ASTM D 7155-06 test, Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils. The remaining quantity of new oil should be retained by the Government for possible further testing. Compatibility testing should be performed at no charge to the bidders.

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Turbine oil[; G][; G, [\_\_\_\_]]

Send 4 Lone gallon of oil to the Government along with the bid. This oil shall be closely representative to the oil being offered in the bid. [The Government plans to send a literquart of this oil in an unmarked container to an independent laboratory for compatibility testing with the in-service oil. The compatibility testing will be performed at no charge to the prospective bidder.

If the submitted oil sample is found to be incompatible with the in-service oil, this oil will not be further considered in the Contract awarding process.]

## PART 2 PRODUCTS

### 2.1 TURBINE OIL CHARACTERISTICS AND REQUIREMENTS

#### 2.1.1 General Properties

The turbine oil shall be a blend of virgin petroleum-based stocks plus additives, free of zinc and chlorine, resulting in high-grade turbine oil having anti-rust, anti-oxidation and anti-foaming properties suitable for use in hydraulic turbines, generator bearings, Kaplan turbine hubs and related applications. Chemical and physical characteristics of oil shall meet or exceed the requirements listed in TABLE 1. Oil characteristics shall be determined by tests conducted in accordance with the tests methods as noted in the table.

#### 2.1.2 Chemical And Physical Characteristics

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**NOTE: Additional characteristics or changes in listed values should not be included in the specifications without prior consultation with the technical proponent of the specification. Corps Districts/Project offices can contact Hydroelectric Design Center for assistance and/or request additional information/clarification related to the information contained in the entire document (POC: John Micetic, 503.808.4216 or john.s.micetic@usace.army.mil).**  
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The turbine oil shall conform to the requirements established in TABLE 1 when tested according to the standards indicated.

TABLE 1: CHEMICAL AND PHYSICAL CHARACTERISTICS REQUIREMENTS AND TEST METHODS FOR RUST AND OXIDATION (R&O) INHIBITED ISO 68 & 100 TURBINE OILS

Chemical and Physical Characteristics	Requirements ISO 68 Oil	Requirements ISO 100 Oil	Test Method
Viscosity at 40 C, centistokes (cSt)	65 - 70	95 - 102	ASTM D 445
Viscosity Index, minimum	98	95	ASTM D 2270
Flash Point, minimum, C (F)	204 (400)	210 (410)	ASTM D 92
Pour Point, maximum, C (F)	-9 (16)	-9 (16)	ASTM D 97
Acid Number (AN) mg KOH/g, maximum	0.15	0.15	ASTM D 664

Chemical and Physical Characteristics	Requirements ISO 68 Oil	Requirements ISO 100 Oil	Test Method
Oxidation Stability by Rotating Pressure Vessel Oxidation Test (RPVOT), minutes, minimum	500	500	ASTM D 2272
Oxidation Characteristics, mg KOH/g, max	0.5*	0.5*	ASTM D 943
Rust Preventive Characteristics, Procedures "A" and "B"	Pass	Pass	ASTM D 665
Water Content, parts per million (ppm), max	250	250	ASTM D 6304
Water Separability of Petroleum Oil	40-40-0 (30)	40-40-0 (60)	ASTM D 1401
Corrosion from Oil by Copper Strip Tarnish Test	Class 1	Class 1	ASTM D 130
Foaming characteristics after 5 minutes blowing period:			
Sequence 1, foam volume in ml, maximum	100	100	ASTM D 892 (Option "A" excluded)
Sequence 2, foam volume in ml, maximum	50	50	
Sequence 3, foam volume in ml, maximum	100	100	
Foaming characteristics after 10 minutes settling period:			
Sequence 1, foam volume in ml, maximum	10	10	ASTM D 892 (Option "A" excluded)
Sequence 2, foam volume in ml, maximum	0	0	
Sequence 3, foam volume in ml, maximum	10	10	
Air Release Properties, minutes, max.	30	60	ASTM D 3427
Cleanliness, ISO Code Particle Count, particle sizes of greater than 4, 6, and 14 m (c)	17/15/12(c	17/15/12(c	ISO 4406 (ISO 11171 Cal)
Appearance	Clear and Bright	Clear and Bright	Visual Observation

\* At the conclusion of the 1,000 hours test, measured AN should be 0.5 or less. In addition, at that point, the oil and water phases shall be

examined for evidence of sludge and catalyst metal corrosion. Permitted maximum level of total sludge in the oil after 1000 hours is 50 mg/kg.

#### 2.1.3 Degradation

The physical and chemical properties of the oil shall not be degraded (changed from the specified values by filtration through two-micron mechanical type filters, by centrifugal purification, or by vacuum type purifier, all of which have been designed for turbine oil.

#### 2.1.4 Homogeneity

Additive agents shall remain uniformly distributed throughout the oil at all temperatures above the pour point and up to 120 °C250 °F. When the oil is cooled below the pour point, it shall regain homogeneity while standing at temperatures of 5 °C10 °F above the pour point, and retain clear and bright appearance.

#### 2.1.5 Compatibility

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NOTE: Delete bracketed parts of this paragraph for new construction. Compatibility between new oil and in-service oils must be evaluated and determined by lab testing. Only oils found to be compatible shall be mixed with in-service oil or used as replacement oil. The compatibility testing is necessary because the new oils currently readily available on the market may have been formulated with different additives, which may not be fully compatible with additives of the in-service oils.  
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[Before the oil is being purchased for addition to existing (in-service) oil or as replacement oil, the Government will send samples of new and in-service oil to an independent commercial laboratory for evaluation of compatibility between the two oils. Compatibility evaluation shall be performed in accordance with ASTM D 7155 test, Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils. Potential suppliers shall contact the Contracting Officer to obtain a representative sample of the in-service oil necessary if they wish to conduct the test.]

### PART 3 EXECUTION

#### 3.1 PRE-DELIVERY TESTING

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NOTE: Delete bracketed parts of this paragraph for new construction.  
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Test the oil or a sample blend for all chemical and physical characteristics set forth in TABLE 1, and provide the certified test results as well as one gallon sample of the oil to the Government at least thirty days prior to delivery.

[The Contractor may conduct compatibility testing of the oil or sample blend. The Government will provide a sample of in-service oils for such



purposes on request.]

[The Government will conduct compatibility testing of the sample, and notify the contractor of the results prior to purchasing of the oil.]

### 3.2 DELIVERY

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NOTE: The method of shipment, type of containers, delivery dates, delivery point, delivery point of contact, and other required information should be included in appropriate sections of the contract specifications.  
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Deliver the oil according to the delivery requirements specified elsewhere in this contract.

### 3.3 INSPECTION AND ACCEPTANCE

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NOTE: The Corps' Districts/Projects may perform Quality Assurance (QA) tests on samples taken at the delivery point. The QA tests should include, as a minimum, the viscosity, acid number, elemental spectroscopy, and oxidation stability. Samples should be taken from each bulk shipment and from not less than 10 percent of the drums taken at random from drum shipments. Such samples should be not less than 4 L (1 gal), which may be stored in more than one sample container, and a portion of each sample should be saved for later confirmation tests in the event that the results from the first tests indicate that the oil does not meet the specification requirements.  
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At the point of oil delivery, the Government will obtain samples in a manner specified in [ASTM D 4057](#) or [ASTM D 4177](#), and may perform such tests as are deemed necessary to determine whether the oil meets the specifications values listed in TABLE 1. The delivered oil will remain in a storage tank (if applicable) and will not be used until the test results are received from the laboratory. Should the oil fail any test, the Contractor is responsible for disposing of the delivered oil and replacing the oil at its own expense.

-- End of Section --