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USACE / NAVFAC / AFCEC / NASA UFGS-48 06 15 (May 2014)  
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Preparing Activity: USACE Superseding  
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2019

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05/14

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SECTION 48 06 15

TURBINE OIL  
05/14

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

Adhere to [UFC 1-300-02](#) Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

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PART 1 GENERAL

1.1 SUMMARY

This specification includes 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.

1.2 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 Reference Identifier (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 D92   | (2012a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester  |
| ASTM D97   | (2017b) Standard Test Method for Pour Point of Petroleum Products  |
| ASTM D130  | (2018) Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test                         |
| ASTM D445  | (2018) Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity) |
| ASTM D664  | (2018; E 2018; E 2019) Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration                |
| ASTM D665  | (2014; E 2015) Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water    |
| ASTM D892  | (2013; E 2016) Standard Test Method for Foaming Characteristics of Lubricating Oils  |
| ASTM D943  | (2018) Standard Test Method for Oxidation Characteristics of Inhibited Mineral Oils  |
| ASTM D1401 | (2018b) Standard Test Method for Water Separability of Petroleum Oils and Synthetic Fluids                                   |
| ASTM D2270 | (2010; R 2016) Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C                    |

ASTM D2272 (2014a) Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel

ASTM D3427 (2014a; E 2015) Standard Test Method for Air Release Properties of Petroleum Oils

ASTM D4057 (2012; R 2018) Standard Practice for Manual Sampling of Petroleum and Petroleum Products

ASTM D4177 (2016; E 2017) Standard Practice for Automatic Sampling of Petroleum and Petroleum Products

ASTM D6304 (2016; E 2016) Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration

ASTM D7155 (2011) Standard Practice for Evaluating Compatibility of Mixtures of Turbine Lubricating Oils

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 4406 (2017) Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles

ISO 11171 (2016) Hydraulic Fluid Power - Calibration of Automatic Particle Counters for Liquids

1.3 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.**

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, 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.

The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING. Locate the "S" submittal under the SD number that best describes the submittal item.

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.][information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

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

Submit the certified test data for approval 30 days before the oil delivery.

SD-04 Samples

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

1.4 DELIVERY, STORAGE, AND HANDLING

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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.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.1.1 Properties

Provide turbine oil which is 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.

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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 L (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 D7155 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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Submit a sample of 4 L 1 gallon of oil[ along with the proposal. This oil shall be closely representative to the oil being offered in the proposal. The Government plans to send a liter quart 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].

### 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

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The turbine oil shall conform to the requirements established in TABLE 1 when tested according to the standards indicated. Submit certified test data showing that the oil meets or exceeds characteristics values specified in TABLE 1.

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 D445
Viscosity Index, minimum	98	95	ASTM D2270
Flash Point, minimum, C (F)	204 (400)	210 (410)	ASTM D92
Pour Point, maximum, C (F)	-9 (16)	-9 (16)	ASTM D97
Acid Number (AN) mg KOH/g, maximum	0.15	0.15	ASTM D664
Oxidation Stability by Rotating Pressure Vessel Oxidation Test (RPVOT), minutes, minimum	500	500	ASTM D2272
Oxidation Characteristics, mg KOH/g, max	0.5*	0.5*	ASTM D943
Rust Preventive Characteristics, Procedures "A" and "B"	Pass	Pass	ASTM D665
Water Content, parts per million (ppm), max	250	250	ASTM D6304
Water Separability of Petroleum Oil	40-40-0 (30)	40-40-0 (60)	ASTM D1401
Corrosion from Oil by Copper Strip Tarnish Test	Class 1	Class 1	ASTM D130
<u>Foaming characteristics after 5 minutes blowing period:</u>			
Sequence 1, foam volume in ml, maximum	100	100	ASTM D892 (Option "A" excluded)
Sequence 2, foam volume in ml, maximum	50	50	
Sequence 3, foam volume in ml, maximum	100	100	
<u>Foaming characteristics after 10 minutes settling period:</u>			
Sequence 1, foam volume in ml, maximum	10	10	ASTM D892 (Option "A" excluded)
Sequence 2, foam volume in ml, maximum	0	0	
Sequence 3, foam volume in ml, maximum	10	10	

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
Air Release Properties, minutes, max.	30	60	ASTM D3427
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.

## 2.2 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, two-micron coalescing filters, balanced charge agglomeration or by vacuum type purifier, all of which have been designed for turbine oil.

## 2.3 HOMOGENEITY

Additive agents shall remain uniformly distributed throughout the oil at all temperatures above the pour point and up to 120 degrees C 250 degrees F. When the oil is cooled below the pour point, it shall regain homogeneity while standing at temperatures of 5 degrees C 10 degrees F above the pour point, and retain clear and bright appearance.

## [2.4 COMPATIBILITY

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**NOTE: Delete bthis 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 will be



performed in accordance with **ASTM D7155** test. The test will be performed with the following ratios, 100 percent new oil, 90 percent new oil 10 percent old oil, 50 percent new oil 50 percent old oil, 90 percent old oil 10 percent new oil and 100 percent old oil. Contact the Contracting Officer to obtain a representative sample of the in-service oil necessary if the oil supplier wishes to conduct the test independently.

]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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- a. 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.
- [ b. Ccompatibility testing may be independently conducted on the oil or sample blend. The Government will provide a sample of in-service oils for such purposes on request.
- c. The Government will conduct compatibility testing of the sample, and notify the contractor of the results prior to purchasing of the oil. The Government will not purchase the oil if incompatibility is found by the test.]

3.2 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. Any of the other tests in TABLE 1 are beneficial and should be considered in addition to the minimum QA tests. 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 D4057** or **ASTM D4177**, 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 must remain in a storage tank (if applicable) and cannot be used until the test results are received from the laboratory. Should the oil fail any test, dispose of the delivered oil and replace at no additional expense to the Government.

-- End of Section --