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MILITARY STANDARD

OIL ANALYSIS IN EQUIPMENT DESIGN, PROVISIONS FOR

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DEPARTMENT OF DEFENSE
Washington, DC 20301

Oil Analysis In Equipment Design, Provisions For

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OIL ANALYSIS PROGRAM

1. SCOPE

1.1 Purpose. The purpose of this standard is to ensure that provisions for the Oil Analysis Program (OAP) are included in the design, development, and fabrication of equipment employing lubrication fluids in enclosed aeronautical and nonaeronautical mechanical systems. Design must facilitate OAP sampling to minimize manpower requirements and ensure the ability to take a representative sample.

1.2 Applicability. Oil analysis is applicable to all equipments having enclosed lubricated mechanical systems. This standard shall apply throughout the development cycle of these systems. Provisioning for oil analysis in the Conceptual, Validation, and Full Scale Development Phases will ensure maximum effectiveness and minimum life cycle costs. The principal oil analysis technique is the application of Spectrometric Oil Analysis (SOA) on turbojet, turbofan, turbo-prop, and reciprocating propulsion systems; airborne and ground gas turbine power units; transmissions, gearboxes; lubricating systems of aerospace ground equipment; ground radar systems; nonaeronautical systems; and other enclosed fluid systems such as hydraulic systems. In addition to SOA, other fluid analysis techniques shall be considered for applicability where cost effective.

2. REFERENCED DOCUMENTS

2.1 Government documents.

DoD FAR Supplement 52.227-7031
DoD 5000.19-L, Vol. II, AMSDL

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

STANDARDS

MILITARY

MIL-STD-1521B	Technical Reviews and Audits for Systems, Equipment, and Computer Software.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein.

TO 33-1-37 Joint Oil Analysis Program Laboratory Manual
NAVIAR 17-15-50 Joint Oil Analysis Program Laboratory Manual
TM 38-301 Joint Oil Analysis Program Laboratory Manual

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2.2 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Oil analysis program. A Department of Defense-wide effort to detect impending equipment component failures and determine lubricant condition through on-line and laboratory evaluation of used oil samples.

3.2 Wear metal. Metallic particles or debris produced primarily by friction of moving parts. Some wear metals become suspended or dispersed throughout the lubricating fluid and do not settle out. This permits early detection of equipment wear through determination of wear metal type and concentration.

3.3 Spectrometer. An instrument used to determine the type and concentration of wear metals in lubricating fluids.

3.4 Wear metal guidelines. The quantitative expressions of wear metals, against which the results of an oil analysis are compared to determine the condition of a component and the necessity for recommended corrective action.

3.5 Wear metal trend. A general term used for evaluating results based on the pattern of wear metal "buildup," the rate of increase from one sample to the next sample, the significance of the wear metal increasing, and other factors.

3.6 End item. The major item being monitored by oil analysis such as engine, transmission, or gearbox, from aircraft, truck, locomotive and related support equipment.

3.7 Component. A part or a combination of parts mounted or assembled together which may be tested, replaced or repaired. For example; engines, gearboxes, transmissions, etc.

3.8 Parts per million (PPM). The standard unit of measure for reporting the concentration of wear metals found by use of a spectrometer in the lubricating fluids; reported as parts per million by weight.

3.9 Seeding. The use of small quantities of a dissimilar metal or element within the composition of an oil-wetted component. The seeded metal or element could be dispersed homogeneously throughout the component, used as a plating, or even included as a plug. The intended result would be that as the component experienced wear, the seeded metal or element would be detected and the failing component identified.

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4. GENERAL REQUIREMENTS

4.1 Discussion. The Oil Analysis Program monitors the condition of enclosed mechanical systems through qualitative and quantitative analysis of the lubricating fluid. Friction occurs when equipment is operated, even though moving parts are well lubricated, some wear takes place. This wear produces metallic particles or debris of various size dependent upon the operating conditions, materials and wearing mechanisms. Also, the dissolving of metal from the surface of the component may occur from deterioration of the lubricant. Oil samples, when analyzed, provide information as to serviceability of the system.

4.1.1 Oil analysis as maintenance tool. The ability to detect impending failures of systems or components prior to failure is extremely important in terms of both safety and cost by preventing more serious and costly failure. Oil analysis, when properly used, becomes an excellent maintenance tool for ensuring safety of flight by detecting potential failures and permitting repair or replacement of failing parts without risk to personnel or other property. This tool is especially valuable for single engine aircraft where in-flight failure of oil-wetted components can result in loss of life and property. Early detection of impending failures can often mean relatively inexpensive repair of components in time to prevent loss or destruction of a much more costly nature.

4.1.2 Oil analysis techniques. Although spectroscopy is the principal oil analysis technique, oil analysis may be performed through other techniques. Other analytical techniques using the principles of light scattering, light attenuation, magnetic attraction, electrical conductivity, colorimetry, ferrography, and radioisotope seeding may have application as monitoring systems. These techniques may, for cost effectiveness, be utilized singly or in combination with the central issues of safety of flight and reduction of maintenance costs traded off against the costs of the applied techniques.

4.2 Wear metal identification. Oil analysis permits the detection of the type and amount of wear metal being produced. Knowledge of the wear metal being produced, either singly or in combination with other wear metals, can be used to pinpoint which component is experiencing excess wear. It is essential that all metals used in oil-wetted components of the system be accurately catalogued for use in the OAP. The rate of production can, through analysis of OAP histories and maintenance findings, be used to establish guidelines or indicators to permit accurate diagnosis of impending failures without causing unnecessary maintenance action on serviceable systems. The effects of fluid consumption and fluid addition must also be considered.

4.3 Sampling interval. The rate of increase of wear metal may be related to the amount of wear occurring. Wear may occur rapidly or slowly. The OAP samples must be taken frequent enough to allow detection of an impending failure, however, frequency must be tempered to preclude excessive sampling. Sampling intervals are not the same for all items of equipment.

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4.4 Sampling techniques. The successful application of OAP depends heavily on obtaining a representative sample of the lubricating fluid. False indications will occur if the sample becomes contaminated with foreign matter. Proper sampling techniques must ensure that a sample is uncontaminated, is representative of the homogeneous mixture in the lubricating fluid and minimizes disturbance of the mechanical system itself.

a. Tube method. Immersion of a sampling tube into a reservoir of the lubricating fluid and withdrawal of a quantity of oil sufficient for analysis.

b. Drain method. Gravity fill of a sampling bottle by means of opening a drain plug or temporarily interrupting a fluid transfer line.

4.5 Wear metal increases. The successful detection of an impending failure may depend on the proper analysis of the wear metal concentration history. Sharp increase in concentrations, readily seen on trend curves, are characteristic indicators of incipient component failure.

5. DETAILED REQUIREMENTS

5.1 Design. The system shall be designed and reviewed in accordance with MIL-STD-1521B to facilitate access to the lubricating system(s) to obtain a representative OAP sample with minimum effort. The access procedure shall be consistent with the maintainability requirements for the system and shall not degrade the reliability or safety of the system.

5.2 Oil sampling techniques. The oil sampling technique shall ensure a representative sample, minimize the possibility of sample contamination and be compatible with OAP analytical techniques. The sampling technique shall not degrade the system maintainability, reliability, or safety requirements.

5.3 Wear metals identification. The oil-wetted components (potential sources of wear metals) of the system shall be identified and documented. The identification shall include the identity, location, and composition of the components.

5.4 Oil sampling interval. The optimum oil sampling interval for the system shall be determined and documented. The interval determination shall include as a minimum, the following factors:

a. The criticality of failure of a component or system.

b. The anticipated time for a component to progress to failure after initiation of adverse wear.

c. The cost of obtaining and processing an oil sample.

5.5 Wear metal guidelines. The critical wear metal guidelines and wear metal trends shall be established. The wear metals identified shall be considered as a minimum. The effects of fluid consumption and fluid addition between samples shall be considered in establishing the guidelines and trends.

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5.6 Documentation. The sampling technique, oil-wetted component identification or trouble-shooting guide, sampling interval and guidelines/trends shall be documented in TO33-1-37/NAVAIR 17-15-50/TM38-301 format for publication. Documentation will be provided to applicable service OAP manager upon introduction of system or shortly thereafter for publication. Published OAP criteria will be updated as operational data is accumulated.

6. NOTES

6.1 Intended use. The oil analysis in equipment design defined herein shall be used in the Oil Analysis Program (OAP).

6.2 Data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of the DoD FAR clause on data requirements (currently DoD FAR Supplement 52.227-7031) are invoked and the DD Form 1423 is not used, the data shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph No.	Data Requirement Title	Applicable DID No.	Option
4.2	Catalogued metals	- - -	- - -
5.3	Wear metals identified and documented	- - -	- - -
5.6	Sampling technique, oil-wetted component, indentification or trouble-shooting guide.	- - -	- - -

(Data item description related to this standard, and identified in section 6 will be approved and listed as such in DoD 5000.19-L., Vol. II, AMSDL. Copies of data item description required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Changes from previous issues. Vertical lines or asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - TM
Air Force - 20
Navy - AS

Review activities:
Army - AV, AT, ME
Air Force - 11, 99

Preparing activity:
Air Force - 82

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1. DOCUMENT NUMBER	2. DOCUMENT TITLE
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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
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