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JOINT OIL ANALYSIS PROGRAM BIBLIOGRAPHY

TECHNICAL SUPPORT CENTER
JOINT OIL ANALYSIS PROGRAM
Naval Air Station Pensacola, Fla. 32508

July 1978

Final Report

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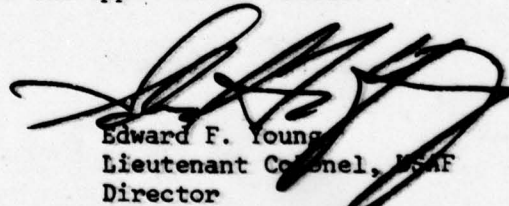
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1978

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This technical report was prepared by the Technical Support Center, a subpanel of the Joint Oil Analysis Program Coordinating Group (JOAP-CG) in the Joint Logistics Commanders organization. Because the Services' oil analysis programs are dynamic and changing, the report represents the best data available to the Technical Support Center at this time. It has been coordinated and approved at the JOAP-CG level. The purpose of the report is to exchange data on all oil analysis programs, thereby promoting interservice awareness of the DOD oil analysis program under the cognizance of the JLC. By careful analysis of the data in the report, personnel with expertise in oil analysis should be better able to determine technical voids and areas of potential duplication or proliferation.

This report has been reviewed and approved for release.



Edward F. Young
Lieutenant Colonel, USAF
Director
Technical Support Center

NOTICE

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report is a compilation of current DOD RDT/E projects that have a direct application to the military services' Joint Oil Analysis Program. Brief abstracts are provided. Included is a bibliographic listing of articles and reports addressing oil analysis. The bibliography is cross-indexed by subject and author.		

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BACKGROUND

Reference

A charter was issued on 23 September 1975 establishing a Joint Oil Analysis Program Coordinating Group (JOAP-CG) for the Joint DARCOM/NMC/AFLC/AFSC Commanders. The function of the Coordinating Group is the monitoring and direction of the Joint Oil Analysis Program. A Tri-Service Agreement for the Joint Oil Analysis Program was issued on 5 January 1976. It directed that the JOAP-CG receive technical advice from the JOAP Technical Support Center (TSC). Among other responsibilities the JOAP-TSC is to review and coordinate oil analysis research, development, test and evaluation (RDT&E) projects, maintain surveillance of state-of-the-art of oil analysis and provide for technical information exchange. These duties were assigned to the JOAP-TSC by a charter dated 9 January 1976. To assist the JOAP-TSC in the development of RDT&E information, a Charter for the JOAP Research and Development Sub-Group was given on 10 November 1976.

Scope

The R&D Sub-Group is composed of members from DARCOM, NMC, AFLC, AFSC, and the TSC. The purpose of this Sub-Group is to identify current and anticipated R&D efforts among the services having a direct application to the JOAP (Work Unit Summaries) and to list in bibliographic format published reports in the oil analysis area.

ACCESSION	
NTIS	<input checked="" type="checkbox"/>
DOC	<input type="checkbox"/>
INDEXED	<input type="checkbox"/>
SEARCHED	<input type="checkbox"/>
SERIALIZED	<input type="checkbox"/>
FILED	<input type="checkbox"/>
MAY 1976	
FBI - MEMPHIS	

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Work Unit Summaries	2
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SECTION I

A 76-001
Dept. of Defense
Tri-State
IND. P. O. Box 241
Beverly Hills
DARTMOUTH
GROUP
09110
ST. LOUIS
MISSOURI
63103

USER'S GUIDE TO WORK UNIT SUMMARIES

- 1 → N 76-009 F53537 ← 2
3 → NAEC Code 92724, Lakehurst, NJ
08733
NAVAIR (AIR-340E), Washington, D.C. ← 4
20361
5 → WEAR COMPONENT LABORATORY TEST PRO-
GRAM
6 → P. B. Senholzi (201) 323-7463 ← 7

8 → Bench testing of bearings to identify oil debris parameters to be monitored. Determine feasibility of monitoring these parameters to determine wear progression with time until failure.

1. Index Number
2. Project Number
3. Performing Organization
4. Sponsoring Organization
5. Title
6. Principal Investigator
7. Telephone
8. Summary

A 76-001 1T161102B35E
Dept. of Surface Treatment and
Tribology, Metallurgical Institute
TNO, P.O. Box 541, Apeldoorn,
Netherlands
DARCOM Research and Standardization
Group, Box 15, U.S. Forces FPO NY
09510
STUDY OF THE LUBRICATION MECHANISM
OF THIN FILM LUBRICATED CONCENTRATED
STEEL CONTACTS
A. Begelinger

Study the mechanisms which control elastohydrodynamic lubrication of steels under conditions where sliding contact occurs.

A 76-002 20161102B33G
Virginia Polytechnic Institute and
State University, Blacksburg, VA
24061
DARCOM Army Research Office,
Research Triangle Park, NC 27709
AN EXPERIMENTAL STUDY OF SURFACE
TEMPERATURES GENERATED AT THE SOLID-
SOLID INTERFACE 10887-E
M. J. Furey (703) 555-6000

To improve the basic understanding of friction generated surface temperatures. Research effort is relevant to the problem of wear and lubrication associated with gears and bearings which are used in most Army equipment.

A 76-003 1G062105A107
Frankford Arsenal MUCOM, Philadelphia, PA 19137
MUCOM Pitman Dunn Labs, Frankford
Arsenal, PA 19137
REACTIVITY OF ORGANIC COMPOUNDS
WITH METAL SURFACES
Dr. H. Gisser (215) 535-2900

To study the interaction of organic compounds with metal surfaces and to relate the reaction products to friction and wear phenomena.

A 76-004 1F262204AA52
SKF Industries, Inc., King of
Prussia, PA 19406
DARCOM Ballistic Research Labs,
Aberdeen Proving Ground, MD 21005
DEVELOPMENT OF ANALYTICAL METHODOLOGY
AND MODEL TO SIMULATE GEARBOX
MODELS
T. Harris (215) 426-6400
Ext. 457

To produce an analytical model capable of (1) predicting steady-state dynamic and thermal performance of a roller and triplex ball bearing/shaft/housing under lubricated conditions and (2) following lubricant cut-off.

A 76-005 1T161101A91A
ARRADCOM BRL Propulsion Division,
Aberdeen Proving Ground, MD 21005
ARRADCOM Ballistic Research Laboratories,
Aberdeen PG, MD 21005
APPLICATION OF OPTICAL INTERFEROMETRY
TO MEASURE BORE WEAR AND BUILD-UP
PROFILES
B. T. Haug (301) 278-4248

To investigate and demonstrate the feasibility of using Michelson interferometry to measure gear wear and to acquire a wear profile throughout the length of the 105 mm cannon with an accuracy of 0.2 micrometers.

A 76-006 1T161102B33G
University of Michigan, Ann Arbor,
MI 48105
DARCOM Army Research Office, P.O.
Box 12211, Research Triangle Park,
NC 27709
WEAR MODELS FOR SEVERE WEAR OF
POLYMERIC MATERIALS 11669-E
K. C. Ludema (313) 764-1817

Development of wear models for polymers that apply to the transition from mild to severe wear. Es-

establishment of conditions that produce severe wear in polymers. Experimental verification of wear models to be developed.

A 76-007 1F262205AH88
SKF Industries, Inc., King of Prussia, PA 19406
ARRADCOM Ballistic Research Laboratories, Aberdeen PG, MD 21005
ANALYTICAL MODEL TO SIMULATE HELICOPTER TRANSMISSION
J. McCool (215) 265-1900

To produce an analytical model capable of predicting steady-state dynamic and thermal performance of the transmission gears, bearings, shafts and casements concurrently under normal lubricated conditions and following loss of primary lubrication.

A 76-008 1T161101A91A
ARMCOM Research Directorate, Watervliet Arsenal, NY 12189
ARMCOM Benet Weapons Laboratory, Watervliet Arsenal, NY 12189
SURFACE CHARACTERIZATION
L. U. Meisel (518) 266-5016

Application of appearance potential spectroscopy (APS) to the solution of materials problems such as erosion and wear, fatigue, which limit gun tube life.

A 76-009 1C062105A107
Rock Island Arsenal, R&E Division, Rock Island, IL 61201
WECOM Research & Engineering Division, Rock Island Arsenal, IL 61201
THE EFFECT OF LOAD, SURFACE SPEED AND TEMPERATURE UPON THE WEAR LIFE OF SOLID FILM LUBRICATION
G. P. Murphy (309) 794-5571

Determination of the effect of such factors as load, surface speed

and temperature and their relation to the wear life of solid film lubricants. Determine the effect of area of contact upon wear life.

A 76-010 1T161102B457
North Carolina State University, Raleigh, NC 27607
DARCOM Army Research Office, Research Triangle Park, NC 27709
DEVELOPMENT OF MATHEMATICAL MODELS TO DESCRIBE THE WEAR PROCESS IN VISCOELASTIC MATERIALS 12726-E
C. Zorowski (919) 737-2117

Develop models of wear on viscoelastic materials, analysis of models and comparison with experimental results in literature.

A 76-011 1T062105A107
Southwest Research Institute, San Antonio, TX 78228
DARCOM Coating and Chemical Lab, Aberdeen Proving Ground, MD 21005
RESEARCH IN APPLIED ENGINE LUBRICANTS TECHNOLOGY
S. J. Lestz (512) 684-2000
Ext. 540

Investigate the fundamental mechanisms of lubricant degradation, deposit formation, engine wear and piston ring/cylinder liner scuffing under high output conditions through the separation of lubricant effects, fuel effects, engine variables and operating conditions.

AF 76-001 WU 2303S302
Battelle Memorial Institute,
Columbus, Ohio
Air Force Aero-Propulsion Laboratory
through an Air Force Office of Sci-
entific Research.
SOLIDIFICATION OF BOUNDARY LUBRICANT
FILMS
C. M. Allen (614)424-5008

Investigation of phase changes,
film solidification and "glassy"
behavior of turbine lubricants and
basestocks when subjected to loads
and temperatures typical of those
found in rolling contact bearings.

AF 76-002 WU 30480686
Monsanto Research, Dayton, OH
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
RECLAMATION OF SYNTHETIC TURBINE
ENGINE OIL MIXTURES
G. A. Beane (88) 785-4347

Contractual effort of Monsanto
to develop and evaluate reclamation
processes for synthetic turbine
engine lubricants.

AF 76-003 3048 06318
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
Air Force
LUBRICANT SPECIFICATION DEVELOPMENT
G. A. Beane (88) 785-4347

Maintains specification control
of Mil-L-7808. Evaluates assessment
requirements and investigates toxic-
ology of lubricants and additives.

AF 76-004 AF304806
Air Force Aero-Propulsion Laboratory,
Wright-Patterson AFB, OH
Air Force
OPERATION SUPPORT
K. L. Berkey (88) 785-4347

Operational support effort for
identification and resolving of field
lubrication problems.

AF 76-005 AFAPL-3048-06-90
Air Force Aero-Propulsion Lab
Air Force Aero-Propulsion Lab,
Wright-Patterson AFB, OH
SQUIRES METHOD OF LUBRICANT EVALUA-
TION
P. W. Centers

To evaluate and apply Squires
Laboratory method for the thermal
and oxidative evaluation of synthe-
tic turbine lubricants and to corre-
late the laboratory assessment of
lubricant capabilities with recent
test stand engine data. Based upon
that correlation, predict thermal
and oxidative performance of synthe-
tic lubricants in operating engines.

AF 76-006 AFAPL-3048-06-89
Air Force Aero-Propulsion Lab
Air Force Aero-Propulsion Lab,
Wright-Patterson AFB, OH
TURBINE LUBRICANT FOAMING AND
AERATION
P. W. Centers

Investigate and identify the
parameters affecting lubricant foam-
ing. Develop satisfactory methods
for measuring lubricant foaming
characteristics and establish ade-
quate and realistic foaming limits
for Specification Mil-L-7808. In-
vestigate and establish required
dispersion characteristics of Anti-
foam additives to ensure storage
stability with respect to foaming.
Investigate foaming characteristics
of used lubricants and the effects
of lubricant filtration on lubri-
cant anti-foaming properties.

AF 76-007 WU 2303S301
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
Air Force Office of Scientific
Research (grant)
WEAR PARTICLE IDENTIFICATION
P. W. Centers (88) 785-4667

Chemical techniques are being developed for potential use in identification of wear debris found on ferrograms.

AF 76-008 WU 30480687
Southwest Research Institute, San Antonio, TX
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
MECHANISMS OF TURBINE ENGINE LUBRICANT DEPOSITION
L. DeBrohun (88) 785-4347

Two selected basestock esters are to be degraded in a controlled test rig environment. The mechanisms of lubricant deposition will be explored.

AF 76-009 23030201
Air Force Materials Laboratory
(AFML/MBT) Wright-Patterson AFB, OH
Air Force Materials Laboratory
(AFML/MBT) Wright-Patterson AFB, OH
LUBRICATION SYSTEMS ANALYSIS
Dr. K. J. Eisentraut (513) 255-4860
Autovon 785-4860

Research is being accomplished in support of the Air Force Oil Analysis Program. New Oil calibration standards are being synthesized and evaluated. Improved analytical methods for the analysis of wear-metals in oil are being developed. New supplementary and improved primary oil analysis instrumentation are being developed and evaluated for application within the Air Force.

AF 76-010 AFOSR-2303-A2
University of Utah, Salt Lake City, Utah
Air Force Office of Scientific
Research
RATES OF RAPID CHEMICAL REACTIONS
E. M. Eyring

To obtain a fundamental understanding of the heterogeneous reaction kinetics at solid-liquid interfaces. Study of chemical reactions taking place (and their rates) on metal surfaces so that better protective techniques can be employed, e.g. more durable film coatings or improved lubricants.

AF 76-011 8174
The Garrett Corp. Aire Search
Manufacturing Co., 2525 W. 190th
St., Torrance, CA 90509
TURBINE ENGINE LUBRICATION AND MOVING PART CHECK-OUT PROCEDURES
Dr. J. Kukel (213) 323-9500

Determination of improved detection, measurement and check-out techniques will improve maintenance scheduling, prolong operational usage time, avoid in-flight shut-downs or mission aborts and deter the progression of consequential damage.

AF 76-012 AFOSR-2303-A2
Sun Oil Company, Marcus Hook, PA
Air Force Office of Scientific
Research
INFRARED SPECTRA OF FLUID FILMS UNDER CONDITIONS OF INCipient BEARING FAILURE
J. L. Lauer

This research is concerned with the determination of changes of composition and state in a thin fluid layer separating two matching metallic surfaces under conditions of boundary lubrication. The determin-

ations are to be made by means of a highly sensitive infrared emission Fourier spectrophotometer through a suitable window in one of the surfaces. Representative, well characterized simple fluids, simulating those now used for lubrication or traction, are to be used. This work will lead to information on phase transitions, absorption/desorption, and composition changes in the fluid and on metal surfaces as a function of temperature, pressure and shear rates.

AF 76-013 AFAPL-3066-13-04
General Electric Company
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
ADVANCED DIAGNOSTIC ENGINE MONITORING SYSTEM
D. W. Leiby

Design, fabrication, and study of an advanced diagnostic engine monitoring system by flight test on an operational aircraft. Conduct state-of-the-art study and recommend follow on diagnostic monitoring systems.

AF 76-014 AFWL-2103-3W-18
Air Force Weapons Laboratory,
Kirtland AFB, NM
Air Force Weapons Laboratory,
Kirtland AFB, NM
COMPARISON OF DIRECT DISPOSAL VS RECYCLE TECHNIQUES FOR DISPOSING OF AIR FORCE WASTE PETROLEUMS, OILS, AND LUBRICANTS
M. Lieberman

Studies problems relative to disposing waste lubricants and waste fuels. Disposal recycle options are discussed. Procedure for effective disposal of petroleum oils and lubricants (POCs) are presented.

AF 76-015 AFOSR-2303-A2
Ford Motor Company, Dearborn, MI
Air Force Office of Scientific
Research
TIME-TEMPERATURE STUDIES OF HIGH TEMPERATURE DETERIORATION PHENOMENA IN LUBRICANT SYSTEMS. SYNTHETIC ESTER LUBRICANTS
L. R. Mahoney

Studies will be conducted utilizing stirred flow reactor techniques to determine (1) kinetics and mechanisms of synthetic ester degradation and (2) the influence of metals and corrosion products on the reactions.

AF 76-016 AFOSR-9536-01
Purdue University, Lafayette, IN
Air Force Office of Scientific
Research
FAST KINETIC METHODS APPLICATION TO TRACE CHEMICAL ANALYSIS AND DETECTION
D. W. Margerum

This research is concerned with the development of chemical and instrumental analytical methods for the detection of trace quantities of materials leading to rapid analysis and detection of metal particles in jet engine oils and pollutants in engine exhausts. To achieve fast analysis, a unique rapid scanning spectrophotometer containing no movable mechanical parts is being developed.

AF 76-017 2421
Air Force Materials Laboratory
Wright-Patterson AFB, OH
Air Force Materials Laboratory MBT
Wright-Patterson AFB, OH 45433
LUBRICANTS AND LUBRICATION BEHAVIOR JOINTS
B. McConnell

Develop new and improved lubricant materials, lubrication techniques, and life prediction techniques for aircraft, space vehicles missiles and support equipment.

AF 76-018 AFAPL-3066-13-04
General Electric Company
Cincinnati, OH
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
ADVANCED DIAGNOSTIC ENGINE MONITORING SYSTEM APPLICATION ASSESSMENT
W. R. Peters

The objectives of this program are to design, develop, and evaluate advanced state-of-the-art in-flight computational and sensing techniques incorporated in an Advanced Diagnostic Engine Monitoring System (ADEMSII).

AF 76-019 2303
Air Force Materials Laboratory
Wright-Patterson AFB, OH
Air Force Materials Laboratory MBM,
Wright-Patterson AFB, OH 45433
SURFACE PHENOMENA
T. W. Haas

Application of surface analysis techniques to provide complete chemical and physical characterization of solid surfaces, study ways in which chemical contamination, surface segregation, surface morphology, and method of preparation affects performance of adhesively bonded structures.

AF 76-020 23030203
University of Dayton Research
Institute, 300 College Park Ave.,
Dayton, OH 45469
Air Force Materials Laboratory
(AFML/MBT)
Wright-Patterson AFB, OH 45433

RESEARCH AND DEVELOPMENT ON WEAR-METAL ANALYSIS IN SUPPORT OF THE AIR FORCE OIL ANALYSIS PROGRAM
AF Contract No. F33615-76-C-5312
Dr. W. E. Rhine (513)255-4612
Dr. C. S. Saba Autovon 785-4612

R&D includes synthesis of new oil calibration standards; stability studies of existing oil calibration standards; development of new analytical methods for the analysis of wear metals; study of the effect of wear metal particle size on instrument analyzability; study of new concepts for oil analysis for advanced engine wear prediction technology; atomic absorption and atomic emission and plasma spectrometry research.

AF 76-021 2307
University of Connecticut, Storrs,
CT
Air Force Office of Scientific
Research
Bolling AFB, DC 20332
WEAR OF MATERIALS UNDER REPEATED NORMAL AND SLIDING IMPACT
S. L. Rice

Investigation of basic effects of critical parameters for normal and sliding impact wear to extend scientific knowledge about friction and wear behavior to better predict the effects of complex mechanical loading.

AF 76-022 23030202
Monsanto Research Corporation,
Station B, Box 8, Dayton, OH 45407
Air Force Materials Laboratory
(AFML/MBT)
Wright-Patterson AFB, OH 45433
TRACE CHEMICAL ANALYSIS METHODOLOGY
AF Contract No. F33615-75-C-1130
W. D. Ross (513)268-3411

Research is being accomplished on the development of a rapid colorimetric procedure for the analysis of iron wear metal in turbine engine oil to be performed by aircraft maintenance personnel at the side of the aircraft. Chromatographic procedures have been developed to follow changes which occur in synthetic ester base turbine engine lubricants with engine operating time.

AF 76-023 23030204
Southeastern Center for Electrical Engineering Education, Inc., Auburn University, Auburn, AL 36830
Air Force Materials Laboratory (AFML/MBT)
Wright-Patterson AFB, OH 45433
ADVANCED ENGINE TRENDING TECHNOLOGY AND SUPPLEMENTARY OIL ANALYSIS TECHNIQUE INVESTIGATIONS
AF Contract No. F33615-77-C-5003
Dr. K. Scheller (513) 255-4611
Dr. J.A. Bierlein Autovon 785-4611

New accurate engine wear trending technology is being developed with specific application to high oil-consumption turbine engines with small oil system volumes. Supplementary oil analysis techniques based on light scattering, particle counting, AC impedance diagnostics, etc. are being developed and evaluated for application within the Air Force.

AF 76-024 AFAPL-3048-06-91
Air Force Aero-Propulsion Lab
Wright-Patterson AFB, OH
Air Force Aero-Propulsion Lab
Wright-Patterson AFB, OH
COMPATIBILITY OF LUBRICANTS WITH RESPECT TO THERMAL AND OXIDATIVE STABILITY
H. A. Smith

Establish basic parameters of

turbine engine lubricant compatibility. Develop new and improved guidelines for assessing and defining the compatibility of current and advanced high temperature lubricant with the use of the Oxidation and Corrosion Test Rig.

AF 76-025 30480626
Air Force Aero-Propulsion Laboratory
Wright-Patterson AFB, OH
Air Force
TURBINE ENGINE LUBRICANT RESEARCH
H. Smith (88) 785-4667
P. W. Centers -4668

Establish basic parameters of turbine engine lubricant degradation from which new and improved methods and guidelines for assessing and defining the performance capability of current and advanced high temperature lubricants. Correlate the physical and chemical characteristics of wear particles with the mechanisms of wear occurring in turbine engine lubrication systems.

AF 76-026 7343
Battelle Memorial Institute,
Columbus, OH
Air Force Materials Laboratory/MBT
Wright-Patterson AFB, OH 45433
BEARING AND SLIP RING LUBRICANT TEST EQUIPMENT
R. D. Stockwell

To develop bearing and slip ring lubricant test equipment to study long term behavior with respect to degradation, dewetting and slip ring wear.

AF 76-027 7343
Amsco Chemicals Corporation, R&D
Department, Naperville, IL
Air Force Materials Laboratory/MBT,
Wright-Patterson AFB, OH

GREASE LUBRICATED MINIATURE BEARINGS
J. Thompson

Determin the performance characteristics of new and advanced greases in miniature bearings under actual long term and accelerated storage conditions, and to develop techniques for predicting the performance characteristics of grease lubricated miniature bearings after storage.

AF 76-028 FJSRL-7903-03-86
USAF Physics Dept., USAF Academy,
CO
FJSRL
ENGINE OIL ANALYSIS
B. Loving

The objective is to investigate the feasibility of employing 252 Cf as a neutron source for neutron activation of aircraft engine oil samples in order to determine the amount of metal products present in the samples.

AF 76-029 AFOSR-2303-A1
University of Florida, Gainesville,
Florida
Air Force Office of Scientific
Research
ANALYTICAL GAS PHASE SPECTROMETRY
AND COMBUSTION DIAGNOSTICS
J. D. Winefordner

Fundamental study of electric probes for measurement of positive iron concentration and electron temperatures in plasmas. Systems for examination plasmas and combustion products studied. Laser source for atomic fluorescence spectrometry examined.

AF 76-030 AFOSR-9336-00
University of Florida
Gainesville, FL

Air Force Office of Scientific
Research
ATOMIC SPECTROMETRIC AND GAS
CHROMATOGRAPHIC METHODS OF ANALYSIS
INCLUDING TRACE METALS
J. D. Winefordner

Primary area of this project is the study of new, novel and improved methods of atomic spectrometric analysis, including spark, flame and RF emission, absorption and fluorescence (Atomic fluorescence analysis).

AF 76-031 AFOSR-9536-01
University of Florida
Gainesville, FL
Air Force Office of Scientific
Research
GAS PHASE SPECTROMETRY METHODS -
TRACE ANALYSIS OF ELEMENTS
J. D. Winefordner

Methodological studies will be directed toward simultaneous multi-element analysis of trace elements by using multiplexing methods based on the use of an electronic image detector and other spectrometric techniques. Coherent Anti-Stokes Raman Scattering (CASRS) technique will be applied to combustion diagnostics, as well as a study of the composition of hydrocarbon species produced in jet engine exhausts. Optical, electrical, and mass spectrometric methods will be developed to measure in-situ temperatures and concentrations of combustion products in flames, as well as simulated jet engine plasmas.

AF 76-032 AFFDL-1987-01-21
Air Force Flight Dynamics Lab
Wright-Patterson AFB, OH
Air Force Flight Dynamics Lab
Wright-Patterson AFB, OH
ESTABLISHMENT OF HYDRAULIC FLUID
PARTICLE CONTAMINATION TECHNOLOGY

FOR MILITARY AIRCRAFT

C. Wisdom

The objective of this program is to establish technology and criteria for determining the levels, effects and filtration methods of hydraulic fluid particle contamination in servo-actuating subsystems and thus provide means to improve overall flight control system reliability and safety military aircraft.

AF 76-033

AFAPL-3066-13-02

Garrett Corporation

Air Force Aero-Propulsion Laboratory

Wright-Patterson AFB, OH

ADVANCED DIAGNOSTIC SENSOR APPLICATIONS TECHNOLOGY FOR TURBINE ENGINES

H. Ziebarth

Investigate incorporation of diagnostic technologies to make aircraft readiness prediction, make timely repairs and extend service life and spare engine inventory.

N 76-001

Foxboro/Trans-Sonics, Inc., Burlington,
MA 01803

NAEC-GSED Code 92724, Lakehurst,
NJ 08733

WEAR PARTICLE ATLAS

Dr. E. R. Bowen (617)272-1000

Development of a Wear Particle Atlas to summarize the NAEC Oil Analysis Program. Results will correlate wear particles to respective wearing surfaces.

N 76-002

F53537

Franklin Institute Research Labs,
Philadelphia, PA 19103

NAEC, Lakehurst, NJ 08733

WEAR COMPONENT STUDY

W. Collins (215)488-1106

Correlation of wear mode parameters with the operational parameters of oil-wetted wear components.

N 76-003

Villanova University, Villanova,
PA 19085

NAEC-GSED Code 92724, Lakehurst,
NJ 08733

HYDRAULIC SYSTEM CONTAMINANT MONITOR

J. J. Coyle

A contamination monitor, particle counter, and two hygrometers were tested for their ability to measure contaminants in hydraulic fluid. The results of the testing formed the basis for a procurement specification for an in-line contamination monitor.

N 76-004

SKF Industries, Inc., Engineering and Research Center, King of Prussia
PA

NAEC-GSED Code 92724, Lakehurst,
NJ 08733

GREASE ANALYSIS PROGRAM

Dr. H.M. Dalal

Effort to explore criteria relating characteristic grease-lubricated rolling bearing failure progression to the quantity and morphology of wear debris in grease samples taken from the bearing.

N 76-005

Franklin Institute Research Laboratories, Philadelphia, PA

NAEC-GSED Code 92724, Lakehurst,
NJ 08733

OIL ANALYSIS METHODOLOGY DEVELOPMENT

Dr. L. Leonard (215)448-1318

Develop an effective oil analysis methodology to reflect possible influence of ultrafine filtration and oil analysis advances on present oil analysis techniques.

N 76-006

F53537

National Bureau of Standards,
Gaithersburg, MD 20760

Office of Naval Research 411,
Arlington, VA 22217

NAVAL VEHICLE DESIGN AND CONSTRUCTION: METALLURGICAL ANALYSIS OF WEAR PARTICLES AND WEARING SURFACES

M. L. Picklesimer (301)921-2951

Characterize the wear particles and surface degradation produced by wear in bearing and gear life tests in which the effects of several variables on failure of the wearing surfaces has been examined.

N 76-007

F41433

NAPTC Research and Technology Group
(PE4), Trenton, NJ 08628

NAVAIR Propulsion Technology Administrator, Washington, D.C. 20361

TURBINE ENGINE DIAGNOSTIC DEVELOPMENT

P. Piscopo (PE42) (609)882-1414
Ext. 316

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Demonstrate feasibility of a diagnostic system which is applicable to current and future Navy aircraft. Develop performance, lubrication system, vibration and hot section diagnostic techniques.

N 76-008 F53537
NAEC (Code 92724) Lakehurst, NJ 08733
NAVAIR (AIR-340E), Washington, D.C.
20361
GREASE ANALYSIS
P. B. Senholzi (201)323-7463

The feasibility and effectiveness of Grease Analysis as a diagnostic technique to be determined. Sample preparation technique has been developed. Work proceeding on sample location and bench testing.

N 76-009 F53537
NAEC Code 92724, Lakehurst, NJ
08733
NAVAIR (AIR-340E), Washington, D.C.
20361
WEAR COMPONENT LABORATORY TEST PROGRAM
P. B. Senholzi (201)323-7463

Bench testing of bearings to identify oil debris parameters to be monitored. Determine feasibility of monitoring these parameters to determine wear progression with time until failure.

N 76-010 P068105
NADC Air Vehicle Technology Dept.,
Warminster, PA.
NAEC-GSED, Lakehurst, NJ 08733
TRIBOLOGICAL INVESTIGATIONS FOR
IMPROVED RELIABILITY IN AIRCRAFT
MECHANICAL EQUIPMENT
L. Stallings (215)672-9000

Translation of lubrication and bearing technology advances into improvements in aircraft mechanical

equipment design.

N 76-011 RR02301
Massachusetts Institute of Technology, Dept. of Mechanical Engineering, Cambridge, MA 02139
Office of Naval Research, Arlington, VA 22217
INTERNATIONAL CONFERENCE ON
TRIBOLOGY
N. P. Suh (617)253-2225

Provide a forum for the interchange of research results in the field of tribology to allow Navy managers, scientists, engineers and contractor personnel to better define research and development opportunities aimed at eliminating friction and wear problems.

N 76-012
Oklahoma State University, Dept. of Engineering, Stillwater, OH 74074
NAEC-GSED Code 92724, Lakehurst, NJ
08733
EFFECTS OF OIL CONTAMINANTS ON WEAR
RATE
D. Tessmann (405)624-7375

Effort to determine the effects of oil entrained contaminants, with respect to size distribution, concentrates and composition on the wear rate of ball bearings.

N 76-013 WR00703
Southwest Research Institute, 8500
Culebra Road, San Antonio, TX 78206
Naval Air Systems Command, Washington, D.C. 20360
RESEARCH ON SPLINE LUBRICATION
J. C. Tyler (512)004-2000

Investigation of wear mitigation characteristics of experimental greases and plastics to obtain improved performance from splines.

N 76-014 WR5109W
Southwest Research Institute, 8500
Culebra Road, San Antonio, TX 78284
NADC Air Vehicle Technology Dept.,
Warminster, PA 18974
EVALUATION OF SPLINE SURFACE
M. Valtierra (512)684-5111

Evaluation of six spline surface treatments in conjunction with Mil-G-21164 or Mil-G-81322 on new and used splines to determine which treatment provides improved performance with a lubricant.

N 76-015 7D10
Foxboro/Trans-Sonics, Inc., Burlington, MA 01803
Office of Naval Research, 411,
Arlington, VA 22217
NAVAL VEHICLE DESIGN AND CONSTRUCTION: ADHESIVE AND FATIGUE WEAR PARTICLE PRODUCTION RATES
V. Westcott (617)272-1000

Research to determine the rates of production of adhesive and fatigue generated wear particles in lubricated systems as a function of applied load, speed and material in order to detect incipient failure in Naval mechanical systems.

N 76-016 F53537
Trans-Sonics, Inc., P.O. Box 326,
Lexington, MA 02173
Office of Naval Research 411,
Arlington, VA 22217
NAVAL VEHICLE DESIGN AND CONSTRUCTION: INVESTIGATION DISTRIBUTION OF WEAR PARTICLES
V. Westbott (617)272-1000

To gain an understanding of how the size, shape and size distribution of wear particles are influenced by the severity of the wear process. Knowledge to be beneficial in developing systems to detect incipient failure in Naval mechanical systems.

N 76-017
NAEC-GSED Code 92724, Lakehurst,
NJ 08733
EFFECTS OF HYDRAULIC FLUID CONTAMINANTS ON WEAR RATE

Effort to determine the effects of hydraulic fluid entrained contaminants on hydraulic component wear rate. Acidity and viscosity are also to be considered.

N 76-018
NAEC-GSED Code 92724, Lakehurst,
NJ 08733
GSE "ON CONDITION" OIL CHANGE INTERVAL

To determine the feasibility of utilizing oil analysis techniques in the determination of "On Condition" ground support equipment oil change intervals this optimizing oil conservation.

N 77-001

Northwestern University, Dept. of
Mechanical Engineering and Astro-
nautical Sciences, Evanston, IL
60201

Office of Naval Research, Atlington,
VA 22217

FRictional WEAR MECHANISMS;
MACHINERY WEAR TECHNOLOGY

Prof. Ralph A. Burton (312) 492-5284

To investigate the effects of
localized heat conductivity, tem-
peratures and pressures on wear
mechanisms which take place between
solid materials in sliding contact.
The investigations include the
effects of thin liquid surface films
and surface features such as non-
flatness, asperities, and patches of
contact.

N 77-002

Framan Distributors, Ltd. of Mon-
mouth House, 87 The Parade, Watford
WD11LR, Hertfordshire, ENG
Office of Naval Research, Arlington,
VA 22217

TRANSIENT HIGH PRESSURE LIQUID
RHEOLOGY

Dr. A. Cameron 01-589-5111

The objective of this work is
to determine the influence of molec-
ular structure on the time dependent
viscosity and density response of
liquids and other viscoelastic
materials.

N 77-003

Imperial College of Science and
Technology, Exhibition Road,
London, ENG SW7 2AZ
Office of Naval Research, Arlington,
VA 22217

HIGH PRESSURE VISCOSITY MEASUREMENT

Prof. A. Cameron 01-589-5111

The objective of this work is to
determine the influence of molecular

structure on the time dependent
viscosity and density response of
liquids and other viscoelastic
materials.

N 77-004

Naval Aviation Integrated Logistic
Support Center, Patuxent River,
MD 20670
Office of Naval Research, Arlington,
VA 22217

FERROGRAPHIC EVALUATION

C. Chandler (301) 863-4721

The objective of this project
is to evaluate the effectiveness of
the ferrograph in an operational
environment.

N 77-005

Exxon Research and Engineering
Company, P. O. Box 51, Linden, NJ
07036
Office of Naval Research, Arlington,
VA 22217M

MATERIAL SUPPORT TECHNOLOGY:
SELF GENERATED ELECTROMOTIVE FORCE
IN SLIDING SYSTEMS

Dr. Irwin Goldblatt (201) 474-2288

The objective is to determine
the interrelationship between metal-
lurgy, chemistry and environment
that controls the rate of wear in
Navy mechanical equipments.

N 77-006

Michigan Technological University,
Houghton, MI 49931
Office of Naval Research, Arlington,
VA 22217

A STUDY OF A HIGH GRADIENT MAGNETIC
WEAR PARTICLE SEPARATION AS APPLIED
TO DIESEL ENGINES

Dr. J. H. Johnson (906) 487-2576

The objective of this research
is to investigate the effect of HGMS
on removing wear particles from

operating diesel engines on engine wear. Also investigate the ability to study wear particles trapped by HGMS and predict engine wear and component life.

N 77-007

Battelle, Columbus Laboratories,
505 King Ave., Columbus, OH 43201
Office of Naval Research, Arlington,
VA 22217

THE MECHANISM OF HEAT GENERATION IN
ELASTOHYDRODYNAMIC CONTACTS

Mr. J. Kannel (614) 424-4626

The objective of this research is to determine the magnitude of the temperature rise accompanying the compression of lubricants in bearing and concentrated contacts.

N 77-008

Oklahoma State University, Stillwater, OK 74074
Office of Naval Research, Arlington,
VA 22217

FLUID POWER COMPONENT SURVIVABILITY

Dr. G. E. Maroney (405) 624-7375

The objective is to conduct wear tests on rotary mechanisms and different types of fluid power pumps to produce data to better understand the fundamentals of wear in hydraulic systems. Also, investigate the relative effects of anodization on the fatigue life of various alloy materials.

N 77-009

The Catholic University of America,
Washington, D. C. 20017
Office of Naval Research, Arlington,
VA 22217

MATERIAL SUPPORT TECHNOLOGY: HIGH
PRESSURE LIQUID PROPERTIES RELEVANT
TO LUBRICANTS AND EXPLOSIVES

Prof. C. J. Montrose (202) 635-5327

A theoretical understanding is sought of the time-dependent changes in properties of liquids subjected to high pressures. Of concern are the nonlinear property changes during nonequilibrium conditions.

N 77-010

Carengie-Mellon University, Dept. of
Mechanical Engineering, Schenley
Park, Pittsburgh, PA 15213
Office of Naval Research, Arlington,
VA 22217

MATERIAL SUPPORT TECHNOLOGY: WEAR
REDUCTION IN SLIDING SYSTEMS

Prof. Milton C. Shaw (412) 621-2600
Extension 204

The objective of this research is to discover the mechanism by which a complex metal chalcogenide (arsenic thioantimonate) provides a 300-400% improvement in wear resistance when compared to molybdenum disulfide. Molybdenum disulfide is the solid lubricant used in most naval solid lubricants.

N 77-011

Massachusetts Institute of Technology, Cambridge, Massachusetts, 02139
Office of Naval Research, Arlington,
VA 22217

APPLICATION OF THE DELAMINATION
THEORY OF WEAR

Dr. Nam P. Suh (617) 253-2225

The objective of the research is to examine wear problems associated with spline gears, aircraft door hinges, and HSS tools and improve the life by application of the Delamination Theory of Wear.

N 77-012

Foxboro/Trans-Sonic, Inc., P. O. Box
435, Burlington, MA 01803
Office of Naval Research, Arlington,
VA 22217

NONMETALLIC WEAR PARTICLES IN
LUBRICANT AND HYDRAULIC FLUIDS

Mr. Vernon Westcott (617) 272-1000

The objective of this research is to support the research of Dr. Suh at MIT and NADC, in demonstrating practical military application of the delamination theory of wear. An additional objective is to apply ferrography to analysis of organic and other nonmagnetic substances, and to determine the population of nonmagnetic contaminant particles in the fluid of hydraulic systems under operating situation.

N 78-001

National Bureau of Standards,
Department of Commerce, Washington,
D. C., 20234
Office of Naval Research, Arlington,
VA 22217

NAVY VEHICLE DESIGN AND CONSTRUCTION: MECHANICAL FAILURE RESEARCH CORRELATION

H. C. Burnett (301) 921-2813

The objective of this effort is to reduce mechanical failure in the Navy vessels through the correlation of work aimed at the detection, analysis, and control of mechanical failures.

N 78-002

Cambridge University, University Engineering Department, Trumpington Street, Cambridge CB2 1PZ ENG
Office of Naval Research, Arlington, VA 22217

NAVY VEHICLE DESIGN AND CONSTRUCTION: INVESTIGATION OF VISCOELASTIC PROPERTIES OF VISCOUS LIQUIDS IN UNIDIRECTIONAL SHEAR

Dr. K. L. Johnson 0223 66466

The objective of this research is to obtain experimental data to verify theory being developed by another ONR Contractor concerning the influence of molecular structure on the transient behavior of density, viscosity, and shear properties of materials subjected to large impulses of normal or shear stress.

N 78-003

University of New Mexico, Dept. of Mechanical Engineering, Albuquerque, NM 87131
Office of Naval Research, Arlington, VA 22217

ELASTOHYDRODYNAMIC LUBRICATION OF MECHANICAL FACE SEALS FOR PROPULSION SYSTEMS

Prof. Alan O. Lebeck (505) 277-4609

To conduct theoretical, analytical, and experimental research on the elasto-hydrodynamic lubrication of mechanical face seals including the effects of wear, asperity contact, thermal and mechanical elastic effects, face geometry, cavitation and leakage of particular importance to Naval machinery applications.

N 78-004

Imperial College of Science and Technology, Dept. of Mechanical Engineering, London SW7, ENG
Office of Naval Research, Arlington, VA 22217

INVESTIGATION INTO THE INFLUENCE OF FILTRATION ON ROLLING FATIGUE AND SCUFFING

Dr. P. B. MacPherson, London, ENG 589-4187

The objective of the research is to provide firm practical guidance in setting design standards and filtration requirements for mechanical transmissions.

N 78-005

The Catholic University of America, Department of Physics, Washington, D. C. 20064
Office of Naval Research, Arlington, VA 22217

HIGH PRESSURE LIQUID VISCOSITY

Dr. C. J. Montrose (202) 635-5327

The objective of this work is to determine how various molecular structure affect those viscoelastic parameters that control the behavior of lubricants in elasto-hydrodynamic contacts.

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N 78-006

Massachusetts Institute of Tech-
nology, School of Engineering,
Cambridge, MA 02139
Office of Naval Research, Arlington,
VA 22217

BASIC WEAR MECHANISMS

Dr. Nam P. Suh (617) 253-2225

The objective of the research
is to investigate through an inter-
disciplinary approach, the mechanism
of crack nucleation and propagation
in two phase material, and to better
understand adhesive wear.

generated and permanent magnet
generated fields approximating
bearing configurations. Axially
opposing and attractive magnetic
forces will be studied.

N 78-007

Daedalean Associates, Inc.,
Springlake Research Center, 15110
Frederick Road, Woodbine, MD 21797
Office of Naval Research, Arlington,
VA 22217

SPHEROID FORMATION BY CAVITATION
EROSION

Dr. A. P. Thiruvengadam
(301) 924-4800

To provide further data to
support the credence of the splash
mechanism of spheroid formation in
cavitation erosion.

N 78-008

Mechanical Technology, Inc., 968
Albany - Saker Road, Latham, NY
12110
Office of Naval Research, Arlington,
VA 22217

CHARACTERISTICS OF MAGNETIC BEARINGS
FOR ADVANCED MACHINERY

Dr. Jed Walwit (518) 785-2359

An analytical model will be
formulated, validated by experiment,
for predicting the performance of
magnetic bearings. Experimental
investigations will be conducted to
determine the interrelationships of
geometric configuration, materials,
and combinations of electrically

O 76001 W77-70271
Lewis Research Center, Cleveland,
Ohio
NASA
MATERIALS FOR LUBRICATION AND WEAR
IN MECHANICAL COMPONENTS
W. J. Anderson (216)433-4000

The objectives are to obtain a greater understanding of the structure of materials and to extend the technology of application methods to improved materials and designs for present and anticipated extreme environments of aerospace devices.

O 76002 W77-70044
Lewis Research Center, Cleveland,
Ohio
NASA
DRIVE SYSTEM MECHANICAL COMPONENTS
TECHNOLOGY
W. J. Anderson (216)433-4000

The objectives of this work is to advance the technology for bearings, shaft seals, gears, shafts, lubricants, lubrication systems and mechanical power transmissions to achieve increased effectiveness, life, reliability and efficiency.

O 76003 W77-70002
Ames Research Center, Moffett Field,
CA
NASA
FATIGUE, FRACTURE AND LIFE PREDICTION
D. R. Chapman (415)965-5065

Emphasis is placed on determining the combined effect of mechanical loads and environmental factors on component integrity and durability.

O 76004 W77-70184
Lewis Research Center, Cleveland,
Ohio
NASA
ENGINE COMPONENT IMPROVEMENT
PROGRAM
J. A. Ziemianski (216)433-4000

To develop components which will reduce fuel consumption and provide technology which can be used to minimize the performance degradation of current and future engines.

Classical

Ag - A. 6, P. 13, 17, 23

Ba - C. 77, 81, 85, 89, 93, 97

Ca - H. 13, 17, 21, 25, 29, 33

Co - H. 1, 5, 9, 13, 17, 21

Cu - C. 25, 29, 33, 37, 41

Fe - C. 1, 5, 9, 13, 17, 21

Ga - C. 1, 5, 9, 13, 17, 21

SECTION II

Elements

Ag - A.8, P.13, R.13
Ba - C.25, C.33, D.10, D.14, F.16,
H.13, H.14, K.18, M.11, P.7,
R.1, S.53, T.27, Z.29
Ca - C.25, C.33, D.10, D.14, F.16,
G.15, H.13, H.14, K.18, L.43,
M.11, M.61, P.5, P.27, R.1,
S.117, Z.29
Cd - R.24
Cl - F.41
Cr - K.5
Cu - A.8, B.12, B.42, F.16, G.13,
H.34, L.2, M.70, P.11, P.13,
R.13, S.116
Fe - A.32, B.34, B.42, B.61, C.11,
E.11, F.7, F.8, F.23, G.8, G.13,
G.25, G.27, K.5, K.15, K.55,
L.2, M.9, M.70, P.11, P.48,
P.49, R.8, R.27, S.40, S.64,
S.67, S.116, T.29
Hg - K.38
K - F.16
Mg - C.9, F.16
Mn - E.18, F.18, R.23
Mo - J.26
Na - F.16, P.24
Ni - A.9, D.36, F.23, M.70, S.66,
S.128
P - B.11, C.33, D.14, E.7, F.42,
G.6, J.19, Z.13
Pb - B.28, B.70, C.25, F.16, F.41,
I.8, R.36, S.5, S.126, V.1
S - A.3, B.5, B.82, D.21, D.32,
F.42, H.13, J.19, K.42, P.24,
S.31, T.24
Sb - N.16
Sn - S.20
Sr - F.16
Ti - K.54, M.28, S.1
V - D.21, F.23, M.30, M.70, P.24,
S.66, Z.33
Zn - A.19, C.25, C.33, D.10, D.14,
F.16, F.41, F.42, G.15, G.36,
H.14, H.35, H.46, I.8, I.9,
J.19, K.44, M.2, M.20, P.5,
P.18, K.18, P.27, P.35, R.1,
S.53, S.116, S.117, Z.13

Additives

General (G), Use (U), Mechanism
(M), Performance (P)

B.9, B.38(G), B.39(M), B.40(M),
B.41(M), B.43(P), D.35(U), F.36(U),
G.14(U), K.9(U), K.68(P), O.10(U),
O.16(P), P.9, R.3(U), R.7(U), R.18(P),
R.58(U/P), S.10(U/P), S.23(U/P),
S.53, S.59, S.60, S.61, S.129, T.12,
T.21, T.27, V.14(U/P), W.12, W.15(G),
Z.6(P), Z.11, Z.24, Z.25, Z.28

Additives - Analysis

IR - Infrared Spectrometry
TLC - Thin Layer Chromatography

A.13, A.17(TLC), B.4, B.8(IR),
B.18, C.13(TLC), C.25, D.15(TLC),
D.22, D.26(TLC), G.15, G.39, G.40,
H.14, H.32, J.19, K.44, K.49(IR),
K.64, K.65, K.72, K.74, K.77, K.84,
L.10, L.35, L.36, L.37, L.38, L.39,
L.42, L.43, M.2, M.20(TLC), M.60,
N.1, P.7, P.14(IR), P.27, P.53(IR),
S.28, S.56, S.110(IR), S.117, S.123,
V.11, V.15(IR), Z.27, Z.30

Additives - Colorimetric, Metals

A.28, B.42, B.46, B.61, C.4, C.11,
K.15, K.35, K.55, L.25, L.27, L.28,
M.9, N.3, N.15, R.27, T.11

Additives - Fluids (General)

A.1, A.7, A.10, A.14, A.15, A.16,
A.17, A.33, A.38, B.7, B.20, B.30,
B.32, B.39, B.41, B.54, B.65, B.71,
B.72, C.1, C.5, C.6, C.13, C.17,
D.15, D.16, D.17, D.18, D.20, D.34,
D.38, E.5, E.13, F.12, F.13, F.15,
F.19, F.29, F.34, F.35, F.37, G.2,
G.4, G.7, G.18, G.19, G.22, G.23,
G.29, G.41, H.2, H.3, H.6, H.7,
H.17, H.18, H.19, H.26, H.28, H.29,
H.30, H.31, H.42, J.9, J.12, J.23,
K.25, K.28, K.37, K.39, K.40, K.60,
K.62, K.63, K.65, L.6, L.7, L.13,
L.55, M.4, M.6, M.7, M.8, M.12, M.13,

M.39, M.52, M.53, M.54, M.58, M.60,
M.67, N.7, O.3, O.4, P.3, P.4, P.9,
P.14, P.16, P.17, P.23, P.28, P.29,
P.30, P.46, P.47, P.52, Q.1, R.9,
R.28, R.39, S.12, S.19, S.24, S.27,
S.29, S.60, S.70, S.71, S.80, S.90,
S.94, S.95, S.98, S.101, S.102,
S.103, S.104, S.108, S.110, S.111,
S.112, S.113, S.115, S.118, S.119,
S.130, T.14, T.15, T.17, T.32, T.33,
V.5, V.6, V.7, V.8, W.28, W.36,
W.38, W.41, Z.21

Analysis -

Metallic, Chemical - instrumental
and unclassified (Other than
colorimetric, spectrometric, radio
or x-ray)

A.35, A.42, B.5, B.28, B.34, C.14,
C.17, K.37, K.45, K.58, K.59, K.62,
K.63, L.15, L.26, L.40, M.10, M.11,
M.24, M.26, M.28, M.38, M.55, M.61,
P.11, P.35, R.8, R.36, S.31, S.40,
S.64, S.67, S.121, S.126, V.2, W.30,
Z.14

Analysis - Neutron Activation

B.87, G.17, G.35, H.38, K.12, M.30,
N.1, O.11, P.19, P.29, S.106

Analysis - Radioactive

A.20, B.5, B.6, B.85, D.39, F.18,
F.20, F.25, F.38, F.40, G.9, G.37,
H.39, I.11, J.3, J.13, K.20, K.43,
L.1, L.24, N.10, N.11, P.6, P.31,
P.37, P.39, P.43, S.42, S.51, S.61,
T.22, T.23, U.1, V.9, W.5, W.6, W.14,
Z.2, Z.4, Z.7, Z.8, Z.10, Z.11, Z.12

Analysis - Trace Metals (General)

B.41, B.79, B.88, C.8, C.26, D.1,
D.22, D.29, D.37, F.1, H.38, I.1,
J.2, J.6, J.11, K.30, K.43, K.45,
K.73, K.78, K.82, L.15, L.28, L.44,
M.35, M.56, O.8, O.16, P.4, P.36,
P.38, P.50, R.37, S.22, S.52, S.99,
V.16, W.19

Analysis - Wearmetal (General)

A.2, A.18, B.19, B.51, B.58, B.60,
B.66, B.68, B.76, B.79, B.81, L.46,
M.52, M.56, N.11, O.11, O.13, P.2,
P.6, P.12, P.19, P.20, P.31, P.37,
P.43, P.44, P.45, R.33, R.34, S.1,
S.47, S.48, T.30, W.3, W.4, Z.19

Assessment, Fluid

A.40, B.77, B.84, E.16, F.14, F.31,
G.4, H.45, K.21, N.12, S.57

Condition, Fluid

A.36, B.52, B.53, D.11, D.31, E.14,
E.15, F.2, G.30, K.1, K.10, L.3,
L.13, M.25, M.26, N.5, Q.2, S.50,
S.72, S.77, S.87, T.34, W.7

Corrosion

G.1, K.14, K.68, M.31, R.20

Debris, Wear

A.31, B.25, B.31, C.21, F.32, F.33,
J.22, K.41, K.50, M.46, M.50, M.62,
O.2, P.40, R.11, R.12, R.31, S.14,
S.21, S.32, S.33, S.35, S.36, S.46,
S.47, S.48, T.4, W.20, W.23

Diagnosis, Machine

A.40, B.13, B.29, B.36, B.44, B.49,
B.62, G.2, L.55, M.3, M.42, M.43,
M.44, O.12, P.26, S.15, S.16, S.17,
S.18, T.13, W.3, W.21, W.36

Ferrography

B.63, B.64, K.50, M.46, M.47, O.2,
P.2, P.40, R.11, R.12, S.36, S.37,
S.43, V.3, V.4, W.20, W.21, W.22,
W.23, W.24, W.25

Filters, Filtering

B.66, D.30, F.11, F.12

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and Contamination (C)

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