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Reliability and Maintainability Data-Source Guide

January 1967

System Effectiveness Branch, Electronics Division
U.S. Naval Applied Science Laboratory,
Brooklyn, New York

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FOREWORD

This Reliability and Maintainability Data-Source Guide has been designed and developed for those who specify or use data sources for reliability and maintainability predictions, and for those who use outputs of data-feedback systems for management control, for engineering analysis, and for evaluations of the performance of Fleet equipment.

ABSTRACT

This Reliability and Maintainability Data-Source Guide was prepared by ARINC Research Corporation for the U.S. Naval Applied Science Laboratory, Brooklyn, New York, under Contract N00140-66C-0151. Under this contract, ARINC Research also was assigned the task of updating and augmenting the data sources referenced in the Naval System Effectiveness Control Manual (Review Copy) published in 1965.

This data-source guide identifies twenty-three Government reliability and maintainability data sources and over ninety-five sources of technical and scientific information for related engineering data. The technical coverage, mission, status, and the address of contacts associated with each data source are summarized in the guide.

The guide tabulates responses received from 118 contractors in reply to a questionnaire prepared by ARINC Research. A matrix shows that ninety-four of the 118 had established reliability and maintainability data collection activities. Also presented is a review of the collected data, as to its utility, optimism, currency, and applicability to multicontractor use.

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1. INTRODUCTION

1.1 Purpose

The purpose of the data source guide is to identify and catalog military and contractor sources of reliability and maintainability data which are applicable to Naval Systems computations and criteria.

The guide is intended to aid Naval Systems Command personnel who require a ready reference to available Government and contractor reliability and maintainability data sources and to provide a directory that represents a consolidated listing of the numerous sources involved.

In addition, the guide serves to identify and describe data elements that are collected by a number of the data sources, including the terminology used, and to combine, or correlate, the numerous elements by their common denominators of definition and application.

1.2 Background

Two previous reports issued by the Naval Applied Science Laboratory (NASL) have indicated the need for the technical information presented in this document. The first of these was a preliminary listing of data sources contained in Appendix B-2 of the Naval System Effectiveness Control Manual, published in July 1965. Since then, a number of new reliability and maintainability data-collection systems have been placed in operation. These systems, often referred to as data banks, have recently undergone changes, programs for expansion, and other forms of growth.

A second NASL report, Reliability and Maintainability Data-Feedback Systems, published in June 1966, revealed that Navy and other military and contractor data-reporting systems use a variety of data-element terminology in their data-collection operations. Such variations often present problems concerned with differences in interpretation of the data.

1.3 Scope

1.3.1 Government Data Sources

One hundred and eighteen Government data sources are identified in this Data-Source Guide. The technical coverage, mission, status, and address of each source are briefly described. The 118 Government data sources are

representative of the three military departments and two Executive Government agencies, as follows:

- Navy
- Air Force
- Army
- Atomic Energy Commision (AEC)
- National Aeronautics and Space Administration (NASA)

1.3.2 Data-Source Categories

The 118 Government data sources are divided into two categories, as follows:

(1) Those that collect reliability and maintainability data, as a part of their primary missions (the 23 data sources in this category are presented in Section 2.)

(2) Those that, as a part of their primary missions, collect technical data which provide information that is potentially useful for reliability and maintainability analyses (The 95 data sources in this category are presented in Section 3.)

1.3.3 Contractor Data Sources

In response to a questionaire (see Appendix A), 94 of the 118 contractors contacted contributed sufficient information to allow tabulation of the reliability and maintainability characteristics of their individual data-collection systems. These are presented in Section 4.

The following data source characteristics, supplied by the contractors, are also tabulated in Section 4:

(1) Data utility

(2) Conservative or optimistic nature of data

(3) Applicability of data for multicontractor systems

(4) Currency of data

Details of the approach used in the data source survey and significant observations related to the survey responses are presented in Appendix A.

1.3.4 Government and Contractor Published Reliability and Maintainability Handbooks

A directory of 15 Government and 18 contractor published reliability and maintainability documents, including tutorial and tabulated failure data, is presented in Section 5. The directory includes document numbers, titles, publication dates, and a brief description of the purpose and context of each document.

1.3.5 Data Element Analysis

Data elements representing 17 Government and 5 contractor data-collection systems are presented in Section 6. The terminology used is correlated with Navy MDCS-data-element definitions.

1.3.6 Terms and Definitions

Appendix B presents a list of terms and corresponding definitions commonly used in reliability and maintainability engineering.

2. GUIDE TO GOVERNMENT SOURCES ENGAGED IN THE DIRECT COLLECTION OF RELIABILITY AND MAINTAINABILITY DATA

This section describes the twenty-three Government sources which collect reliability and maintainability data as a part of their primary missions. The outline presented for each data source includes the address of the representative to be contacted for detailed data provided by the department or agency concerned.

2.1 U.S. Navy Data Sources

2.1.1 MDCS (SHIP), Maintenance Data Collection Subsystem

Technical Coverage: Maintenance and equipment malfunction data, including operating times and active repair times.

Mission and Description: The Maintenance Data Collection Subsystem (MDCS) is the data-collecting and processing section of the Navy Maintenance and Material Management System (3-M). The other section, the Planned Maintenance Subsystem (PMS), controls all phases of preventive maintenance programs. MDCS (SHIPS) is designed to provide a means of recording maintenance actions in substantial detail so that a variety of data concerning maintenance actions and the performance of operational equipments can be retrieved. In addition, it provides data on the discovery of the malfunction, nature of the malfunction, man-hours expended, equipment involved, repair parts and materials used, delays incurred, reasons for delay, and technical specialty or rating that performed the maintenance.

Status: The Maintenance Data Collection Subsystem provides a document on which maintenance personnel record, at the source, designated information on planned or corrective maintenance actions. The information is recorded in a coded configuration that permits machine processing. Each maintenance action is reported in this manner. Copies of issue documents prepared by supply personnel regarding these actions provide material and cost information to the Shipboard Data Collection Center. To ensure accuracy and completeness of documentation, data-collection centers or focal points for the MDC organization have been established aboard each ship or activity. Supervisors are responsible for ensuring that all maintenance data and supply forms are complete and accurate and that documents are submitted where required. A listing of the types of errors and the work centers responsible is prepared periodically by the Maintenance Support Office. This listing is sent to each command to assist in training and in evaluating documentation.

Size and Growth: The system was started in 1965 and will be fully implemented during 1967. The number of data elements collected will be increased in the near future. Additional data are currently being collected on a test basis by approximately 28 ships.

Contact:

LCDR C. R. Oberg
U. S. Naval Maintenance Support Office
Mechanicsburg, Pennsylvania
Telephone: (717) 766-8511, Ext. 3124

Performing organization: Same

2.1.2 MDCS (Aviation), Maintenance Data Collection Subsystem

Technical Coverage: Maintenance, aircraft statistical, and man-hours data, including support actions and maintenance actions.

Mission: Similar to MDCS (Ships). See 2.1.1

Status: The system is fully operational; it provides to commanders and managers factual, documented, and accessible statistical information to answer such questions as the following:

(1) How are maintenance personnel being used? How much of their time is devoted to actual maintenance work?

(2) Which work centers are undermanned? Which are overmanned?

(3) What skills are lacking or are in excess?

(4) What are the causes of maintenance work stoppages: Lack of supervision? Lack of people? Lack of skills? Lack of facilities, equipment, tools, parts?

(5) What are the specific causes of low aircraft readiness? Which systems, components, or parts are failing excessively?

(6) How closely do units approach the ideal of self-sufficiency?

(7) How much unnecessary maintenance are personnel performing?

(8) What is the optimum interrelationship of maintenance man-hours, flight hours, and aircraft readiness in a unit?

Growth: It is now planned to establish job standards, readiness standards for various models of aircraft, and maintenance-personnel-utilization standards. This system will make such standards possible by providing the basic data.

Contact:

LCDR C. R. Oberg
U. S. Naval Maintenance Support Office
Mechanicsburg, Pennsylvania
Telephone: (717) 766-8511, Ext. 3124

Performing organization:

Same

2.1.3 FARADA, Tri-Service and NASA Failure Rate Data Program

Technical Coverage: The Failure Rate Data (FARADA) Program -- sponsored by the Army, Navy, Air Force, and NASA -- comprises the collection, summarization, analysis, compilation, and distribution of failure-rate and failure-mode data to be used in reliability and maintainability prediction.

Mission and Description: From the inception of the program in February of 1962 through September 1966, there has been steady growth in the number of participants, now totaling 190 prime and major subcontractors and 80 Government agencies. These participants are engaged in the design, development, production, and evaluation of hardware for the entire spectrum of military and space equipments.

Status: The FARADA Information Center is located at the Fleet Missile Systems Analysis and Evaluation Group (FMSAEG) at Corona, California. Information supplied by FARADA is compiled into handbooks (SP-63-470) of five volumes, which are updated quarterly and classified as follows:

Volume 1A presents tabular failure-rate data for electrical-electronic parts, with supporting information such as vendor, part number, and the electrical and environmental stress levels present during observation.

Volume 1B presents tabular failure-rate data for mechanical, hydraulic, pneumatic, pyrotechnic, and miscellaneous parts, with supporting information such as vendor, part number, and the operational and environmental stress levels present during observation.

Volume 2 presents failure-rate data in the form of stress curves by which failure rate is plotted versus an environmental or electrical stress condition.

Volume 3 provides background information on each source of failure-rate or failure-mode data utilized in the FARADA handbooks, including system description, system statistics, conditions present during surveillance, failure reporting system, and maintenance concepts involved.

Volume 4 tabulates failure-mode-distribution data for all part types.

Three additional documents are provided to FARADA participants:

(1) The FARADA Standard Operating Procedure (SP-63-467). This document outlines policies, practices, and procedures employed in the operation of the program and provides guidelines to participants for data collection and submittal.

(2) The FARADA "Permanent Issue Handbook" (SP-E63-01), a permanent issue of the first 64 sources of failure information in the FARADA handbooks.

(3) The "Statistically Analyzed FARADA Data" (CAI-NY 6155). This document provides median failure rates with 90-percent confidence intervals for common part types in normal applications, as determined by a weighted, nonparametric multiple-comparison test of the Kolmogorov-Smirnov type applied to FARADA data points.

The nature of the FARADA program is approaching that of a total integrated data package by which, for each reliability event, the failure rate, failure mode, vendor, part number, and environmental and stress level information are provided and correlated.

Tabular failure-rate and failure-mode data are currently stored, manipulated, and retrieved by an IBM 7074 Computer that uses an IBM 360 input-output device. FARADA data are statistically analyzed by an IBM 7097 computer that uses an SC-4020 data printer and plotter, a high-speed microfilm computer recorder.

FARADA program outputs include component/part failure rates, with supporting information such as vendor, part number, and environmental and operational stress levels (Volumes 1A and 1B); part-failure-rate stress curves (Volume 2); background information on sources of failure-rate or failure-mode data (Volume 3); failure-mode data (Volume 4); and statistically analyzed FARADA data (Report CAI-NY-6155).

FARADA part failure-rate and failure-mode information is derived from all types of military and space systems, including applications in ground-stationary, ground-mobile, shipboard, aircraft, missile, satellite, and other environments.

FARADA data are intended for use in reliability and maintainability prediction for military and space systems.

Contact:

Officer-in-Charge (Code E-6)
U. S. Naval Fleet Missile Systems
Analysis and Evaluation Group
Corona, California 91720
ATTN: FARADA
Telephone: (714) 736-4677

Performing organization:

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U. S. Naval Fleet Missile
Systems Analysis and Evaluation
Group
Corona, California 91720
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2.1.4 IDEP, Interagency Data Exchange Program

Technical Coverage: Qualification reports, engineering analysis, contractor high-reliability specifications, materials reports, processing, failure analysis, and general technical reports -- all as related to parts and components.

Mission and Description: The IDEP program is sponsored jointly by the Army, Navy, Air Force, and NASA. It provides for the voluntary automatic interchange of parts and components test data among Government contractors and agencies, reducing duplicate expenditures for parts testing and improving system reliability. Three data centers have been established:

NAVY -- U. S. Naval Fleet Missile Systems Analysis and Evaluation Group, Corona, California

ARMY -- Army Missile Command, Redstone Arsenal, Huntsville, Alabama

AIR FORCE -- Air Force Space Systems Division, El Segundo, California

IDEP participants are prime or major subcontractors, and certain Government activities in the missile, ASW, aircraft, and space programs, engaged in parts-testing activities under Army, Navy, Air Force, and NASA contracts. The approximately 100 participating contractors and agencies are parts users, not parts manufacturers or vendors.

Status: The operation of IDEP requires that participants complete and submit to the IDEP Offices (IDEPO's) a standard summary sheet and a hard copy of each report pertinent to the program. The IDEPO's review the submitted material and make only those alterations necessary to conform with standard format. Average time from contributor to other participants is less than three weeks. The output of the program consists of a hard copy of each "Summary Sheet", a 16mm roll film file of all reports, a visual coincidence-type card deck (search capability for specific inquiries of the file), and report listings (with quarterly supplements) of all reports in the file. The file now contains about 20,000 reports. Approximately 300 reports are added each month.

To participate in IDEP, a contractor mails a summary sheet and two copies of his report to the data-distribution center of the cognizant service. The center microfilms the entire report and adds a summary, based on the one accompanying the report from the contractor, to a microfilm card. The only alterations made in submitted material are those that may be necessary to comply with standard formats. The filmcard combination is then mailed to all contractors interested in the topic.

Every month the data-distribution center distributes to all participants a listing that includes a monthly index of reports distributed in all categories. The information in the summary sheets is encoded in a standard format that is readily convertible to a computer input medium. The processing of the data into historical data files provides up-to-date reliability-performance criteria that are especially useful when the files are subsequently used as the data source for a reliability prediction and analysis program.

The types of information included in the IDEP files consist of qualification reports, engineering analysis, contractor high-reliability specifications, materials reports, failure analysis, and general technical reports -- all as related to parts and components.

The processing of the data into historical data files provides a continuously expanding bank of up-to-date information as a data source for part and component selection; application; and reliability prediction and analysis by design, reliability, and parts engineers.

Data processing is accomplished by use of an IBM 1401 configuration with two disc drives to create report listings and EAM cards for visual coincidence card decks. There is no equipment specialization at present. The outputs include data on all military and space equipments.

Contact:

(1) U. S. Army:

Mr. B. W. Barnett
AMSMI-RBP-Building 4484
Redstone Arsenal, Alabam 35809
Attention: Army IDEP Office
Telephone: (205) 876-0891

(2) U. S. Air Force:

Mr. W. T. Bookman
Headquarters Space System Division
U. S. Air Force Unit Post Office
Lost Angeles, California 90045
Attention: IDEP Office (SSSD)
Telephone: (213) 643-1021

(3) U. S. Navy:

Officer-in-Charge (Code E-6)
U. S. Naval Fleet Missile Systems
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Performing organization:

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U. S. Naval Fleet Missile Systems
Analysis and Evaluation Group
Corona, California 91720
Telephone: (714) 736-5267

2.1.5 DTMB, David Taylor Model Basin*

Technical Coverage: Reliability and maintainability data.

Mission and Description: The DTMB computerized data system is still in use, but is scheduled to be phased out as far as Fleet data are concerned. This program is being replaced by the new MDCS described in Section 3.1.1 for Fleet data. The DTMB system is scheduled to be maintained for shore-installations data only.

Status: Form 10550-1, "Electronic Equipment Failure Replacement Report", is used for the input data, together with NAVSHIPS 4855, "The Equipment Operational Time Log". These forms require information on which part failed, the manifestation of failure, and the repair action. The reports are collated through a computer program -- developed at the Applied Mathematics Laboratory of the David Taylor Model Basin -- that results in the following six reports:

(1) Traffic Report

(2) Reliability and Maintainability Report

(3) Contractor Report

(4) Federal Stock Numbers

(5) Maintenance Time Factor

(6) Equipment Operating Time Log

These reports were related to 130 of the 600 equipments that were previously reported on the 10550-1 form.

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* Now the Naval Ship Research and Development Center.

System reaction time is generally one to two weeks; but in an emergency, the time can be shortened. At this time it is not known what data will be maintained for shore installations after programmed changes have been implemented.

Contact:

Mr. A. L. Bowman
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Department of the Navy
Washington, D. C. 20360
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Performing organization:

David Taylor Model Basin
Applied Mathematics Laboratory
Washington, D. C. 20007

2.1.6 MEARS, Maintenance Engineering Analysis Records System (WR-30)

Technical Coverage: Integrated maintenance data for aeronautical weapons, weapon systems, and related equipment.

Mission and Description: Under the criteria of a central data source, the MEARS function does not represent a data bank in conventional terms. The requirements document has all the characteristics of a specification, but the scope of data collected and depth of elements covered in the data-collection forms would qualify the system as a data bank when it is used.

Data are collected only when the MEARS reporting requirements are part of the contract for a given equipment. There is no central data-storage source. The collected data are maintained by contractors and transmitted to contracting officers on a program-by-program basis as required.

Status: MEARS forms are prepared by the manufacturer to document an integrated maintainability and support program for weapons, weapons systems, and related equipments being procured under a specific contract. The MEARS forms set forth training requirements, provide information for technical manuals, determine support-equipment requirements, and provide the basis of progress and status reporting for support requirements.

Contact:

Research, Development, Test, and Evaluation
Naval Ordnance Systems Command
Washington, D. C. 20360

2.1.7 OPTEVFOR, Operational Test and Evaluation Force

Technical Coverage: Performance and maintenance data on preproduction equipments.

Mission and Description: OPTEVFOR is primarily concerned with the latter part of the research and development phase and with the test and evaluation phase in the life cycle of Naval equipment. OPTEVFOR influences procurement decisions by furnishing CNO with factual information on the operational performance and material suitability of new equipment. It aids other operational commands by providing quantitative performance and tactical information.

Status: This system is collecting reliability and maintainability data on a limited basis. The equipments to be tested and evaluated are selected by CNO, and the number involved are small quantities of preproduction models, thereby limiting the data to small population spreads.

OPTEVFOR has developed an events-counter system to maintain records of events and monitor specific equipments for operational levels automatically. This device consists of an events recorder that records on paper tape using a standard teletype code and records monitor times and events to 1/100 of a minute for a 10,000-hour period. Events are recorded into the continuous-tape monitor record by means of an auxiliary 25-switch control box. The technician can automatically record event times by punching a matrix of switches that indicate when a malfunction/failure occurs, action taken, logistic delays, administrative delays, type of repair or failure, and completion of repair action. Also included with the system is an accumulator that stores up all the information on the tape during a read-out and prints this on a tape, giving accumulated read-out values in standard teletype code. These teletype tapes can then be fed through a standard teletypewriter machine to give a tabulated read-out in plain language of time and events recorded and the duration of these events.

Contact:	Performing organization:
Staff Electronics Officer Operational Test and Evaluation Force U. S. Naval Operating Base Norfolk, Virginia 23511 Telephone: (703) 444-5319	Same

2.1.8 FMSAEG, Fleet Missile System Analysis and Evaluation Group

Technical Coverage: Reliability, maintainability, and availability data for fire control radars and computers, search radars, guided missile launching systems, weapon direction systems, test equipment, and missiles.

Mission and Description: FMSAEG is an Ordnance Systems Command organization that has an integrated program for the collection, processing, and analysis of reliability, operability, and component part-failure data for surface-missile systems. While the major portion of the data-collection function will be replaced by the MDCS, the FMSAEG processing and analysis will continue. During the transition period, both FMSAEG and MDCS will be used.

FMSAEG has the following three principal areas of analysis:

(1) Surface-missile flight analysis, including firing reports, telemetry records, and flight-test scoring

(2) Surface-missile test equipment and missile checkout experience, including failure-rate tabulations of missile modules and checkout equipment.

(3) Analysis and summarization of certain Fleet equipment data to yield measures of average uptime in various operation states. This type of analysis produces a gross measure of readiness.

Status: Information not available from the MDCS, but required by FMSAEG for its analyses, includes the following:

(1) Periodic, identified readings of all time meters on the "selected" equipments, as formerly provided in Form 8000/23. These data yield comparative-usage time comparisons in the various operating modes and allow the single meter reading, taken at the time of maintenance in the MDCS, to be far more useful.

(2) Daily System Operability Test (DSOT) scoring and results, formerly provided in NAVWEPS Form 8821/9; results of all daily and weekly planned maintenance.

(3) Continuity detail, showing the sequence, time of day, and interaction of maintenance jobs. These data are invaluable during a detailed engineering review of selected portions of the data base.

(4) Operational challenge and administrative pre-emptive information, useful in analysis of the relationship of ship operations to readiness, or in obtaining fault-detectability measurements.

(5) Status categorization showing, on a continuous basis, the operational state of the equipment as adjudged by the ship's crew. This type of reporting makes possible the Status Indices.

The required information is currently obtained through the use of an additional reporting form, 8821-5. There is a minimum of data duplication between this report and the MDCS report.

FMSAEG has access to a sizable computer complex (The Naval Ordnance Laboratory, Corona Computer Facility) and also utilizes considerable contractor services. Portions of the incoming data are key-punched for computer input, and the entire contents of the forms are entered on a MIRACODE indexed microfilm system.

Contact:	Performing organization:
Mr. Roy D. Beck, Head Surface Launched Missile Department U. S. Naval Fleet Missile Systems Analysis and Evaluation Group Corona, California 91720	Same

2.1.9 ARMMS, Automated Reliability and Maintainability Measurement System

Technical Coverage: Reliability and maintainability characteristics.

Mission and Description: The ARMMS is a data-collection and analysis system designed to permit accurate measurement of aircraft characteristics. Data inputs will consist of standard Navy aircraft Maintenance Data Collection System (MDCS) data elements, augmented with data elements designed for further subdivision of maintenance support actions and actual corrective-maintenance tasks.

Status: The ARMMS system has not yet been implemented. The programming vehicle for ARMMS will be an adaptation of the 1410 Formatted File System (FFS). The decision to utilize FFS was reached after an investigation into the capabilities and complexities of FFS and after an unsuccessful contractual effort to develop a computer program specifically for ARMMS. The initial evaluation of ARMMS will utilize data collected or to be collected, in accordance with ARMMS procedures, during the CH-53A, A-7A, and UH-2C Board of Inspection and Survey (BIS) trials.

Growth: Output products will be maintenance-oriented and will be based on scheduled and unscheduled maintenance events occurring during an accumulated number of flight hours/sorties/cycles for a specified calendar period of flight-hour accumulation. It is anticipated that the ARMMS system will be operational late in 1966 and will be available for official application to weapon-system evaluations early in 1967.

Contact:

Commander, Naval Air Test Center
Service Test Division (ST373)
U. S. Naval Air Station
Patuxent River, Maryland 20670
Telephone: (301) 863-3111

Performing organization:

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Maintenance Engineering Analysis Branch
NAS, Patuxent River, Maryland 20670
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2.1.10 MEAL, University of Pennsylvania Module Engineering Analysis Library

Technical Coverage: Electrical and physical characteristics of Naval electronic assemblies. User-computer mean-time-between-failures and mean-time-to-repair factors on a contractual, predicted, and actual basis.

Mission and Description: The Module Engineering Analysis Library (MEAL) has been established to document general, electrical, and physical characteristics of Naval electronic assemblies. Applications of this data system include management of provisioning records, automatic programming of automatic test equipment, and standardization of assemblies for design and test.

The primary development center for MEAL is located at the University of Pennsylvania, Philadelphia, Pennsylvania, where information-processing services, data input, and system-development activities are carried out with Navy funding.

Status: A flexible assortment of fixed- and free-form outputs can be generated on paper, cards, or magnetic tape. The general-purpose search routine permits selection of classes of assemblies based on any logical combination of parameters stored. The Module Engineering Analysis Library is implemented on an IBM 1401 Magnetic Tape System with 12,000 core locations.

Growth: Although currently restricted to electronic assemblies, MEAL has the capability of storing mechanical, acoustical, and other parameters, as well as electrical parameters. All data pertinent to the maintenance of an assembly are of interest to MEAL.

The master file contains information in varying degrees of completeness on 5,000 assemblies.

During the eight-month period from July 1965 through February 1966, 4,000 assemblies were added.

A program is under way to develop a generalized mechanical language for describing test procedures.

Contact:

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Naval Ship Systems Command
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Washington, D. C. 20360
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Performing organization:

Mr. A. M. Hadley, Project Monidan
Institute of Cooperative Research
University of Pennsylvania
3634 Walnut Avenue
Philadelphia, Pennsylvania 19104
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2.1.11 NAVSECNORDIV Data Bank

Technical Coverage: Reliability, maintenance, and equipment performance data.

Mission and Description: The collection of data at NAVSECNORDIV is limited to specific systems or equipments that have been assigned for evaluation. The organization currently has cognizance of 419 prime equipments, ranging from radar systems to general communications equipment.

Status: NAVSECNORDIV receives data-element inputs from Naval activities that have not been included in the MDCS system and currently report under the system described in BuShips Instruction 10550.73A. These data are punched on EAM cards, which are forwarded to the David Taylor Model Basin (DTMB) for processing and storage in the data bank. Data product summaries processed by DTMB are then analyzed by NAVSECNORDIV personnel in the course of reliability and maintainability improvement programs for equipments for which they are assigned responsibility. Computer programs are being developed for processing and analyzing MDCS data when available.

NAVSECNORDIV has no data computer processing facilities under their direct cognizance that are capable of producing usable outputs for their Reliability/Maintainability Improvement Programs. Data-processing facilities utilized are under the operation and control of DTMB personnel and services are provided to NAVSECNORDIV as requested. The DTMB computer facilities utilized consist of a LARC computer with its peripheral equipment. Input storage and output capacity information on this computer is not available at NAVSECNORDIV.

The NAVSEC (BUSHIPS) Consolidated Failure Analysis Data Bank at DTMB has a total of 20 reports available for use by NAVSECNORDIV. The report titles and types of outputs available from this data bank are tabulated below. Report 4 and those reports marked as REMAP are the outputs currently being utilized by NAVSECNORDIV. The other outputs are available upon request.

BuShips Report No.	Title
1	Summary of BuShips Electronic Equipment Failure (replacement data)
2	BuShips Electronic Equipment Reliability-Maintainability Figure of Merit Summary
2A	BuShips Electronic Equipment Reliability-Maintainability Figure of Merit Summary (Time constraints on data base)
3	Summary of BuShips Electronic Equipment Failure/Replacement Data by Contractor
3A	Summary of BuShips Electronic Equipment Failure/Replacement Data by Contractor (Time constraints on data base)
4	BuShips Electronic Equipment Failure/Replacement Summary by Federal Stock Number
5	BuShips Electronic Equipment Maintenance Task Summary
6	Operational Time Log Report
7	BuShips Electronic Equipment List
8	BuShips Electronic Equipment Contractor List
9	Equipment Model - Contractor List
10	(REMAP Report #1) - Primary Failure Analysis Tab (PFAT)
11	(REMAP Report #2) - Standby and Radiate Status Tab (STARS)
12	(REMAP Report #3) - Replacement Rate Tab (PARRT)
13	(REMAP Report #4) - Priority Equipment Action Tab (PEAT), controlled by EMD
14	(REMAP Report #4A) - Priority Equipment Action Tab (PEAT), controlled by A_1A_p
15	(REMAP Report #5) - Frequency of Repair Times Tab (FORTT)
16	(REMAP Report #6) - Cost of Replacement and Replacements not on Board (CORNOB)

17 (REMAP Report #7) - Maintenance Man Hour Costs

18-20 Currently not in use

21 Code (679C) - Equipment Performance Summary Report

Contact:

Head, Statistical Engineering Branch
NAVSECNORDIV, Code 6643
Norfolk, Virginia 23511
Telephone: (703) 444-2720

Performing organization:

Applied Mathematics Laboratory
David W. Taylor Model Basin
Carderock, Maryland
Mail Address: Washington, D.C. 20007

2.1.12 BWAMMIS, Armament Maintenance Management Information System

Technical Coverage: Shipboard weapons systems maintenance.

Mission and Description: The system was developed to provide a data bank for the results of management and engineering evaluations of shipboard maintenance on weapons systems. Twenty-three elements are stored in the file for each maintenance action. The number of questions that can be answered is twenty-three times the number of ships in the Navy times the number of armament equipments.

Status: Files are arranged so that 80 percent of routine data requests are satisfied by sequential selection of data by identifiers. The balance are satisfied by random search.

A UNIVAC solid-state 80, Mod 2, digital computer is available, in addition to high-speed printer, magnetic tape, and EAM punched cards.

Size and Rate of Growth: The equivalent of 210,000 EAM cards are stored, with new cards added at an average rate of 35,000 a month.

Contact:

Mr. P. M. Ferman, Code QEL
U. S. Naval Weapons Station
QEL-BWAMMIS
Concord, California
Telephone: (415) 686-0550, Ext. 36

Performing organization:

Same location

Dr. Paul M. Healy, Code QEL
Mr. Eugene L. Keefe, Code QECB
Extensions 70 and 54

2.1.13 GMSR, Guided Missile Variable Information Processing Retrieval System

Technical Coverage: Technical data and information on configuration and OrdAlt Management Program for Surface-Launched Guided Missiles.

Mission and Description: Provides a data storage and retrieval system for multiple-usage basic information on technical reports, service records, and specifications for surface-launched guided missiles.

Status: The system was evaluated in May 1966 and was scheduled to become operational later in 1966. Data in the system are now being evaluated to modernize existing records by purging all unnecessary data. Programs will be developed to produce special reports on a routine basis.

Size and Rate of Growth: The system now contains 16 reels of magnetic tape. Approximately 35,000 reports will be entered each year.

Contact:

Mr. R. D. Beck
U. S. N. FMSAEG
Corona, California
Telephone: (714) 736-4647

Performing organization:

Same

2.1.14 ADP System for Air Launched Missile Guidance and Control Sections

Technical Coverage: Missile component reliability for Sidewinder and Sparrow III.

Mission and Description: To provide a data and information storage and retrieval system for the results of G & C components testing of air-launched guided missiles. To assist in engineering and statistical analyses of test results.

Status: The system was evaluated in June 1966, with equipment refinements now in progress. It will be fully operational by January 1967. Test reports include all parameters of each unit. Data to be recorded are accumulated on punched cards for conversion to magnetic tape files. The computer is interrogated by parameter cards that identify required output information.

Size and Rate of Growth: The system now contains 44,000 source documents and is expected to add 30,000 more annually.

Contact:

Mr. C. A. Candiotti, Code QEWE
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Performing organization:

Same location

Mrs. Joyce Procter
Mrs. Frances M. Harz
Extension 52

2.1.15 MFS-A, Surface Missile Systems Availability Evaluation

Technical Coverage: Reliability, maintainability, logistics, configuration control, Planned Maintenance System implementation, cost and logistic projection, availability, and effectiveness in the areas of fire-control radars, search radars, fire-control computers, weapon direction systems, and guided-missile launching systems.

Mission and Description: The system was developed and is now maintained by the Fleet Systems Division at the Applied Physics Laboratory of the Johns Hopkins University. As part of its Surface Missile Systems effort, APL maintains pilot

programs in reliability, maintainability, availability, and effectiveness analysis. The data inputs are the same as those used by other SMS analysis activities -- data from the MDCS, supplemented by special reporting Forms 8821-5 and the Commanding Officers Narrative Report.

The system is designed to supplement the efforts of the Navy in-house analysis activities (FMSAEG, OMMIC, and NSMSES) through the preparation of special studies and the development of improved techniques of data-processing analysis.

Status: Currently, the laboratory is developing a comprehensive system for the synthesis of all SMS operability-data sources, their initial review and screening, and their merger into an integrated data bank. A wide variety of management products will be derived from this integrated source, providing totally consistent measures, monitors, problem indicators, projections, summaries, etc. All programs and products developed at APL and officially approved for future use will eventually be implemented through the previously mentioned Navy in-house facilities.

Most of the initial work in data purification and product development is done manually, with the use of data listings obtained from OMMIC, MSO, and FMSAEG. Pilot programming and automatic data processing are accomplished through the APL computer facility, which includes two IBM 7094 computers and considerable peripheral equipment.

Outputs provided include failure rates, mean repair times, measures of logistic delays, measures of "indetectability downtime", evaluation of the effectiveness of Ordalts, MIL STD 778 availability measures, measure of maintenance burden, equipment duty cycles, system and equipment stress levels, unit and part problem-identification indexes, etc.

Contact:

Mr. F. L. W. Moehle, Supervisor MFS-A
Applied Physics Laboratory
The Johns Hopkins University
8621 Georgia Avenue
Silver Spring, Maryland 20910
Telephone: (301) 776-7100, Ext. 7153

Performing organization:

Same

2.2 U. S. Air Force Data Sources

2.2.1 AFM 66-1 Air Force Maintenance Data Collection System

Technical Coverage: Maintenance data; maintenance analysis and control; failed-parts summaries; and maintenance manpower management in the areas of aircraft, missiles, electronic communications, ground equipment, and munitions.

Mission and Description: The AFM 66-1 Maintenance Data Collection System is designed for management of the maintenance resources. This system has a dual purpose. It is used primarily for base-level mangement within the Chief of Maintenance complex, and for management needs at intermediate and major-command headquarters. It is also designed to provide data to the Air Force Logistics Command for materiel management and logistic support requirements. Some of the detailed AFLC uses for data collected in this system are as follows:

(1) Analysis of the high system failure rate and the high consumption of man-hours by weapon systems

(2) Identification of items and substantiation for product-improvement action

(3) Analysis of established inspection requirements and the establishment of inspection criteria

(4) Analysis and adjustment of the component time-change cycles

(5) Analysis of component and end-item data to screen out unreliable parts

(6) Analysis of the not-repairable-this-station (NRTS) listings

(7) Computation of spares requirements based on use, in lieu of the stock balance and consumption report

(8) The recording of configuration status of aerospace vehicles and selected equipments

In addition, commodity information is used for supply consumption reporting, buy programs, and master repair schedules. Accounting and budget data are also being obtained from this program.

Three important ground rules for AFM 66-1 data collection are as follows:

(1) The importance of accurate data cannot be overemphasized. The submission of accurate data is a responsbility of each individual within the maintenance complex and of each work-center supervisor. However, the overall responsibility for ensuring the accuracy of data resulting

from any maintenance function within a unit belongs to the unit Chief of Maintenance. Data sources for maintenance management information are becoming increasingly available; and as the scope of available data broadens, and elements of data from different sources are combined, the accuracy of data becomes more important.

(2) Currently possible combinations of data include operation data (AFM 65-110), Maintenance Data Collection information, man-hour reporting information, mechanized schedules for maintenance, operations and training, and others. With the use of computers, data from these different sources can be combined to produce meaningful products for use in management decisions. Analysis of these data by trained analysts will identify problem areas in maintenance units. Analysis of a problem area is not completed until the data are thoroughly evaluated and alternate courses of action are identified.

(3) As methods for combining and manipulating data improve, more analysis capability is made available to provide management with brief, usable studies instead of masses of figures that frequently are not usable in decision-making. Proper use of the analysis function will give maintenance managers total surveillance of maintenance data, a source of information valuable to maintenance management, and an effective research tool.

Analysis includes, but is not limited to the following:

(1) Preparing studies for organizational changes

(2) Troubleshooting, to include management and logistics procedures and technical methods

(3) Evaluating maintenance capability, including manning, skills, training, and facilities

(4) Monitoring data trends

(5) Developing maintenance policy and procedures as directed by the Chief of Maintenance.

Status: Maintenance Data Collection Forms (AFTO Forms 210, 211, and 212) are utilized to record production credit for all maintenance tasks requiring expenditure of direct labor. Maximum use is made of this information for maintenance and materiel management to obviate additional reporting requiring. Coding procedures are employed so that this information can be processed through punch-card accounting machines and computers to produce summary reports and analysis products. Because many different types of equipment are used by the Air Force throughout the world, the recording procedures cannot be made identical.

Standard reporting procedures are prescribed to the extent practical. This is necessary to facilitate data processing and analysis, and to minimize the retraining of maintenance personnel when they are transferred from one activity to another.

The AFM 66-1 Maintenance Data Collection System is applicable to the complete life cycle of an end item. It includes maintenance-data recording by contractors on contractor-maintained equipment and serves to promote uniformity of materiel-deficiency reporting between industry and Air Force units.

The maintenance data system is based on the input of data from the mechanic or specialist. These input data identify the work required, the work accomplished, the activity accomplishing the work, end-item identification, why the work was required, when the requirement was discovered, operating time, and other essential data.

Provisions have been made in the documents to show the work center at which the maintenance was accomplished and the work center that either accomplished or assisted in accomplishing the maintenance. This permits the labor time to be reported as assigned to one work center but expended in another. It also permits reporting of loaned and borrowed direct labor time by job, and the elimination of certain exception-time cards from the man-hour accounting system.

Maximum use is made of the maintenance data to satisfy major command and AFLC reporting requirements, as well as the requirements for reports and data exchanges between the commands, or between the Air Force and industry. Reports required of subordinate units are submitted as directed by the intermediate or major command headquarters.

Contact:

Director, Data Management Division
Reports Mangement Branch, MCCDQ
U. S. Air Force Logistics Command
Wright-Patterson AFB, Ohio 45433

2.2.2 RADC -- Reliability Analysis Central

Technical Coverage: Part failure rates, part characteristic-drift data, and part failure-mode and failure-mechanism data as a function of time and stress. Part failure distributions and distribution parameters, part application information, and environmental limitations. Lists of parts of established reliability, principal characteristics of parts, including physical attributes and pertinent electrical and performance properties. Relationships between reliability properties and part characteristics as established by materials, process controls, quality controls, function, and cost. Comparison of reliability obtained under field operation with reliability obtained under laboratory and qualification tests, and summaries of part test programs planned and under way.

The areas of interest will encompass electronic parts, semiconductor integrated circuits, and electromechanical and mechanical parts. The objective is to obtain reliability information on parts and devices.

Mission and Description: The development and establishment of a Reliability Analysis Central at Rome Air Development Center is now under way. The Central will serve as the Air Force focal point for the acquisition, storage, reduction, analysis, and dissemination of reliability data. The operation will be limited to part types and devices expected to be used in the future design of Air Force equipment and will include parts already in the inventory and new types that are candidates for the inventory.

A Central Management Office of RADC personnel has been established to implement the Central with necessary contractual support. The Central's organization will include a field team or liaison group, a parts engineering group, and a data processing and analysis group.

Prior to the establishment of a full-scale Central, a test operation has been undertaken to build a working model of the Central and to demonstrate the feasibility and potential of the full-scale system. The test operation is now in progress and will be completed in the fall of 1967.

The Central is starting with a semiconductor transistor and diode data base in its test operation. After the test operation is completed, the Central will be expanded smoothly over a two-year period to incorporate semiconductor integrated circuits, mechanical and electromechanical parts, and discrete electronic parts, in that order. Although present plans for the Central limit its coverage to the parts and devices described, the Central will have the capability to expand rapidly to incorporate reliability information on equipment and systems. The Central will become fully operational by mid-1969.

Status: The volume of data to be handled by the Central, the required response time, and the diverse outputs to be provided from the raw data collected have made it necessary to establish a data-processing system to provide quick and direct analysis functions. The following are some of the design features of the data-processing system:

(1) The system provides for multilist files and directories that describe and locate the data. The data base is physically separated from the directories, and processing is accomplished through the directories that identify the data locations. The data-base logic structure is independent of the physical location of the data. This makes it easy to enter new data or delete old data from the data base.

(2) Means are provided for keeping records concerning the frequency of access to various data in the file and for automatically notifying operating personnel of data structure changes that would be more efficient.

(3) Programs are being written in "macro packages" or tasks so that they can be linked together to perform jobs. This will reduce to a minimum the need and cost for special programming and reprogramming.

(4) Prestored program jobs are being provided so that Central personnel can state the data parameters and identify the sequence in which tasks are to be executed. The system will contain predefined programs to provide scheduled data outputs at regular intervals.

(5) Programs will automatically extract data from the file by means of complex Boolean expressions, enter and delete data from the file, add new items to the file, enter and delete index items in the directory, and change the logical structure of the file.

(6) Engineers not skilled in programming will, through the use of a Query/Response Console, be able to extract selected data from the file and automatically execute analysis routines that will operate on the extracted data.

(7) Means are provided for handling multiple queries through the use of the Query/Response Consoles and for carrying out scheduled program executions for the preparation of Reliability Notebooks and other outputs at regular intervals.

(8) Means are provided for on-line analysis and manipulation of data.

(9) The capability will exist for adding other random-access devices, consoles, addressable memories, and other general-purpose units to the system.

The RADC Computer Facility is being used for the test operation of the Central; with some additional equipment it will serve as the operational computer system for the Central.

Contact:

Mr. Milton Haus, Chief
Reliability Analysis Central
Rome Air Development Center (AFSC)
Griffiss Air Force Base, New York 13440

Attention: EMERC
Telephone: (315) 330-4102

2.2.3 Air Force Project Rand

Technical Coverage: Subjects are classified in 28 major subject areas, including the following:

Game Theory: Best strategies, continuous games, discrete games, games in extensive form, games of timing, games over function space, general theory, methods of solving, models and applications, non-zero-sum and n-person games.

Logistics: Data processing, logistics systems laboratory studies, maintenance, supply, transportation, and mobility.

Materials: Producibility, structural weight reduction, heat ablation and absorption, advanced metallic and ceramic materials, materials analysis.

Mathematics: Computing machines, differential equations, dynamic programming, extremum problems, functional representation, game theory, inequalities, integral equation, learning theory, linear programming, linear spaces, machine translation, moment spaces, numerical analysis, offense studies and mathematical models, polynomials and special functions, transportation problems and network theory, utility theory, war gaming, new concepts and techniques.

Reliability: Reporting and analysis, quality assurance and control, probability analysis, military essentiality, automated replacement and repair.

Statistics: Distribution theory, estimation procedures, probability, randomization, significance tests.

Systems Analysis: Methodology, operations research, interdisciplinary analysis, problem-solving, military-effectiveness analysis, operational-methods design, operational-requirements analysis, military-systems evaluation.

The subject areas are associated with the fields of aircraft, missiles, communications, cost analysis, electronics, propellants, propulsion, radar, and space flight, to name a few.

Mission and Description: Project Rand was initiated in 1946 to assist in long-range Air Force planning and programs of research and development in selected areas of the physical sciences, economics, mathematics, and the social sciences. The research staff consists of some 500 full-time professional personnel, with an additional 300 consultants available for work on projects in their special fields.

Three-fourths of the work of the Corporation is performed for the Air Force under Project Rand. The remaining effort is devoted to contractual research for the Advanced Research Projects Agency of the Department of Defense, the National Aeronautics and Space Administration, the Atomic Energy Commission, the National Science Foundations, and private foundations. The Rand Corporation also conducts independent research with its own funds.

Project Rand does not manage Air Force programs; it investigates areas of potential research and recommends projects, many of which are eventually carried out or sponsored by the Air Force. Its primary mission is to provide the Air Force with objective advice in the formulation and implementation of AF plans, policies, and programs, through studies, analyses, and syntheses in the fields of scientific research and development, intelligence, operations, logistics, and other applicable areas. It helps the Air Force to determine the character and limitations of future air-combat weapons and strategies. Each weapon system or strategy is studied in a context that includes its economic, social, and political impact and realistic estimates of future weapon developments and human behavior.

Status: It is the policy of Project Rand to report the results of research to the sponsors in the shortest possible time. This is accomplished through informal oral briefings as a project progresses, through formal briefings at the conclusion of each major study, and through dissemination of the various types of Rand publications. In the interests of scientific progress and in keeping with the Air Force policy of disseminating results of unclassified research as widely as possible, more than 700,000 copies of publications reporting results of research have been distributed to date. These publications have been made available not only to the sponsoring agency, but to other Government agencies, to industrial research and development organizations, to individuals engaged in research at universities and other educational institutions, and to a system of depository libraries, both in the United States and abroad, so located that maximum availability can be achieved through interlibrary loan services.

Classified research results are made available only to authorized Government agencies and Department of Defense contractors. All publications containing proprietary information are labeled "Privileged Information" by the Corporation and are distributed only to the military. Reports are marked "Priviliged Information" only by direction of an industrial or contractual source; no information originating in Project Rand studies or reports is so labeled.

Rand Reports: Rand Reports are formal reports of completed research studies or technical investigations. Some Rand Reports are published simultaneously by commercial publishers and offered for sale to the public.

Rand Memoranda: Rand Memoranda are primarily working papers reporting the progress of research or the completion of a single phase of a large research project. They may be expanded, modified, withdrawn, or published at a later date in another form. Often they become chapters in Rand Reports. New Rand Translations are also issued in the RM series.

Rand Papers: Rand Papers are not prepared under contract. They are essentially papers prepared by the staff for publication in professional journals or for presentation at scientific meetings. Most papers are eventually published in journals or proceedings. If a Rand Paper has not achieved outside publication when the annual Index of Selected Publications goes to press, it is listed in the Index with a symbol indicating that it is available only as a Rand Paper. If a Paper has already been published in a scientific journal or in the proceedings of a conference or symposium, the place and date of publication are given in the Index. Between two hundred and three hundred Rand Papers are issued each year.

The primary announcement media for new Rand publications are the annual Index of Selected Publications and its bimonthly Supplements. The Annual Index is issued in both classified and unclassified seditions. It contains a cumulative listing of titles and abstracts of all Rand Reports, Memoranda, Translations, and Papers. A subject and author index is included. The bimonthly Supplements contain cumulative lists of titles and authors of Rand publications of all types that have been added to the depository libraries since the latest annual Index was published.

The classified Rand Index of Publications and its Supplements are not made available to industrial contractors or to Air Force consultants with commercial affiliations. They are made available only to authorized recipients appearing on the Master Distribution List established in Headquarters USAF. The unclassified Rand Index of Selected Publications and its Supplements are distributed to all Rand depository libraries and to several hundred other public and university libraries throughout the country. They may be obtained by Government contractors on a subscription basis for $10 a year.

Symposia: Symposia arranged by the Rand Corporation in the interest of current research projects are usually held at the Rand building in Santa Monica, California. Symposia may be sponsored by the Air Force, the National Aeronautics and Space Administration, or the Air Force Systems Command, or may be conducted independently at Rand. Proceedings are published as Rand Reports and are frequently published simultaneously as trade books by commercial publishers.

Contact:

Project Rand Office
Director of Development Planning
Headquarters, U.S. Air Force
Washington, D.C. 20330

Performing organization:

The Rand Corporation
1700 Main Street
Santa Monica, California

2.3 U.S. Army Data Sources

2.3.1 TAERS, The Army Equipment Record System

Technical Coverage: Maintenance-management data, part repair and replacement frequency, maintenance resources, and manpower requirements.

Mission and Description: The system has been designed to collect and process data to provide the maintenance-management information required by field commanders and managers. The objectives of collecting, processing, and utilizing these maintenance data are to provide the information necessary for the evaluation of (1) equipment status and material readiness, (2) effectiveness of maintenance operations, (3) adequacy of resources, and (4) support requirements.

Status: The maintenance data are collected in accordance with TM 38-750-1, and are processed and analyzed. These data are then distributed to all command and staff elements that need such information, including the organizations and support maintenance activities that produced the raw data. Organizational Commanders are held responsible for the accuracy and completeness of information and for the submission of all data-collection documents. Major Commanders are responsible for providing necessary machine-processing capability, personnel, facilities, and organizational structure to accomplish the data-processing function.

The processed data are subjected to close scrutiny during the analysis phase of the processing cycle. Analysis of the data is programmed to indicate what equipment is failing, why it is failing, how often the failure is occurring, and the amount of time required for repairs. Results of this analysis provide a statistically valid forecast for planning purposes.

Contact:

Mr. Michael J. Venezia
AMSEL-MR-NMP-MT
U.S. Army Electronics Command
Fort Monmouth, New Jersey 07703
Telephone: (201) 532-1202

Performing organization:

Mr. Frank Faraci
U.S. Army Logistics Command
Logistics Data Center
Blue Grass Army Depot
Lexington, Kentucky
Telephone: (606) 299-4135

2.3.2 DLSIE, Defense Logistics Studies Information Exchange

Technical Coverage: Logistics and related data.

Mission and Description: The Exchange was started in July 1962 to collect, store, and disseminate bibliographic information on logistics. It uses an RCA 501 Computer to produce the Annual Department of Defense Bibliography of Logistics and Related Subjects. Specific data can be retrieved on such subjects as NIKE ZEUS missile maintenance, certain phases of SWIFT STRIKE, and Capehart housing construction.

Status: Reports, books, and periodical articles in the field are analyzed and processed for inclusion in the Master File. The staff receives requests for information from the Logistics Management School, DOD logistic agencies and their contractors, and qualified civilian requesters. The majority of users are managerial personnel and mathematicians. The Exchange does not lend items; thus most requests are for reference and bibliographic materials.

Size and Rate of Growth: Approximately 6,000 items of data are in the collection, with increases of about 2,000 each year. Plans call for the development of a thesaurus during calendar 1966-67. Terms will then be selected from the thesaurus, and new words will be added only after careful consideration.

Contact:

Mr. Jack P. Wilson, Manager
U.S. Army Logistics Management Center
Defense Logistics Studies Information Center
Fort Lee, Virginia 23801
Telephone: (703) 734-2500

2.4 U.S. Atomic Energy Commission Data Sources

2.4.1 AEC Division of Technical Information

Technical Coverage: Nuclear science and related sciences.

Mission and Description: The Division of Technical Information plans, directs, and operates a comprehensive nuclear technology information program to meet the needs of the Atomic Energy Commission, its contractors, other Government agencies, industry, and the world technical community. It establishes AEC standards, policies, and procedures for the reporting and dissemination of technical information developed through AEC research and development. Principal activities of the Division are divided between the Headquarters office and the Division of Technical Information Extension.

Status: Headquarters activities include management of AEC systems for exchanging, processing, controlling, and publishing technical information, as well as liaison with other Government technical information activities. A special publications program includes the preparation and publication of technical books, handbooks, monographs, periodic technical progress reviews, and proceedings of scientific meetings. An exhibits group is responsible for the planning and administration of an exhibits program to inform U.S. students, teachers, and

the lay public of the fundamentals of nuclear technology and its applications. The exhibits group is also responsible for the preparation of educational booklets and brochures; for AEC participation in domestic exhibits sponsored by professional societies, industrial groups, and Government organizations; and for the management of technical information centers at foreign exhibitions and scientific conferences.

Contact:

Division of Technical Information
Headquarters, Atomic Energy Commission
Germantown, Maryland

2.5 National Aeronautics and Space Administration Data Sources

2.5.1 NASA APIC/PRINCE Information Center

Technical Coverage: Technical information on parts and materials, specifications, and testing results.

Mission and Description: The overall objective of APIC is to collect, consolidate, abstract, store and disseminate a broad spectrum of information and data. Some of the specific objectives are to collect information and analyze it for its usefulness, arrange the information in useful forms, and provide rapid-response services to the user.

The APIC operations, techniques, methodology, and related services are designed to satisfy current and future needs, the scope of which was defined by the system's application to the Apollo Program.

With APIC as the focal agent for data exchange, many benefits are realized through the succession of services and documents, including significant monetary and time savings through rapid access to many areas of information. This information offers opportunities for decreasing duplication in design, preparation of procurement specifications, conducting tests, and conducting qualification of items. APIC assists in the development of a system by which a small variety of different parts can be used in similar applications. All Apollo Program participants are encouraged to use the APIC system to avoid unnecessary design delays and component failures in the Apollo System. Information is being processed into the system at the rate of approximately 5,000 line items per week. This information is furnished by NASA, its many contractors, the Air Force, the Army, and others. This variety of information constitutes data of considerable interest and benefit to all Apollo Program participants. New data from many sources are being processed into APIC to enhance its capabilities and to offer additional services to users.

These services are provided free of charge to all Apollo Program participants. The only cost involved is the cost of the communications mode used in contracting APIC.

The APIC System encompasses three major operations: the technical data systems, the communications, and the computation systems. These operations are intermeshed; they constitute the overall APIC activity by which two outputs are produced -- Standard Services and Special Services.

A Standard Service is one in which an inquiry can be processed and a reply given within a short time after receipt of the inquiry. Only routine search operations are involved in this type of service.

A Special Service, in response to a complex inquiry, involves not only time-consuming searches to retrieve the requested information but also investigation of the information by analysts and engineers. Consequently, a period of up to 5 working days may be required to provide this kind of service.

The APIC Index is sequenced by Drawing Number. The PRINCE Index is arranged by Part Classes, and within each of these part classes the items are sequenced by Part Number. If the information desired is "Parts" oriented, the PRINCE Index is used; if the information desired is oriented by a Part Drawing Number, the APIC Index is used. In addition, the Indices can be cross-referenced.

Requests for the information contained in APIC are made through the Inquiry Service. The Apollo Parts Information Center Inquiry Service can be contacted by mail, telephone, or facsmile.

The communication systems utilized by APIC allow the Inquiry Service Operation to accept requests for parts and materials information from almost any point in the United States. Direct access to APIC is provided by major Federal and commercial communications networks from almost any point in the free world, including the NASCOM Network. The communication systems employed in this network permit facsimile, voice, teletype transmission, and the transmission of records such as magnetic tapes, EAM cards, etc.

A 24-hour recording service is available for continuous receipt of inquiries. Inquiries received after normal working hours, and on weekends, are processed the first working day after they are received. Normally, an inquiry will be answered by the same mode of communication by which it was received.

Answers to inquiries are forwarded to participants through the mail in the form of computer printouts, microfilm copies of test reports, and hard copies of documents. In general, replies to inquiries are made by the most compatible communications mode, depending on the material that is to be transmitted.

Contact:

AFIC/PRINCE
Building 4708
Marshall Space Flight Center
Huntsville, Alabama 35812
Telephone: (205) 842-3231
Data Fax: 8-337

2.5.2 RATR, Reliability Abstracts and Technical Reviews

Technical Coverage: Reliability information as related to aerospace research, development, and operation.

Mission and Description: RATR is published monthly by the National Aeronautics and Space Administration. It is an abstracting and critical-review service covering published literature on reliability. RATR is available without charge to reliability- and quality-assurance officers of U.S. Government agencies and their contractors, industrial librarians, and engineering faculty members.

Status: The Journal abstracts, indexes, and critically reviews an average of 50 literature items per month. Copy for the abstract-reviews is prepared by modified Photon equipment; copy for the indexes is prepared by computer printout with IBM 1410 equipment.

The Journal covers literature on reliability as related to aerospace and is directed at an audience whose ultimate interest is in space probes and manned space vehicles and the components of the equipment they carry.

RATR produces abstracts, indexes, and reviews of published literature on reliability.

Contact:

(1) For editorial matters,

National Aeronautics and Space Administration
Reliability and Quality Assurance Office
Washington, D.C., 20546
Attention: Code KR

(2) To determine availability of the journal,

National Aeronautics and Space Administration
Scientific and Technical Information Division
Washington, D.C., 20546
Code US

(3) For subscriptions to the journal,

Clearinghouse for Federal Scientific and
Technical Information
Port Royal Road
Springfield, Virginia, 22151
Attention: Code 410.14

3. GUIDE TO GOVERNMENT SOURCES ENGAGED IN THE COLLECTION OF RELATED TECHNICAL DATA

This section presents a brief summary of the mission, description, and status of 95 Government data sources which store technical information related to reliability and maintainability analyses. The sources are grouped according to their applicable military departments of Government agencies and includes the address of the contact for each source.

3.1 U. S. Navy Sources

3.1.1 NARDIS, Navy Automated Research and Development Information System

Technical Coverage: Technical and management information on Navy research and development projects.

Mission and Description: NARDIS establishes and maintains a common data bank to serve as the prime source of technical and management-oriented information on all Navy-sponsored research and development. Meets DoD requirements that certain Navy-sponsored R&D be reported in digital form to DDC. Promotes inter-communication among Naval scientific, engineering, and technical personnel through a responsive information-storage and -retrieval system.

The system establishes and maintains a computer-oriented UNIVAC LANG information-storage and -retrieval system capable of receiving and processing Navy R&D reports. The complete or partial file is available to authorized Navy components, and textual replies are made to technical inquiries. Subject-indexes the objective, approach, etc., of all R&D reports to make them amenable to subject-matter searches. Digitalizes (on magnetic tape), checks the consistency, and transmits to DDC all R&D data required by ODOR&E. Assists Navy management to plan and formalize requirements to include all Navy R&D efforts and systems in the data bank. Designates NARDIS personnel to participate in the ODORTSE system to enhance its functional and operational capabilities.

In operation since July 1965, the current NARDIS data bank comprises more than 990 R&D work units that have been transmitted to DDC, and more than 2000 reports at the task and project levels. The number of queries per week currently averages 14. From 40 to 75 reports are processed daily.

Status: In FY67-69 the Navy R&D data bank will be maintained and organized as required. NARDIS personnel will participate in DTMB preparation and programming for new computer hardware. A NARDIS system mock-up will be made for the new computer hardware expected at DTMB in FY68 or FY69. The oceanographic data bank will be expanded. A better data input is being planned, by means of either an optical scanner or direct computer input.

Contact:

Mr. J.O. Baker
Office of Naval Research
Washington, D. C. 20360
Telephone: (202) OX. 6-1152

Performing organization:

Mr. G. R. Gray, 880
David Taylor Model Basin
Washington, D. C. 20007
Telephone: (301) 995-1766

3.1.2 DMPS, Depot Maintenance Planning System

Technical Coverage: Technical simulation.

Mission and Description: This is a simulation program for computing proposed workloads and the distribution of these workloads among the seven industrial air stations. It provides the capability for examining the impact of management decisions over a projected five-year period, and assists in pinpointing deficiencies in facilities, skills, equipment, manpower, etc. Basically this is a compound matrix calculation utilizing punch-card input, large computer memory, and tape files.

Status: Estimated computer time, 25 hours per quarter.

Contact:

Mr. Charles Dahl
Fleet Readiness Representative -- Pacific
Naval Air Station
North Island, California
Telephone: (714) 435-6611, Extension 1568

Performing organization:

Data Processing Department
NAS North Island
San Diego, California

3.1.3 ADCS, Aircraft Directives Configuration System

Technical Coverage: Aircraft maintenance.

Mission and Description: Reports on all Naval Air Stations, aircraft carriers, squadrons, and detachments. It is a mechanized system for the collection, reporting, and accounting of aircraft directives that are incorporated and applicable to all Naval aircraft. The objectives of the system are to provide all levels of aircraft maintenance with information concerning the mission capability, outstanding directives, and the man-hours required to incorporate these directives and related management information.

Status: This program requires a minimum of 100 hours per month of ADP services at each performing activity.

Contact:

Mr. H. Marshalk, Code FDM-11
Documentation Management Division
Naval Air Systems Command
Washington, D. C. 20360
Telephone: (202) OX. 6-4318

Performing organizations:

BWFRRPAC
BWFRRLANT
BWSRTS
NATSF
NAS North Island
NAS Norfolk
NAS Pensacola
NAS Philadelphia

3.1.4 AMMRL, Aircraft Maintenance Material Readiness List

Technical Coverage: Aircraft maintenance.

Mission and Description: AMMRL reports on all Naval air stations, aircraft carriers, aircraft squadrons, and detachments. It establishes and maintains a list of the support equipment required to perform aircraft maintenance. Whole documents and a separate list are prepared by a computer for each activity operating Naval or Marine aircraft. Such lists are prepared when any change is made concerning the type, model, or configuration of aircraft operated, quantity of each, level of maintenance performed, and geographical or environmental condition. All files are maintained on computer tape, and all requests are triggered by punch cards.

Status: The preparation of these tailored lists consumes an average of 200 hours of RCA 501/301 computer time per month at the performing activity.

Contact:

Mr. A. Aversa, Code FTM-23
Technical Material Management Division
Naval Air Systems Command
Washington, D.C. 20360
Telephone: (202) OX. 6-5520

Performing organizations:

BWFRRPAC
BWFRRLANT
NAS North Island
NAS Norfolk
NAS Pensacola

3.1.5 SMACS, Serialized Missile Accounting and Control System

Technical Coverage: Ordnance maintenance.

Mission and Description: SMACS establishes and maintains an inventory and configuration control for missiles and their components. All stations and ships report transactions, receipts, firing, off-loads, etc., to a centralized point to facilitate accurate appraisal of readiness posture.

Status: Prepares reports upon request.

Contact:

Mr. L. Perrus, Code FTM-23
Technical Material Management Division
Naval Air Systems Command
Washington, D.C. 20360
Telephone: (202) OX. 6-1745

Performing organizations:

Mr. J. Stewart, Code E-3
FMSAEG, NEL
Corona, California
Telephone: (714) 736-5231

3.1.6 UADPS, Uniform Automatic Data Processing System for Industrial Naval Air Stations

Technical Coverage: Aircraft maintenance.

Mission and Description: UADPS establishes and maintains, between industrial air stations, a uniform flow of management and technical information, utilizing compatible ADP hardware and programs. The objectives also include relieving management of routine and quantitative decisions and improving manufacturing and repair efficiency and the effectiveness of related functions.

Contact:

Fleet Readiness and Training Group
Naval Air Systems Command
Washington, D. C. 20360

Performing organizations:

NAS Alameda
NAS Cherry Point
NAS Jacksonville
NAS Pensacola
NAS Quonset Point
NAVAIR

3.1.7 TDS, Technical Data System (NAVAIR)

Technical Coverage: Analysis of Naval weapons systems effectiveness and support development programs.

Mission and Description: In-house studies of existing and proposed weapons systems under representative conditions of employment with probabilistic and other analytical techniques being used to estimate expected effectiveness. Digital-computer processing of analysis. Intended to provide basis for operational and procurement management programs. Results presented in complete study reports containing recommendations.

Status: A CDC G-15 computer has been used since 1957 for about one-fourth of the studies by TDS. Substantial use of computer is also made by other RDT&E offices. Average estimated usage is 165 hours per month in single-shift operation.

Intercom language is used, and one programmer attends the computer. Other office personnel can use the facility. Typewriter input and output.

Contact:

Mr. F. M. Gloeckler, Code R-5
Advanced Systems Office
Naval Air Systems Command
Washington, D. C. 20360
Telephone: (202) OX. 6-5840

Performing organization: Same as above.

3.1.8 TDS, Technical Data System (NAVFAC)

Technical Coverage: Engineering and scientific fields relating to docks and Naval shore facilities.

Mission and Description: Provides technical data and information storage and retrieval services. Abstracts, codes, and indexes printed books, design manuals, and maintenance and operational manuals.

Status: TDS plans to refine abstracting and indexing. A computer installation is planned.

Contact:

Mr. Norman H. Roth, Code 41-234
Naval Facilities Engineering Command
Washington, D. C. 20390
Telephone: (202) 697-7280

Performing organization: Same as above.

3.1.9 ALREP, Missile Performance Data and Retrieval System, Air-Launched Missiles

Technical Coverage: Reliability and performance of air-launched missiles fired by fleet operational units.

Mission and Description: To provide missile performance data by an information-storage and -retrieval system. Evaluation is by means of statistical and engineering anslysis to determine areas for improvement in missile weapons. System and performance characteristics are analyzed, for use in the solution of logistics problems. The system combines digital and graphic data outputs and is intended for use by working-level technical personnel. Data include reports of aircraft intercepts, captive flights, and missile firings originating in Fleet operational squadrons.

Status: All searching is accomplished by computer programming. Processes are determined by particular job requirements. Planned changes include simplifications to improve internal procedures and processing, and standardization to reduce duplication of effort.

Contact:

Mr. J. J. Pierce
U. S. FMSAEG
Corona, California
Telephone: (714) 736-4344

Performing organization: Same as above.

3.1.10 ASROC Identification and Transaction System

Technical Coverage: ASROC component usage, serviceability status, service environments for surveillance, and service life studies.

Mission and Descriptions: External reports from Naval facilities and ships are provided on all component identification data for new weapon assemblies. User suggestions regarding additional system requirements and/or modifications are solicited through regular contact with appropriate Fleet Command, Bureau Management, and field-activity R&D personnel.

Status: Current plans call for inclusion of this program on ADP equipment projected for station delivery late this year. Preliminary systems analysis work is currently under way. Total mechanization of this program will greatly reduce special operator demands and requirements, accelerate processing, and increase utilization of information available from this program through more timely responsiveness, especially to urgent telecon requests.

Size and Annual Rate of Growth: 3,500 documents now in the system, with approximately 1000 new documents being added each year.

Contact:

Mr. W. H. Warhurst
Quality Evaluation Laboratory
Naval Weapons Station
Seal Beach, California
Telephone: (213) 596-5511, Extension 489

Performing organization: Same as above.

3.1.11 UWSRD, Underwater Weapons Systems Reliability Data

Technical Coverage: Reliability evaluations of underwater weapons systems.

Mission and Description: This data source has capabilities in technical data and information storage, processing, and retrieval. No formal system-evaluation method is utilized. The efficiency of the system is measured by its capability for providing the technical data necessary for weapon system analyses and reliability and effectiveness determinations by both in-house engineering and technical personnel and its outside users, including Naval Ordnance Systems Command activities, ASWSP, CNO, and Fleet units. When system weaknesses are

evidenced by the system's failure to provide expeditiously the necessary technical information required for the wide variety of demands, consideration is given to improving specific facets of the system. The system's ability, to date, to respond to the frequency and variety of demands placed on it is a measurement of the system's effectiveness.

Status: Reporting documents used as the input media to this system are currently being redesigned to improve their usefulness in providing the data necessary for more accurate evaluation and analysis of complete ASW weapon system performance. It is estimated that the reporting forms will be redesigned and the data retention restructured by mid-1966.

Because of the demands being placed on this system, a request for computerizing the installation has been submitted. Computerization is required if system effectiveness is to be significantly maintained and improved.

Size and Annual Rate of Growth:

Item	Annual Growth	Size
Firing Reports	6,000	18,802 in system
RUDTORPES	7,500	24,527 in system
FIR Reports	6,000	14,934 in system
Daily Defects	8,000	21,500 in system
Daily Defect Follow-Up Reports	27,500	79,760 in system

Contact:

Mr. W.R. O'Neil, Code FS-4
U.S. Naval Underwater Weapons
Research and Engineering Station
Newport, Rhode Island

Performing organization: Same location as above.

Mr. J.J. O'Connel, Jr., Code CS-5
Mr. C.T. Harris, Code DO-3

3.1.12 UWSDDMS, Underwater Weapons Systems Design Disclosure Management System

Technical Coverage: Service engineering and maintenance for underwater weapons systems.

Mission and Description: Data reduction, storage, and retrieval to support in-service engineering, procurement, production, and maintenance for underwater weapons systems, including torpedoes, underwater missiles, fire-control equipment launchers, torpedo tubes, and associated equipments.

The relationships of an engineering drawing to any part, entire weapons system configuration, and associated equipment, along with its supporting documentation, can be determined by E&M file organizations.

While there is no formal method for evaluating the system, which has been in use for 18 years, the wide extent to which it is employed by in-house engineers and technicians and by outside users attests to its success. Additional evidence of its usefulness is that while this system is considered the pioneer for controlling documentation, it is being widely emulated by the U.S., other governments, and many commercial activities for similar purposes.

Status: Because of the expanded responsibilities assigned to this activity, which require data-processing services for UWSDDMS and other applications, it has become apparent that EAM equipment is no longer adequate. A request for computerization of the installation has been submitted, to improve the overall system capabilities.

The system is in the process of locating and acquiring for these systems the documentation that was widely dispersed. The rate of growth is indicated by the fact that at the end of 1964, 47,362 drawings were held, as compared with 69,861 at the end of 1965. For the next two or three years, it is estimated that the number of drawings will increase at a similar rate.

Contact:

Mr. J.J. O'Connel, Jr., Code CS-5
U.S. Naval Underwater Weapons
Research and Engineering Station
Newport, Rhode Island

Performing organization: Same location as above.
Mr. C.T. Harris, Code DO-3

3.1.13 IHS, Information Handling System

Technical Coverage: Engineering calculations, drawings, design sketches, technical data, and tables on NOTS weapons testing.

Mission and Description: To provide an information data bank consisting of NOTS weapons project developmental and engineering source information. A central index is maintained, utilizing microfilm data storage and quick-scan retrieval equipment.

Status: The system has been implemented to meet mission objectives.

Size and Growth Rate: Twelve-month estimate on growth is 50,000 images or 12,000 documents, with a 50-percent increase to 100,000 images after the first year of system implementation.

Contact:

Mr. J.L. Cox, Code 55
Naval Ordnance Test Station
China Lake, California 93555
Telephone: (714) 7-411, Extension 71459

Performing organization:

Mr. Robert W. Weakley, Code 55642
Engineering Department
Naval Ordnance Test Station
China Lake, California 93555
Telephone: (714) 7-411, Extension 71356

3.1.14 ADP System for Summarization of QEL Surveillance and Fleet-Firing of VT Fuzes

Technical Coverage: Component reliability of VT fuze performance.

Mission and Description: To assist in statistical and engineering analyses of test results and to provide for identification and retrieval of data for assigned special tasks; to provide a data and information storage and retrieval system for laboratory test and fleet firing data; and to provide summarization of test results reported by laboratories conducting surveillance and OCL evaluation and tests.

Status: The system was evaluated in July 1964; it was scheduled to become fully operational by 1 January 1967. Computer programs identify VT fuzes of specific manufacturers and provide printouts of test results. Test results are related to comparisons of various components in terms of malfunctions and frequency of defects.

Size and Rate of Growth: The system currently contains 40,000 test documents. Approximately 4,800 items are added each year from fleet firings and 18,000 from laboratory tests.

Contact:

Mr. C.A. Candiotti, Code QEWE
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 61

Performing organization: Same location as above.

Mrs. Frances M. Harz, Code QECS
Extension 52

3.1.15 ADP System for Summarization of QEL Surveillance of Navy Gun Ammunition

Technical Coverage: Performance reliability of Naval gun ammunition.

Mission and Description: To assist in engineering and statistical analyses of laboratory test results of gun ammunition and components, and to provide a data and information storage and retrieval system for the results of QEL and special tests performed on conventional Navy gun ammunition and components.

Status: The system was scheduled for complete evaluation by 1 October 1966 and for operation by 15 March 1967. Outputs will be listings and summaries of specific ammunition types, lots, and components resulting from the application of statistical techniques to the collected data.

Size and Rate of Growth: 30,000 cards are now in the system, with estimated additions at 2,600 annually.

Contact:

Mr. C.A. Candiotti, Code QEWE
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 61

Performing organization: Same location as above.

Mrs. Frances M. Harz, Code QECS
Extension 52

3.1.16 ADP System for Fleet-Fired Navy Gun Ammunition

Technical Coverage: Reliability of stockpile ammunition.

Mission and Description: To evaluate the performance of U.S. Navy gun ammunition expended by the Fleet, and support Naval Ordnance Systems Command in evaluating Fleet shoots of Navy gun ammunition. The system also monitors the effectiveness of ammunition provided to the Fleet and identifies factors adversely affecting reliability and serviceability, and provides information leading to correction of material defects in the ammunition stocks.

Status: The system became fully operational on 1 September 1966. The computer is interrogated by parameter cards that identify specific information required. Outputs are listings of ammunition lot performance from test data and statistical summaries.

Size and Rate of Growth: 160,000 source documents are now in the system, with 40,000 to be added annually.

Contact:

Mr. C.A. Candiotti, Code QEWE
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 61

Performing organization: Same location as above.

Mrs. Frances M. Harz, Code QECS
Extension 52

3.1.17 SMS, Configuration Management Monitoring System

Technical Coverage: Missile systems engineering for Engineering Change Proposals, ORDALTS, and SHIPALTS.

Mission and Description: To provide status accounting of all information related to SMS problems and resolution thereto: Deficiency Corrective Action Information, Technical Instruction indices, ECP status accounting, ORDALT

procurement status accounting, SMS Improvement data plan, and First Class Change installation status accounting.

Status: The current active file will remain reasonably stable in size, while history files used relatively little will grow in size. The total number of active items should not exceed 5,000. Plans include development of a total integrated system in support of configuration management on an IBM 360/40 computer.

Size and Rate of Growth: Additions or changes to elements on file are approximately 5,000 each month.

Contact:

Mr. J.C. Story, Code 4310
U.S. Navy SMSES
Port Hueneme, California 93041
Telephone: (805) 487-5511, Extension 312

Performing organization: Same as above.

3.1.18 SMS Engineering Drawings and Documentation Support System

Technical Coverage: Missile systems engineering drawings and data.

Mission and Description: To maintain an indexed control over and provide a means for accessing SMS-related engineering drawings and documents.

Status: The system contains index information as necessary to maintain control over data repository. Drawings and manuals are related via an equipment file and a site file that includes equipment configuration to the piece-part level as a function of ORDALT accomplishment status.

Size and Rate of Growth: Microfilm file contains 1.3 million records; LD detail file 1.5 million records; technical manual file 2,000 records; and there are approximately 20,000 uncategorized records. The files are now 90-percent complete. Future growth will not be over 10 percent of present size.

Contact:

Mr. A. Vasquez, Code 4340
U.S. Navy SMSES
Port Hueneme, California 93041
Telephone: (805) 487-5511, Extension 350

Performing organization: Same as above.

3.1.19 SMS, Configuration Accounting System

Technical Coverage: Missile systems reliability studies and predicted failure rates.

Mission and Description: To provide configuration identification and accounting for all Ships Missile Systems equipment.

Status: Basic documents generated are (1) Ships Packages, (2) second-source procurement packages, (3) provisioning data, and (4) reliability studies. Other stored data include technical manuals, Ships Plan Index, Item Identification, where used, site file, and predicted failure rates. The system is now being reprogrammed and redesigned for the IBM 360/40 in COBOL. The system now uses the IBM 705 and 1401 computers.

Size and Rate of Growth: The equipments file currently contains approximately 1,000,000 line items of information and is expected to increase in size by 50 percent over the next two years, after which it will remain relatively stable in size.

Contact:

Mr. R.E. Van Dermay
U.S. Navy SMSES
Port Hueneme, California 93041
Telephone: (805) 487-5511, Extension 8123

Performing organizations: Same as above.

3.1.20 UICP, Uniform Inventory Control Point Program

Technical Coverage: Repair parts, allowance lists, and provisioning requirements.

Mission and Description: To provide technical data and information storage, processing, and retrieval to support project management programs. The data describe characteristics of repair parts and application relationships. Technical data and information are provided for constructing allowance lists, provisioning, purchase, and weapons systems support.

Status: Data to be stored and indexed are accumulated on punched cards for conversion to magnetic tapes and drums. Search equipment includes a U-490 computer with tapes, drums, and peripheral equipment. Output equipment consists of a UNIVAC 1004, Burroughs 283, and Teletype KSR-33. Continuing analysis of the system by staff for improvements is under way.

Size and Rate of Growth: 1.5 million current items of data on record, with a 4-percent annual growth rate.

Contact:

Captain R.A. Jones, SC, USN
Naval Supply Systems Command
Main Navy Building, Code SANDA-45
Washington, D.C. 20360
Telephone: (202) OX. 6-5776

Performing organization:

LCdr. S.D. Frost, SC, USN
Fleet Material Support Office
Naval Supply Depot
Mechanicsburg, Pennsylvania
Telephone: (717) 766-8511, Extension 2504

3.1.21 ADP System for Indexing and Retrieval of Engineering Drawings and Technical References

Technical Coverage: Technical data on components and weapons systems.

Mission and Description: To provide ready reference to engineering drawings needed for effective accomplishment of RDT&E, production, renovation, and other assignments with respect to advanced and conventional weapons systems and components; and to provide indexing and retrieval systems for technical documents, texts, etc., to support engineering, quality control, and reliability programs.

Status: The systems became operational on 1 July 1966. They have been developed to provide a quick-response reference to technical documents relating to test results and evaluations. Data to be indexed are accumulated on punched cards for conversion to magnetic tape storage. Methods are currently being developed for keypunching directly from microfilm and standardizing the terminology.

Size and Rate of Growth: Engineering drawings total 62,000 documents, with 30,000 more added each year. Technical references are estimated at 20,000, with 1500 added annually.

Contact:

Mr. Philip M. Ferman, Code QE-1
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 36

Performing organization: Same location as above.

Mrs. Frances M. Harz, Code QECS
Extension 52

3.1.22 ADP System for the Navy Calibration Program, Nuclear Weapon Test Sets

Technical Coverage: Reliability of test and measuring equipment for nuclear weapons.

Mission and Description: To provide a system for storage and retrieval of technical data and information for Nuclear Weapons Test Sets, and provide data source for continuing engineering, mathematical, and statistical analyses of test results obtained from calibrations conducted on Nuclear Weapons Test Equipments.

Status: The system has been operational since August 1963; it was developed to permit more effective employment of mathematical and statistical techniques in summarizing, analyzing, and reporting program findings, and to provide for the reflection of reliability of equipments and systems covered by the Navy Nuclear Weapons Test Equipment Calibration Program. Capability includes retrieval of technical data and information in statistical reports. Data are keypunched and entered on magnetic tape for storage.

Size and Rate of Growth: The system now contains approximately 2,500 retrievable documents. About 250 new entries are added each year.

Contact:

Mr. Robert Sanders
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 63

Performing organization: Same location as above.
Mrs. Frances M. Harz, Code QECS, Extension 52

3.1.23 ADP System for Navy Calibration Program for MEC, Pomona

Technical Coverage: Reliability of test and measuring equipment.

Mission and Description: To provide an electronic data processing (EDP) system to monitor the calibration servicing of test and measuring equipment by Navy calibration facilities. The data are used to optimize calibration intervals, provide a means of detecting equipment not performing acceptably, and determine laboratories whose performance deviates significantly from the average. Data summaries, listings, and statistical reports generated by the EDP system are analyzed to determine the optimum calibration interval for a specific make and model of instrument or equipment.

Status: The system has been operational since 1 June 1965. Data to be recorded are accumulated on punched cards for conversion to magnetic tape files. The system can continuously retrieve data and information to monitor and improve the calibration program, and can obtain information for engineering studies to improve one or more specific parameters resulting in improved equipment reliability.

Size and Rate of Growth: 100,000 data records, with approximately 150,000 to be added annually.

Contact:

Mr. Stanley K. Crandon
Naval Weapons Representative
Metrology Engineering Center
Pomona, California
Telephone: (213) NA. 9-5111

Performing organization:

Mrs. Frances M. Harz, Code QECS
Q.E. Laboratory
U.S. Naval Weapons Station
Concord, California
Telephone: (415) 686-0550, Extension 52

3.1.24 USNIRS, Underwater Ship Noise Information Retrieval System

Technical Coverage: The physics of underwater ship noise, ship silencing, and mine warfare.

Mission and Description: To develop a library of available acoustic signatures of Naval and commercial vessels on magnetic tape and in digital form over a spectrum of 5 Hz to 40 KHz, and pressure signatures on the same types of vessels.

Status: Reports, issued at irregular intervals, contain tabulated signatures giving noise figures in absolute levels. Copies of magnetic tapes are supplied upon request of Naval activities or contractors. Pressure reports are copies of strip recorder traces, and these are issued at irregular intervals.

Size and Growth: An acoustic signature library of more than 900 signatures has been compiled on more than 400 vessels, including many special types of vessels. A pressure library of more than 300 signatures has been compiled. Magnetic tapes have been copied by and for contractors for various types of analysis and development. Accumulation of both is continuing.

Contact:

NAVSHIPS Code 0343
Naval Ship Systems Command
Norfolk Naval Shipyard
Portsmouth, Virginia 23709

Performing organization:

Mr. H.A. Summers
Range Division, Building 704
Acoustic and Pressure Check Section
Fort Story, Virginia 23459
Telephone: (703) 428-1111, Extension 4121

3.1.25 VSMF, Marine Engineering File

Technical Coverage: Electronic and mechanical product data for research and development maintenance engineering.

Mission and Description: To provide commercial product data on microfilm for storage and retrieval and use by engineering and technical personnel at U.S. Naval shipyards.

Status: Complete specification information is available from 20,000 pages of data from 800 suppliers in every category of equipment.

Growth: It is planned to include military specifications, APL's, and standard Navy catalog material under the storage and retrieval system in the future.

Contact:

Mr. A.V. Petruccelli
Naval Ship Systems Command
Department of the Navy
Washington, D.C. 20360
Telephone: (202) OX 6-4705

Performing organization:

Information Handling Services
Denver Technological Center
Englewood, Colorado
Telephone: (303) 771-2600

3.1.26 DSD, Diving Systems Development

Technical Coverage: Underwater-diving-systems evaluation and human-factors analysis.

Mission and Description: To provide an information storage and retrieval system for technical reports on diving systems evaluation, human-factors analysis, and equipment performance.

Status: A data coding system has been established to reduce information to an acceptable format for computer handling and to write FORTRAN IV programs for retrieval and analysis. The system was scheduled to become operational in January 1967.

Size and Rate of Growth: About 2,000 data cards are added each year. All experimental dives for the year 1965 have been coded.

Contact:

LTJG T. E. Berghage, MSC, USNR
U. S. Navy Experimental Diving Unit
Washington Navy Yard
Washington, D. C.
Telephone: (202) OX. 8-3528

Performing organization:

Mr. F.J. Bauer
U. S. Naval Station
Supply Fiscal Department
Data Processing Division
Washington Navy Yard
Washington, D. C.
Telephone: (202) OX. 8-2530

3.1.27 LYQAL, Lead Yard Quality Assurance Lists

Technical Coverage: Shipbuilding and submarine maintenance quality-assurance data.

Mission and Description: To provide documented evidence of compliance with quality-assurance requirements at the time of submarine-safe certification. The system serves local shipyard quality-assurance personnel.

Status: Drawings with QA requirements lists are provided. Input equipment includes an IBM 1401C computer system with magnetic tape as the storage medium. Monthly reporting was refined to additions, deletions, and changes on 1 August 1966.

Growth: An interface-pipe-joint control system is now under study.

Contact:

Mr. R. Cramer
Portsmouth Naval Shipyard
Portsmouth, New Hampshire 03801
Telephone: (207) 439-1000, Extension 852

Performing organization: Same as above.

3.1.28 CDL, Crack Data List

Technical Coverage: Shipbuilding and Submarine Maintenance.

Mission and Description: To provide a systematic listing of all frame cracks located for repair during the overhaul of a submarine. The data serve local shipyard personnel.

Status: Frame and crack number data are maintained in sequence on hand-recorded feeder forms. Data are recorded by a technician and transferred to cards by a keypunch operator. Output equipment includes an IBM 1401G computer.

Size: Approximately 1,000 items are assembled in two groups of data.

Contact:

Mr. Stuart Chaplin
Portsmouth Naval Shipyard
Portsmouth, New Hampshire 03801
Telephone: (207) 439-1000, Extension 520

Performing organization: Same as above.

3.1.29 NUMIS, Navy Uniform Management Information System

Technical Coverage: Ordnance Maintenance

Mission and Description: To implement a uniform flow of management information, utilizing compatible ADP hardware and programs, between ordnance activities. The objectives also include relieving management of routine and

quantitative decisions, and improving efficiency and effectiveness of management functions.

Contact:

Fleet Readiness and Training Group
Naval Ordnance Systems Command
Washington, D.C. 20360

Performing organizations:

NAD Bangor	NTS Keyport
NAD Charleston	NWS Concord
NAD Crane	NAD Earle
NAD Hawthorne	NAD McAlester
NAD Oahu	NWS Seal Beach
NAD St. Jilian Creek	NWS Yorktown
NOI Forrest Park	NAF Indianapolis
NPP Indian Head	NOP Louisville

3.1.30 NODC, National Oceanographic Data Center

Technical Coverage: Physical, geological, and biological aspects of oceanography and related environments.

Mission and Description: The NODC is primarily a central repository for the Nation's oceanographic data. Part of its mission is to receive, compile, process, and preserve oceanographic data for rapid retrieval; establish procedures for ensuring that the accuracy and general quality of the incorporated data meet the criteria established by the Advisory Board; and prepare data summaries, tabulations, and atlases showing annual, seasonal, and monthly oceanographic conditions.

Status: The Data Center is located at the Navy Yard Annex, Washington, D.C., and is a depository for data in all areas of oceanography -- physical, geological, and biological -- and their related environments. Administered by the Naval Oceanographic Office and sponsored jointly by nine Federal organizations, it functions as a national clearinghouse for oceanographic data. It prepares data summaries, tabulations, and atlases, showing annual, seasonal, and monthly oceanographic conditions. The Center's Technical Library is available for use by all interested individuals.

Contact:

Officer in Charge
U.S. Naval Oceanographic Office
Washington, D.C. 20390

Performing organization:

Dr. Woodrow Jacobs, Director
National Oceanographic Data Center
Washington Navy Yard, Building 160
Washington, D.C. 20390
Telephone: (202) 698-3757

3.1.31 CPIA, Chemical Propulsion Information Agency

Technical Coverage: Research, development, test, and evaluation information on chemical rockets.

Mission and Description: To acquire the information and data from Government-sponsored programs in chemical propulsion technology; organize this information and data in the publications useful to members of the rocket community, including Government organizations, industrial concerns, universities, institutes, and consultants working with chemical rocketry; disseminate chemical propulsion information and data through meetings, briefings, consultations, and publications; serve as a central source for chemical-propulsion contract information so that duplication in Government-funded research and development programs can be minimized; provide the Interagency Chemical Rocket Propulsion Group with status reports in specific areas of research and development to aid managerial decisions; provide technical data in response to inquiries from scientists and engineers engaged in chemical-propulsion research and development.

Status: Performance calculations of selected existing or theoretical chemicals, species, and combinations; chemical synthesis; combustion studies; formulation of chemicals into solid or liquid propellant systems; physical characterization of chemicals and propellants; design of liquid rocket engines and solid rocket motors; ground tests of chemical rockets; integration of chemical rockets into flight vehicles and missiles; correlation of flight data and ground test data.

Contact:

Mr. John Murrin, RMMP
Naval Ordnance Systems Command
Washington, D.C. 20360

Performing organization:

Mr. Patrick J. Martin
Applied Physics Laboratory
The Johns Hopkins University
8621 Georgia Avenue
Silver Spring, Maryland 20910
Telephone: (301) 589-7700, Extension 560

3.1.32 IIAC, Infrared Information Analysis Center

Technical Coverage: Infrared physics and technology, including such areas as solid-state physics, radiation physics and optics, infrared spectroscopy, atmospheric phenomena, information processing, military infrared equipment, and industrial and medical infrared.

Mission and Description: To collect, analyze, and disseminate information on infrared research and technology. The services include the publication of annotated bibliographies, state-of-the-art reports, the Proceedings of the Infrared Information Symposia, and a classified handbook on military infrared technology; the sponsorship of symposia; and the provision of library and consultation services.

The Infrared Information and Analysis Center was established at the Institute of Science and Technology for the collection, analysis, and proper dissemination of information about infrared research and technology with particular emphasis on military technology. It is one phase of the research activity of the Infrared Laboratory, in the Optics and Information Group. The Center employs scientists and technicians who, with the rest of the personnel of the Infrared Laboratory, form a team for the handling of infrared information.

All information -- classified and unclassified, published and unpublished -- that will advance military infrared technology is collected. Particular attention is given to the acquisition of up-to-date contractor reports. The cooperation of all agencies is sought to ensure that no useful information is overlooked.

Status: Information is analyzed for content and value and catalogued according to the type of research or technology discussed. This enables IRIA to provide contractors with the proper information about a specific development or with evaluative surveys of broad trends of research and development.

This information is actively disseminated to keep contractors informed of the latest work. IRIA follows the work of various contractors and, when possible, notifies them of reports that might be useful to them. It also notifies contractors of others engaged in similar work when such notification is not prohibited.

Contract work is continuously monitored through study of project cards, contact with military agencies, and direct association with contractors. As a result, most reports are now received by IRIA directly from contractors. IRIA attempts to receive new reports quickly and automatically in order to learn of any new infrared work and to obtain any special information in the field.

When a report is first received in IRIA, it is briefly examined by the supervisor or one of his assistants, who generate notes about the report that are put on library cards together with the report title and other pertinent information. These cards are filed and used later in the preparation of an Annotated Bibliography.

Following this preliminary reading, the report is screened for assignment to an appropriate reviewer-analyst. It is his job to indicate the content of the report by assigning category numbers and code words. He also evaluates the information content of the report and assigns a number to indicate what type of report it is -- experimental, theoretical, administrative, etc. The IRIA category numbers are part of a classification system that divides infrared work into ten categories and each of these categories into ten subcategories, and then subdivides these by ten once again. Thus there are 1000 numbers available for the classification of information. Up to three of these three-digit numbers can be used by the reviewer to specify the contents of the report. A large number of four-letter code words is also available to him to define the subject matter further. These words (e.g., SCAN, which represents scanner; ATMO, atmosphere; IIIV for three-five compounds) are quite distinct from the numbers and are used quite independently to identify specific data. The report is evaluated on a scale of one to five (from valuable new contribution to marginal reading for a few researchers), and one of seven "report type numbers" is assigned.

This information, together with identifying information (date, author, corporate author, contract, cognizant agency, etc.), is then punched on the IBM card for rapid retrieval.

This analysis operation enables IRIA to prepare Annotated Bibliographies, Subject Bibliographies, and State-of-the-Art Reports, and to provide library consultation service. The Annotated Bibliography consists of a compilation in report form of the library cards, produced by the scanning operation, organized according to the IRIA cataloging system. It is a quarterly publication including information about the reports received during the most recent quarter. The first of these was published in January 1957.

Subject Bibliographies are prepared on special request and are sent only to the applicant. Reports pertinent to the contractor's interest are selected from the information on the IBM cards. A bibliography is prepared from these cards and sent to the requester; the responsibility for obtaining the reports listed is left with the contractor.

If such a Subject Bibliography is not sufficient for some reason, the user may desire to visit IRIA. The fields of interest of the contractor are decided by the authorized need-to-know of the visitor and by consultation with the IRIA staff. IBM techniques are used to locate reports pertinent to the particular research or development problem, and the reviewers are available for discussion on topics relating to their fields of interest and the research of the contractor.

IRIA cannot lend documents from its holdings to anyone on any basis.

The dissemination of IRIA information is intended to be as broad as security considerations warrant. In all cases, requests for information must first be authorized by the applicant's contracting officer and verified by the IRIA contracting officer. Contractor visits are based on the usual security procedures (including an authorized need-to-know), and reports on specific fields are made available only after authorization has been demonstrated.

The IRIA method of document classification provides an automatic system for adhering to the intent of the security regulation as well as to the letter. It ensures that contractors receive all the information they need to do the job, but only that information. Regardless of title, contract, or author, the IRIA user receives only those reports the contents of which are pertinent to his work.

In addition to security regulations IRIA is cognizant of proprietary rights. All information so designated is handled with discretion. Only authorized Government personnel are allowed access to proprietary information unless prior approval has been granted.

Contact:

Mr. F.B. Isakson
Physics Branch, Code 421
Office of Naval Research
Washington, D.C. 20360

Requests for inclusion on the distribution list for IRIA reports should be addressed to:

Mr. T.B. Dowd
Office of Naval Research
Boston Branch Office
495 Summer Street
Boston, Massachusetts

Performing organization:

Mr. William Wolfe, Director IRIA
Institute of Science and Technology
The University of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107
Telephone: (313) 483-0500, Extension 281

3.1.33 NSD-Phila, Naval Supply Depot -- Philadelphia

Services:

This data source permits automatic retrieval of DOD and federal specifications, standards, and related publications such as handbooks. Federal agencies and industry contractors draw information from this file of 57,000 documents at the rate of 9,000 requests per day. The primary input information is derived from the Department of Defense, and the output is in the form of hard copies.

Documents may be obtained from:

Naval Supply Depot
5801 Tabor Avenue
Philadelphia, Pennsylvania 19120

3.1.34 Library Information Search and Retrieval Data System

Services: Provides document retrieval by subject, author, issuing agency, report series, and contract number for working-level engineers, scientists, and technicians.

Organization: The subject search file is organized into two magnetic tapes: (1) an inverted descriptor tape arranged serially by descriptor number and containing descriptors, descriptor code numbers, and accession numbers of reports posted to them, and (2) a master report file containing bibliographic data for each report title in the system, arranged in sequence by accession number. The document file is also arranged by accession number.

Status: Maintains indexes to authors, issuing agencies, report series number, and contract number in a standard card catalog. Cards for these are produced and sorted by computer. Also, a manual coordinate index of subjects is maintained. This is updated by computer every four to six weeks, when a printout of a complete card is made for each term to which an accession number has been posted within that period of time.

Size and Rate of Growth: More than 66,000 report titles (individual issues of progress reports are kept together under one title). Annual rate of growth is approximately 10,000 documents. It is hoped that early in 1967, the present 1401, 1460, 7094 system will be replaced with an advanced EDP system. This new system will have remote display and inquiry consoles and high-speed mass-storage devices with high-speed input/output devices.

Contact:

Mrs. C.J. Kruse
Library Division, Code 753
U.S. Naval Ordnance Test Station
China Lake, California 93555
Telephone: (714) 7-7411, Extension 71604

3.1.35 Library Information Retrieval Program

Services: Provides technical data system used for document retrieval, bibliographies, and bibliographic identification for engineering and research personnel.

Organization: External and internal technical reports are processed, including bibliographic identification and descriptors. Input is by author identification, date of report, security, and descriptor codes assigned to the report. Steps for title processes are: (1) Descriptive catalog information is

typed on Flexowriter-output typed copy; (2) paper tape is used to produce weekly accession list; (3) new continuous tape is produced for Mathematics Department containing descriptive catalog information; and (4) paper tape is transferred to magnetic tape for title program.

Status: Searches can be done by subject, corporate author, date of report, security classification, restricted-data category, and proprietary information.

Outputs Include: Report identification number, security classification, date of report, coded corporate entry, the first four most important terms related to the report, and bibliographic identification by corporate author, title, date, series, and contract.

Size and Rate of Growth: 72,000 at present, with an annual rate of increase of 8,000. Approximately $30,000 in book catalogs are among the planned additions. It is also planned to add $75,000 in an expansion to provide full bibliographic information not available at present on the computer. Completion dates are not known.

Contact:

Eva Liberman, Chief
Library Division, Code 194
U.S. Naval Ordnance Laboratory
White Oak, Maryland 20910
Telephone: (301) 495-7550, Extension 550

3.1.36 Document Information Retrieval

Services: Information storage and retrieval of books, documents, technical reports, and other reference material for scientific and professional personnel.

Organization: The input equipment includes IBM Document Writing System No. 870, Key-Puncher with matrix, and output typewriter. Storage is on magnetic tape, with an IBM 7030 search computer. Output is in the form of descriptive catalogs, abstracts, and natural descriptors.

Status: The system is fully operational to serve the needs of personnel at the Naval Weapons Laboratory.

Size and Rate of Growth: Current size is 33,000; 30,000 additional to be included as older reference material is microfilmed and indexed on contract. Normal rate of growth is 10 percent per year.

Contact:

Cathryn Lyon, Library
U.S. Naval Weapons Laboratory
Dahlgren, Virginia, 22448
Telephone: (703) NO3-2511, Extension 603

3.1.37 SMS Technical Library Index Control System

Services: Rapid storage and retrieval of SMS technical information and documentation for Ships Missile Systems technical personnel.

Organization: The master file is maintained in accession number sequence, with one full-time clerk filling out loading forms at the rate of 60 documents per day. Inputs are card-punched, with storage on magnetic tape.

Status: Two clerks search output listings for accession number of document requested and deliver to the customer. An IBM 705 and IBM 1401 produce the accession keyword and report-number listings.

Size and Rate of Growth: Present size is 63,386 documents, with 14,500 documents incoming annually and 5,500 outgoing annually. It is planned to convert to the IBM 360 Mod 40 system during 1966-67.

Contact:

Mr. A. Vasques
USNSMSES, Code 4340
Port Hueneme, California 93040
Telephone: (805) 487-5511, Extension 350

3.1.38 PROJECT SHARP, Automated Library Information Storage and Retrieval System

Technical Coverage: Marine engineering and ship maintenance.

Mission and Description: To provide a technical information storage and retrieval system to support marine engineering and scientific command programs, and to provide ship-maintenance data to serve working-level technical and engineering personnel.

Status: The system provides multiple usage of basic information, identifies technical documents relating to Command Projects, and determines available documentation pertaining to specific subjects of NAVSHIPSYSCOM cognizance and interests. Development started in 1961; the system is scheduled for operation in December 1966.

Size and Rate of Growth: The total collection of data to be converted is 210,000 documents. Approximately 15,000 documents have been converted to data processing and are retrievable by subject-information and descriptive data. Annual rate of growth is 15,000 documents.

Contact:

Mr. J.J. Nicolaus, Code 2021
Naval Ship Systems Command
Technical Library, Ships-2021
Washington, D.C. 20360
Telephone: (202) OX. 6-5765

Performing organization:

Mr. Gilbert Gray, Code 88C
Applied Mathematics Laboratory
David Taylor Model Basin
Carderock, Maryland 20007
Telephone: (202) 365-2600, Extension 766

3.1.39 Navy Libraries, General

The Navy libraries referenced in the preceding sections cover only a limited range of library locations and services.

Other libraries and data centers are located throughout the Navy. They may be contacted directly for information at local bases, shipyards, and stations for further information. For an overall listing, write to: Head, Scientific and Technical Information, Office of Chief of Naval Research, Department of the Navy, Washington, D.C., 20360.

3.2 U. S. Air Force Sources

3.2.1 AFOAR, Air Force Office of Aerospace Research

Technical Coverage: Engineering and scientific information applicable to aerospace technology.

Mission and Description: The Office of Aerospace Research plans and manages the Air Force basic-research program and certain portions of the applied research program having broad applications of potential value to the Air Force in the design and development of aerospace systems. Research is carried out either in laboratories administered by the Office of Aerospace Research or by contracts and grants with universities and industrial and nonprofit research organizations throughout the world.

Three units of the Office of Aerospace Research are described separately in Sections 2, 3, and 4, respectively, of this appendix: the Air Force Office of Scientific Research, the Air Force Cambridge Research Laboratories, and the Aeronautical Research Laboratories. A fourth unit, the European Office, OAR, Brussels, Belgium, monitors basic research abroad as an agent for the other OAR units.

3.2.1.1 Basic Research

3.2.1.1.1 Propulsion

Energy is the common denominator in the OAR propulsion research program. Subjects have been arranged accordingly into four categories:

(1) Energy Sources: High-energy chemical bonds (dissociation, ionization, mechanisms of free-radical formation, concentration, stabilization, storage of metastable compounds); properties of energy sources (lifetimes, density, release, structure, activation, corrosivity, additives, inhibitors, catalysts); thermodynamics and thermophysical data; nuclear energy (reaction energy, forms of released energy, types of radiation emitted, reaction cross-sections, reaction products); electromagnetic energy (radiation field of the sun, magnetic and gravitational fields of the earth, fields for accelerating ions and plasmas).

(2) Energy Release and Transformation: Micro-structure of flames; high-temperature chemical kinetics and equilibria; stability of flames; ignition and extinction limits; detonations; catalysis; release of nuclear

energy; solar energy; electromagnetic and particulate bombardment of the upper atmosphere; distribution of ions, atoms, and free radicals in the earth's atmosphere; interaction of electromagnetic radiation with matter in the short ultraviolet region; absorption characteristics of solids and gases; photochemical and photoelectric effects in the short wavelength regions.

(3) Conversion to Useful Work: Photomechanical propulsion utilizing electromagnetic radiation; magneto-mechanical propulsion utilizing magnetic fields adjacent to heavenly bodies; electromechanical propulsion and its applicability to electric motors and the electric-gun type of rocket engine; ionic and plasma propulsion; other unconventional energy converters (closed-cycle heat engines, compression and expansion of new working substances, thermoelectric motors).

Theoretical and Experimental Techniques: Mathematical techniques for theory design of propulsion systems; new mathematical methods for machine solution of partial differential equations and for data reduction; research leading to the development of test facilities for use in the areas of hypersonic simulation, gas dynamics, energy-release processes, heat transfer in nuclear reactors, high-temperature physics, ionic processes, and nuclear reactor processes.

3.2.1.1.2 Materials

OAR materials research relates to the structure and energy relationships of matter and their correlation to physical, chemical, and mechanical properties. There are four major subdivisions:

(1) Internal Structures and Properties of Matter: Effects of subatomic, atomic, crystalline, or amorphous structures on properties of structures and structure stabilization; changes in structure with time, temperature, pressure, and radiation; mechanics of fatigue, strength, plastic flow, and fracture; thermal instability; nuclear radiation resistance; effects of impurities on magnetic and electrical properties.

(2) Structure and Properties of Interfaces: Atomic and molecular interactions; homogeneous and heterogeneous reactions of species; aggregates of species in gas, liquid, and solid phases; theories of alloys, ceramics, solid solutions, intermediate phases, and compounds; ductile and shock-resistant ceramic and transparent materials; relationship of the interface to creep, brittleness, fracture, and strength of macroscopic specimens; mechanisms of catalysis, adhesion, and corrosion.

(3) Proposed Synthetic Methods: Crystal latices with predetermined imperfections; synthesis of complex structures (such as silicate and protein structures); use of extreme pressures, temperatures, or radiation to effect subatomic, atomic, and molecular combinations.

(4) Theoretical and Experimental Techniques: Trace quantity analysis; determination of atomic or molecular arrangements; quantitative characterization of imperfections in crystals; methods for investigating physical and chemical structure of surfaces; preparation of pure materials; methods for attaining uncommon experimental conditions (extremely high temperatures, pressures, etc.)

3.2.1.1.3 Electronics

OAR electronics research is oriented to new technologies rather than to the enhancement of existing technologies. The program is divided into four broad areas:

(1) Particle Physics: Ion and electron ballistics (generation, detection, control, and instrumentation); basic emission phenomena (photo, field, ionic, thermionic, and secondary emissions); photoconductivity; gaseous electronics; plasma dynamics (magnetohydrodynamics of plasma growth, propagation, and oscillation).

(2) Interaction of Fields and Matter: Energy generation, detection, and control; atomic, molecular, and nuclear resonance generated by nuclear spin relaxation phenomena, plasma oscillation phenomena, and molecular oscillators; quantum transition effects in solids and gases; particle beam-wave interactions; interactions of particle beams with periodic structures as a source of energy; crystal structures (stability, optimization, effects of temperature and nuclear radiation, physics of imperfections).

(3) Transfer of Electromagnetic Energy: Sporadic E effects and meteoric streams; disturbance predictions; emission or absorption phenomena of gases in and above the atmosphere; transmission to vehicles traveling at Mach 10 and above; generation of radiation from high-velocity gases; exospheric scatter; lithospheric-layer propagation; high-altitude scatter; refraction and scintillation; propagation and radiation research in the mm. and sub-mm. wave regions; atmospheric attentuation research in the region between microwaves and infrared radiation; electromagnetic diffraction; microwave optics; synthesis of shaped antenna patterns; lens systems (geodesic types, three-dimensional lattices, reflector optics).

(4) Information Sciences: Information systems research; biophysical information systems; concepts of machine organization; artificial intelligence; information extraction and classification; transmission of information; language and linguistic research; electronic techniques for information systems.

3.2.1.1.4 Geophysics

OAR investigates not only terrestrial phenomena but the interactions of related solar and universal phenomena. There are five subject areas:

(1) Planetary Studies: Elastic wave theory; geodesy; nature of gravity and geomagnetism; geology; geomorphology; glaciology; seismology (wave propagation, disturbances, microseisms, instrumentation, data and signal analysis and display); arctic exploration.

(2) Lower Atmosphere: Hydrodynamical variables, chemical composition; trace elements and contaminants; electric field and phenomena; optical properties and visibility factors; coefficients of electromagnetic propagation (reflectivity, absorption, scattering); hydrometeors; turbulence.

(3) Upper Atmosphere: Particle and radiation-induced chemical reactions; photochemistry; magnetohydrodynamics; collision reactions; aurorae and airglow; ionospheric physics; cosmic rays; meteor physics; ion rings; whistlers; radiation and material transport processes; energy balance and storage; chemical structure of the atmospheric layers.

(4) Space Environment: Astrophysics; astronomy; solar studies; celestial mechanics; extraterrestrial radiation throughout the electromagnetic spectrum (sources, causes, energies involved, spatial distribution); composition; physical properties, and distribution of matter in interplanetary and interstellar space (electrons, mesons, nuclei, ions, neutral gases, dust particles, meteorites, asteroids, plants, and stars); gravitational, electric, and magnetic fields throughout the universe.

(5) Experimental and Theoretical Techniques: Instrumentation for measuring radiation through the entire electromagnetic spectrum and for measuring particle distribution and energy levels of radiation in the transition region; laboratory synthesis of environmental parameters; use of scaled models; space platforms; balloon research.

3.2.1.1.5 Life Sciences

Six major subject areas can be identified in OAR inter-disciplinary studies in the life sciences:

(1) Molecular and Cellular Biology: Formation and interaction of molecular species; regulation of cellular processes; energy transformation; structure and coding in DNA and RNA; photosynthesis.

(2) Biological Organization: Cellular specialization and differentiation; structure and function of chromosomes; nature and mode of action of RNA for storage and retrieval of information; effects of stress on structure and function of various organs and tissues.

(3) Integrative and Regulatory Functions: Interrelationship of nervous and endocrine factors; basic homeostatic mechanisms; adaptive and regulatory processes and mechanisms; metabolic and catabolic role of enzymes; circulatory processes; logic and theory of neural network switching and multiplexing; reflexes and feedback systems; random redundant processes; sensing and transducer mechanisms; specificity of stimuli.

(4) Complex Higher-Order Functions: Learning, pattern recognition, information processing, storage and retrieval, concept formation, problem solving, decision-making.

(5) Individual and Group Performance and Behavior: Psychochemical, psychophysical, and psychological research in mechanisms and processes governing intellectual capacity, motor performance, individual and group behavior, personality structure, motivation, and emotional states; optimum performance in stressful environments.

(6) Theoretical and Experimental Techniques: High-capacity-computer analysis of complex functions and interactions of living systems; refined observational devices for the study of cellular components.

3.2.1.1.6 Aeromechanics

OAR research in aeromechanics is designed to solve the technical problems involved in missile and space vehicle development. It demands the use of many diverse disciplines, some of which are not usually considered a part of aeromechanics proper. There are three major subject areas:

(1) Properties of the Flow Field: Cosmic aerodynamics; magnetohydrocynamics; plasma flows; non-Newtonian flow; surface-gas interactions; compressible flows; visco-compressible flows; slip-flows; free-molecule flows; flows involving free surfaces; nonhomogeneous flows; properties of the medium; classical hydrodynamics and thermodynamics (inviscid flow, viscous flow, turbulence, unsteady flow, boundary layer, transport phenomena).

(2) Mechanics of Flight: Aerodynamic theory, internal and external; airloads, gusts, and blast effects; flutter, aeroelasticity, thermoelasticity, and viscoelasticity; high-speed aerothermodynamics and gas dynamics; boundary-layer transition skin friction and heat transfer; shock-wave boundary layer interaction; aerodynamic noise; aerodynamic and thermal considerations associated with high-speed rotating machinery; stability control and structural problems arising from heating, slip-flow, free-molecule flow, and real gas interactions; impact and erosion.

(3) Experimental and Theoretical Techniques: Free-flight vehicles; captive test vehicles; wind tunnels; flow simulation; model studies; loading of structures under varying environmental conditions; instrumentation; applications of mathematical and computer techniques and statistical theory.

3.2.1.2 Applied Research

3.2.1.2.1 Nuclear Weapon Effects

OAR research in this area is aimed at obtaining information on the output of nuclear explosions; interaction of such output with any environment; the response, protection, and recovery of representative targets (including human targets); nuclear weapon phenomena; vulnerability of warheads and aerospace vehicles to nuclear effects; effects of thermal radiation; atmospheric distribution of bomb debris; and nuclear radiation hazards.

3.2.1.2.2 Nuclear Applications

OAR research in nuclear applications includes: technology for integrating nuclear munitions into Air Force weapons system, with emphasis on improved safety and reliability; improvement and development of new radiation instrumentation; studies and analyses of contemporary and advanced weapon systems with nuclear capabilities.

3.2.1.2.3 Aerospace Environment

OAR's aerospace environment program is concerned with subjects that contribute to the knowledge of the Air Force's operating environment so that it can be predicted or controlled. In addition to the basic research subjects, subjects of OAR research in this field include programming techniques and procedures for use with large-scale computers for analysis and reduction of data from balloon, rocket, and satellite experiments concerning the physical and chemical composition of the upper atmosphere; aircraft, rocket, and satellite measuring systems for obtaining geodetic and gravity data bearing on naviguidance; techniques of studying terrestrial environments (particularly the Arctic) applicable to lunar and planetary composition studies; the earth's magnetic field within and beyond the magnetosphere; structure of the ozone layer, routine measurements of its variability, and its role in radiation balance and "explosive warnings."

Subjects of meteorological interest include techniques and sensors to measure variability of meteorological elements up to 400,000 feet; statistical and mathematical models for plotting time and space distribution of meteorological elements from the surface of the earth to the outer fringes of the atmosphere; weather prediction techniques; radar techniques for observing clouds and storms; satellite meteorology (use of satellite pictures for tropical analysis and forecasting, high-speed analog rectification devices for cloud pictures);

techniques for simple weather data extraction and read-out capability for air weather stations; theoretical and laboratory models for investigating fluctuations in general circulation; effects of solar variability on tropospheric circulations; prediction of stratospheric circulations.

3.2.1.3 Technical Information Policies

OAR research information is almost exclusively unclassified, and policies concerning its dissemination are extremely liberal. In reporting projects that involve classified subject matter, contractors are urged to exclude all unnecessary classified information in order to promote the widest possible distribution of the report. An exception to this rule is the preparation of reports of research supported by the Advanced Research Projects Agency of the Department of Defense. All such reports are published by that agency and are subject to its policies.

Office of Aerospace Research policies regarding the publication of research findings vary. The Air Force Office of Scientific Research waives the preparation of interim and final reports of projects in favor of journal publication. The Air Force Cambridge Research Laboratories use technical documentary reports for formal presentation of all project results but encourage eventual publication of these reports, in whole or in part, as articles in scientific or technical journals. The Aeronautical Research Laboratories normally report in-house and contracted research findings as journal articles, although some efforts, particularly in the engineering sciences, are printed only as technical documentary reports; reprints of ARL journal articles are issued also as technical documentary reports in order to incorporate them into the Armed Services Technical Information Agency program for announcing research results to the defense community. Page charges levied by some scientific journals are chargeable to research funds in accordance with Federal policy.

Contact:

Director of Research Programs (OAR)
U. S. Air Force Office of Aerospace Research
Building Tempo D
Fourth and Independence Sts., S.W.
Washington, D.C.

3.2.2 AFOSR, Air Force Office of Scientific Research

Technical Coverage: Engineering, chemical, physical and mathematical sciences. Life and information sciences and research analysis.

Mission and Description: The Air Force Office of Scientific Research, located at the Office of Aerospace Research headquarters in Washington, D.C., monitors between 1,100 and 1,200 basic research contracts and grants in the United States, South America, Canada, Australia, Japan, and other areas not serviced by OAR's

European Office. In addition, AFOSR supports research and abstracting journals and services, maintains the library at OAR/AFOSR headquarters, sponsors a program of information research, and provides support to a number of scientific meetings each year.

Research sponsored by the Air Force Office of Scientific Research originates in unsolicited proposals, which are evaluated in terms of originality, investigator competence, and AF requirements. The decision to investigate a proposed project may be made by the staff or by one of the seven advisory committees, composed of 10 to 15 distinguished non-Air Force scientists. Research results are evaluated in terms of Air Force needs, and investigations of promising areas are conducted to determine the feasibility of military application.

Contracts and grants are monitored by seven Directorates, each of which determines areas to be emphasized within its major subject field and is responsible for orienting the scientific community to its respective needs.

Status of Directorates:

(1) The Directorate of Engineering Sciences manages a program designed to meet the higher-speed longer-range requirements of hypersonic flight. The Directorate's Mechanics Division sponsors studies on the characteristics of aircraft and space vehicles in new flight regimes and on problems posed by radical new vehicle configurations. The Propulsion Division investigates the mechanisms by which chemical or molecular energy is transformed into thermal energy. Research in nonconventional methods of energy transformation is encouraged.

(2) The Directorate of Chemical Sciences gives priority to projects that combine an experimental and theoretical approach with general applicability. Principal fields of investigation are surface chemistry and catalysis, theory of chemical binding and intermolecular forces, chemical kinetics and thermodynamics, high-temperature and high-pressure chemistry, energy-matter relationships, nuclear chemistry, and photochemistry, including the production of ions, free radicals, active atoms, and excited molecules.

(3) The Directorate of Life Sciences monitors a greatly expanded research program to meet the challenge of space flight. Studies of the structure, composition, and function of living organisms are the bases of new concepts in the improvement of human performance and the design of improved military systems. The Biological Sciences Division concentrates on physiology, molecular biology, and biophysics; the Behavioral

Sciences Division on group dynamics, intergroup relations, cultural anthropology, physiological psychology, sociology, and the behavioral aspects of military intelligence and strategic planning.

(4) The Directorate of Mathematical Sciences develops techniques that can be used in other Air Force basic research. The Mathematics Division monitors contracts in theoretical mathematics. The Applied Mathematics Division sponsors research in numerical and computational analysis, physical applications of mathematics, and applications of mathematics to logistics, operations analysis, control systems, and biology.

(5) The Directorate of Physical Sciences consists of four Divisions:

(a) General Physics Division

(b) Nuclear Physics Division

(c) Solid State Sciences Division

(d) Geophysics Division

(6) The Directorate of Information Sciences has two divisions. The Information Research Division monitors the principal Air Force basic research program in the information sciences, comprising such areas as information systems, biophysical information systems, machine organization, artificial intelligence, information extraction and classification, information transmission, and language and linguistics. The Technical Information Division has operating responsibility for the Headquarters library and for reports control.

(7) The Directorate of Research Analysis is located at Holloman Air Force Base, New Mexico. Although it is an operational organization of the Air Force Office of Scientific Research, this Directorate performs most of its work for the Air Force Systems Command. It analyzes and synthesizes hypothetical and future weapons systems and makes recommendations concerning the technical validity, operational effectiveness, and program feasibility of proposed weapons systems.

Contact:

Research Director
U.S. Air Force Office of Scientific Research
Building Tempo D
Fourth and Independent Streets, S.W.
Washington, D.C.

3.2.3 AFCRL, Air Force Cambridge Research Laboratories

Technical Coverage: Electronics and geophysical research information.

Description and Mission: The Air Force Cambridge Research Laboratories is the Air Force center for research in electronics and geophysics. The Laboratories monitor approximately 700 contracts in direct support of their in-house research programs.

In addition to support from the Air Force Office of Scientific Research, the Air Force Cambridge Research Laboratories receive research support from other Government agencies, notably the Electronic Systems Division of the Air Force Systems Command, from the Advanced Research Projects Agency of the Department of Defense, and lesser amounts from such military and civilian agencies as the Defense Atomic Support Agency and the National Science Foundation.

The present staff numbers over 1,100, of whom approximately two-thirds are scientific personnel. In addition to 15 laboratories, numerous field sites are maintained in the Arctic and elsewhere for projects in communications, electromagnetic wave propagation, weather observation, radar, and radioastronomy.

Slightly more than half of AFCRL's work is in basic research. The work of the laboratories is about evenly divided between electronics and the geoastrophysical sciences. Seven of the 15 laboratories at Hanscom Field are under the jurisdiction of AFCRL's Electronics Research Directorate. Eight laboratories and the solar observatory are directly responsible to the Geophysical Research Directorate.

Status: The Electronics Research Directorate evolved from the Cambridge Field Station, which was staffed largely by scientists who had engaged in electronics research during World War II at the MIT Radiation Laboratory and at Harvard's Radio Research Laboratory. Many of the large command and control systems that are now an important part of the national defense program had their inception in projects conceived and carried out by this group of scientists in the late 1940's and early 1950's. Research projects of the present Electronics Research Directorate are conducted and monitored by one of the seven following laboratories:

(1) The Computer and Mathematical Sciences Laboratory, in addition to its work in mathematics and computation, conducts research in computer principles and techniques, in data-processing techniques, and in the analysis and evaluation of real and simulated data. Computer research relates to the improvement of conventional computers and to new concepts in computer design. Several contracts are devoted to microminiaturization of computer elements. Current projects include the development of ultra-

reliable performance in computer networks and investigations of animal neural systems.

(2) The Electronic Materials Sciences Laboratory is concerned with the creation of new electronic materials and with the improvement of existing materials. Emphasis is on solid-state physics and chemistry; this is the largest single research endeavor at the Air Force Cambridge Research Laboratories. Currently under study is the use of semiconductors to transform heat to electrical power to heat or cold. Radiochemistry projects emphasize the analysis of materials by radiochemical techniques and the preparation of ultra-pure materials. There is also a plasma program involving the study of natural plasmas and the generation of plasmas for analysis of their thermal and electrical properties.

(3) The Electromagnetic Radiation Laboratory conducts studies in microwave physics and electromagnetic theory. There is applied research on aircraft, missile, and space-vehicle antennas, with applications for bombing reconnaissance, navigation, and communications. Radiation and reflection studies yield novel antennas and antenna scanning systems of potential value to the Air Force, with emphasis on missile detection and space communications. There is research on the plasma sheath and its effect on communications and detection, and on techniques for the transmittal of guidance information during missile re-entry.

(4) The Astrosurveillance Sciences Laboratory performs research on techniques for the collection of data on objects and phenomena above the surface of the earth, and on data processing for the recognition and threat evaluation of such objects. Problems under analysis include missile detection, decision theory, and the feasibility of concepts and techniques used in typical air and space situations.

(5) The Propagation Sciences Laboratory studies terrestrial and extra-terrestrial emission and propagation of electromagnetic waves. Its studies are directed toward the acquisition of knowledge required for the design of new and improved electronic equipment in terrestrial, aeronautical, and astronautical environments. Studies in radio-astronomy include radiation from stellar, solar, and interstellar sources and their application to problems of guidance and control. The Radioastronomy Branch operates the 84- and 150-foot radiotelescopes at Sagamore Hill, Hamilton, Massachusetts. Studies are also made of the effect of propagation of the aurora, of seasonal variations in the ionosphere, and of radio waves reflected from meteor ionization trials. Special studies include the interaction of radio waves and plasma and the propagation effects associated with nuclear detonations.

(6) The Communication Sciences Laboratory directs its research and development effort toward the improvement of AF communications systems and toward new concepts of communications in both terrestrial and extraterrestrial environments. Experimental work is conducted on techniques of signal generation, modulation, transmission, and detection, on techniques for compressing information in audible and visible form for more secure and more reliable transmission in terrestrial and extraterrestrial environments, and on the feasibility of satellite communication systems and other long-range systems with low susceptibility to interference and jamming.

(7) The Instrumentation and General Engineering Laboratory provides consultative and technical services (design, fabrication, measurement, and field work) in mechanical, electronic, and instrumentation engineering. The laboratory also supports the directorate's in-house and contractural program with data-reduction and processing services, including computer maintenance and operation, programming, and related functions.

The Geophysical Research Directorate, the largest unified research effort of its kind in the Department of Defense, supervises basic and applied research in almost every branch of the atmospheric and terrestrial sciences and in astronomy and astrophysics. More than 40 research rockets and satellites carry AFCRL instruments aloft each year to investigate the upper atmosphere and to study the phenomena and characteristics of space. Research is monitored or conducted by eight research laboratories located at Hanscom Field and by the Sacramento Peak Observatory. The program of each of these organizational units is described separately below.

Photochemistry Laboratory. This laboratory conducts experiments, largely by the use of research rockets, on the physics and chemistry of the upper atmosphere. Experiments range from investigations into the structure of atmosphereic molecules to the controlled release of chemicals at high altitude to study the fundamental mechanics of atmospheric perturbations. Areas of interest include spectrometric observations of visible missile trails, the development of micrometeorite detectors, the electrical structure of the upper atmosphere, airglow, the measurement of extreme ultraviolet solar radiation, and solar and thermal energy conversion for use in satellites and space vehicles. Research into aerospace composition involves the development of a model atmosphere up to 1,000 kilometers.

Thermal Radiation Laboratory. This laboratory is primarily interested in atmospheric thermal radiation effects, as distinguished from effects caused by nuclear radiation and by the transient processes involved in photochemical reactions. Radiation studies range from far-infrared, infrared, near-infrared, visible, and near-ultraviolet, to the intense ultraviolet radiation associated with

nuclear fireballs. The analysis of radiative properties of nuclear bursts necessitates fundamental studies of fireball physics and magnetohydrodynamics. There is also a substantial program for investigating plasmas. The laboratory develops equipment for balloon-borne measurements of sky brightness and visibility, such as biaxial pointing control systems.

Research Instrumentation Laboratory. Formed in 1961 from the former Space Flight Physics Laboratory and the Balloon Development Laboratory, this laboratory conducts instrumented flights, using balloons, rockets, and satellites, and analyzes the data thus obtained. Studies relate to geodesy, space gravitational fields, non-nuclear blast effects at high altitudes, satellite orbit analysis, constant-density altitutude observations, origin of tektites, and moon and planet characteristics. Among the devices and instruments developed by this laboratory are nose-cone sensing devices for rockets, airborne gravity instrumentation systems, telescopic scintillometers, and control systems for balloon-flight termination, command ballasting, and data transmission. The laboratory is responsible for the design, development, and testing of balloons and balloon-borne equipment for the Air Force, and maintains facilities at Chico, California, and at Holloman Air Force Base, New Mexico, for balloon launching, tracking, and control.

Atmospheric Circulations Laboratory. This laboratory sponsors an upper-atmosphere circulation program that includes the collection of data through the analysis of radioactive and stable aerosols and the measurement of atmospheric ozone content, and a boundary-layer program that utilizes models to simulate the effects of the earth's surface on atmospheric circulation. The laboratory develops techniques and methods for interpreting the data produced by meteorological satellites and makes the data available for operational analysis. Complementing these primary studies are studies in natural and artificial radioactivity, such as atmospheric dissemination of bomb debris, distribution analysis of cosmic-ray spallation products, radiation fog, and the effect of atmospheric diffusion on the design and operation of nuclear power plants.

Terrestrial Sciences Laboratory. This laboratory performs research in seismology, atmospheric acoustics, geology, glaciology, oceanography, and hydrology. There are special programs in Arctic Ocean research and Arctic lake analysis. Since 1952 the laboratory has sponsored a scientific program on drifting ice stations in the Arctic, where data are collected on micrometeorology, oceanography, gravity, magnetics, and ice physics. There is a large program on ice engineering, which involves alloying of ice to increase its strength, techniques of flooding ice surfaces to produce accelerated growth, and methods of producing airstrips from compacted, finely ground ice particles. The laboratory is responsible for seismological studies leading to the detection and identification of underground nuclear explosions and the identification and analysis of air pressure waves.

Ionospheric Physics Laboratory. This facility has programs in auroral physics, ionospheric characteristics, cosmic radiation, and geomagnetism. Rocket nose cones are used to obtain data on ionospheric characteristics. In addition to direct probes, there is a program for investigating ionospheric phenomena from an aircraft laboratory. Current plans for magnetic research include plans for flying magnetometers on a series of satellites in orbits from 300 to 3000 miles to determine spatial distribution of the field. There are additional programs in celestial mechanics (research and instrumentation) and in the evaluation of radiation effects for space-biomedical purposes.

Aerophysics Laboratory. This laboratory studies the basic principles and mechanisms behind the formation, growth, precipitation, and dissipation of typical cloud systems in the free atmosphere. Its long-range objective is to obtain a detailed knowledge of these mechanisms that will form the basis for understanding cloud systems composed of aerosols other than water and will enlarge knowledge of the fog and cloud covers of other planets. Current work includes radar research (kinematic relations between wind and water distribution, identification of thunderstorms and hail, development of equipment and instruments), and studies in cloud physics (fog and stratus dissipation, dynamics and physics of cumuliform clouds, aircraft penetrations, and soundings).

Meteorological Development Laboratory. This laboratory performs and sponsors short-term research and development in applied climatology, forecasting techniques, and meteorological equipment. Equipment currently under development includes a digital temperature sensor, a visual distance computer for use in the landing of aircraft under poor visibility conditions, and data-handling equipment for instrumented observing and forecasting systems. The laboratory conducts a program in the analysis of civil ATC (air-traffic control) weather-support requirements and serves as consultant to Air Force engineers and contractors and to other U.S. military agencies on problems of meteorological-design criteria.

The Sacramento Peak Observatory, located at Sunspot, New Mexico, is equipped with optical instruments for solar observations in use today. It designs and develops its own observation equipment, such as spectroheliographs, telescopes, coronographs, and photometers. The objective of the research program, divided equally between solar observations and theoretical interpretation of the observations, is the determination of the physical processes responsible for the emission of radiations that maintain and disturb the ionosphere. Information is also provided to meet Air Force requirements in long-range communications, space navigation, and the identification of health hazards in space travel. A complementary observing program, utilizing radio frequency rather than optical techniques, is carried out at Fort Davis, Texas, by Harvard College under a contract with the observatory.

Contact:

Research Director
U.S. Air Force Cambridge Research Laboratories
Laurence G. Hanscom Field
Bedford, Massachusetts

3.2.4 AFARL, Air Force Aeronautical Research Laboratories

Technical Coverage: Research information and data on metallurgy, ceramics, chemistry, physics, applied mathematics, aeromechanics, and propulsion.

Mission and Description: The Aeronautical Research Laboratories, located at Wright-Patterson Air Force Base, is the primary Air Force facility for in-house research in metallurgy, ceramics, chemistry, physics, applied mathematics, aeromechanics, and propulsion. Since April 1960, it has been an element of the Air Force Research Division and its successor, the Office of Aerospace Research, from which it receives 95 percent of its research support. Remaining research funds are supplied by the Advanced Research Projects Agency of the Department of Defense.

The laboratories are housed at Wright-Patterson Air Force Base, largely in a single research building with a total area of 105,000 square feet. The facilities include a Mach 14 wind tunnel, a Mach 20 wind tunnel, 200-kw induction heater, equipment for spectrography and gas chromatography, computers, X-ray apparatus, a 500-kw a-c arc-plasma apparatus, crystal-growing equipment, and cryogenic and high-pressure equipment. About two-thirds of the dollar value of the research program is carried out by contract in direct support of the laboratories' in-house efforts or in performing tasks that cannot be accomplished in the laboratory. ARL monitors approximately 200 contracts, 60 percent of them with universities, the remainder with nonprofit research organizations and private industry. About one-fifth of this contracted research is performed by scientists in Europe and Canada.

The major part of the program is directed toward long-range basic research, with a smaller fraction devoted to non-time-oriented research related to the determination and demonstration of advanced concepts for ultimate application rather than toward the solution of minor short-range problems.

Status: The work of each branch is outlined below:

The Chemistry Research Branch conducts research in the physical, inorganic, and analytical chemistry, and in the chemical aspects of propulsion. In the area of physical chemistry, investigations are made of molecular energy exchange, transport properties of fluids, and the radiolysis of organic molecules. The principal effort in organic chemistry centers around the study of carbon heteroatom systems. Research in analytical and inorganic chemistry is directed toward developing new methods of analysis applicable to metals used in special-property alloys and toward investigations of X-ray techniques (fluoreacence and diffraction) for

use in structural analysis. Research in the chemical aspects of propulsion includes two primary efforts: the development of new concepts of propulsion through theoretical and experimental investigation of deflagration and detonation in small-scale laboratory flame systems; and studies of the unfamiliar chemistry of several classes of high-energy molecules.

The Metallurgy and Ceramics Research Branch is organized to conduct interdisciplinary research in materials. The metallurgy program is concentrated in the areas of deformation and fracture, fatigue, and alloy structure. The ceramics research program is concerned with the chemical, physical, mechanical, and electrical behavior of high-temperature materials such as oxides, borides, and silicides. Present investigations include the kinetics of high-temperature reactions, phase equilibria studies, physical-property measurements, and deformation studies.

The Solid State Physics Research Branch investigates compounds of the II-VI class, particularly cadmium sulfide, zinc sulfide, and their solutions. A varied research program has been designed to elucidate the detailed structure and properties of these compounds. Pure and doped crystals are grown, and their optical and electrical properties are studied, both in the natural state and with structural alterations caused by bombardment from a 250-kV Cockcroft-Walton and a 1-Mev Van de Graaff accelerator. Several applications of military and industrial importance have grown out of these studies, such as the development of efficient cadmium sulfide solar cells, both single-crystal and thin-film types.

The Plasma Physics Research Branch concentrates its efforts in the area of partially ionized fluids, conducting both theoretical and experimental studies chiefly in the areas of arc and gas discharges, plasma-microwave interactions, and plasma diagnostics. The laboratory uses a variety of apparatus, such as capacitor banks, arcs, and spectroscopic equipment, and develops its own instruments for transient measurement and diagnosis.

The General Physics Research Branch is concerned chiefly with nuclear physics and general field physics. In the first area, the branch performs theoretical and experimental research in nuclear reactions brought about by low-energy particles. The laboratory's 1-Mev Van de Graaff accelerator is used in experiments, as is the leased ARL-Brookhaven National Laboratory Reactor Facility. Current studies in atomic physics concern determination of wave functions and transition probabilities, together with various spectroscopic and astrophysical applications of these data. Research in general field physics covers general relativity and unified field theory, with specific efforts directed at the formulation of field equations that couple gravitational-electromagnetic with nuclear-field interactions.

The Applied Mathematics Research Branch conducts programs in mathematical physics, numerical analysis, and mathematical statistics. The mathematical physics work is primarily concerned with obtaining new techniques for handling physical problems and involves the application of these techniques to the areas of aerodynamic theory, plasma dynamics, and magnetohydrodynamics. Numerical analysis is concerned with problems that are amenable only to numerical treatment, such as problems relating to wave propagation and axial symmetric transonic flow patterns. The solution of these problems is aided by the availability of computers. Research in mathematical statistics is concerned largely with the design and analysis of experiments and with operations research techniques.

The Thermo-Mechanics Research Branch concentrates research effort in propulsion dynamics and the development of new concepts of energy-release mechanisms and thrust generation. Studies are conducted in internal flow, electrical propulsion techniques, and energy release from reacting fluids. Heat-transfer research involves high-enthropy methods, such as arc and plasma jets, and the principles of free and forced convection heat transfer. Structural research emphasizes the application of theories of elasticity, plasticity, and viscoelasticity to the analysis of structures.

The Hypersonic Research Branch conducts theoretical and experimental studies on the characteristics of bodies in hypersonic flow, including heat-transfer and control aspects as well as aerodynamic properties. The properties of bodies with nonconventional aerodynamic shapes are investigated, with emphasis on achieving static and dynamic stability of short and long bodies without the use of spin or tail and fin configurations. Experimental programs include model firings for free-flight simulation studies and the use of such facilities as 3-inch and 20-inch Mach-14 tunnels, a vertical wind tunnel, and a specially constructed autorotation test unit.

The Fluid Dynamics Facilities Branch designs and develops novel facilities required for experimentation in aerodynamics, such as arc jets, unusual heating methods, and test stands capable of operating above Mach 14.

Contact:

Research Director
U.S. Air Force Aeronautical Research Laboratories
Wright-Patterson Air Force Base, Ohio 45433

3.2.5 AFIT, Air Force Institute of Technology

Technical Coverage: Educational and research information in the technical areas of Engineering, Systems, and Logistics.

Mission and Description: The Air Force Institute of Technology is the chief Air University facility for advanced training in scientific, technological, managerial, and engineering subjects. Through it, instruction is provided for more than 4,000 Air Force personnel each year. Most of the educational program is contracted to colleges and industry; approximately two-thirds of this training is on the graduate level.

The resident program at the Wright-Patterson Air Force Base is coordinated with the activities of the Aeronautical Research Laboratories and the Aeronautical Systems Division, both at Wright-Patterson. Laboratory facilities are made available to faculty and students of the Institute for graduate seminars and for research in problem areas proposed by both these organizations. Students' research is reported in theses; research by the faculty is reported in journal articles, books, and Air Force technical reports. Laboratory scientists act as visiting lecturers and instructors and conduct special courses.

Status: Research conducted by the faculty and students of the Air University's Air Force Institute of Technology at Wright-Patterson Air Force Base is reported in the form of technical reports or theses:

- Technical Reports (TR). About 15 technical reports are issued each year by the Air Force Institute of Technology, describing results of research conducted by the faculty. These bear letter and number designations such as TR 66-12, first set of digits representing the year published and the last set the serial number of the report. Most technical reports are classified; journal articles written by the faculty and published in scientific and technical journals are issued as unclassified technical reports.

- Theses. As a result of recent program expansion approximately 240 theses on technical subjects will be produced annually by students of the Air Force Institute of Technology, many on subjects proposed by the Air Force laboratories at Wright-Patterson Air Force Base, in which the investigations are conducted. About one-fourth are classified. Theses of significant scientific or technical interest are reproduced and forwarded to the Defense Documentation Center (DDC) for announcement in the Technical Abstract Bulletin Tab and distribution to the Department of Defense and its contractors,

Contact:

Commander, Air University
U. S. Air Force Institute of Technology
Wright-Patterson Air Force Base, Ohio 45433

3.2.6 AFASI, Air Force Aerospace Studies Institute

Technical Coverage: Aeronautical, chemical, and electrical engineering; military science and history.

Mission and Description: The Air University's Aerospace Studies Institute conducts research, develops concepts, and prepares studies and monograph responsive to the needs of Air University and the Air Force, on aerospace power and its relationship to other instruments of national power. The Institute administers the Air Force historical and museum programs. It supports the Air University and the Air Force by research, writing, and lecturing in socio-military fields. The results of research dealing with concepts are reported in special studies for distribution to interested military agencies. Many of these studies are classified. Reports dealing with such subjects as survival training are published as manuals and pamphlets for operational use.

The Aerospace Studies Institute is staffed by Air Force officers and by civilians. It is composed of six organizational units:

(1) The Arctic, Desert, Tropic Information Center evaluates, compiles, and distributes information pertinent to Air Force operations in non-temperate regions. The research program places special emphasis on the employment of Air Force weapon systems and equipment in climatic extremes and on emergency survival techniques. The Center is also concerned with basic survival techniques, geographic intelligence, ethnography, and human factors in environmental extremes. Liaison is maintained with Federal agencies and non-Federal organizations engaged in environmental and geographical research. The center coordinates the Air Force geographical research program with similar programs of the Army and Navy.

(2) The Concepts Division develops long-range studies concerned with various aspects of aerospace power and examines basic Air Force concepts in the light of technological advances. It analyzes the impact of new weapon systems on the three military organizations.

(3) The Documentary Research Division, with a staff of specialists trained in history, linguistics, political science, and economics, prepares special studies on the military, political, and social aspects of the U.S. and Russian military programs. The preparation of these studies is integrated into the educational program of the Air University. The Division is interested in Air Force terminology and has compiled the USAF Dictionary.

(4) The Historical Division, the largest Division in the Research Studies Institute, administers the Air Force historical and museum programs. Historians assigned to the Division prepare monographs on such aspects of Air Force history as aeromedical evacuation and the development of aerospace doctrine in the USAF. The Archives Branch of the Division is the official repository for histories prepared by all active Air Force units.

(5) The Communications-Electronics Doctrinal Project Office prepares for publication Air Force Manuals on communications-electronics doctrine. The Division evaluates existing communications and electronic systems, and weapon systems from the communications-electronics viewpoint, and submits recommendations for the improvement or acceptance of such systems.

(6) The Air University Review Division produces and publishes the Air University Review, the Air Force professional journal of aerospace power.

Status: Between 15 and 20 manuscripts reporting the work of the Aerospace Studies Institute at Maxwell Air Force Base are prepared annually; approximately 10 of these are reproduced in multiple copies or printed for wider distribution (typescripts of others are deposited in the Air University Library and the Institute's Archives Branch). Research Studies Institute publications are of three types.

AIR FORCE MANUALS (AFM). These include publications of operational use on such subjects as basic Air Force concepts, survival, and aerospace terminology. They are published by Headquarters USAF. Some are offered for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402

SPECIAL REPORTS (SR). These are prepared at the request of other Air Force agencies. Usually they cover only those areas of the special subject that are under study at the Institute.

SPECIALIZED PUBLICATIONS (SP). Publications of the Institute that do not appear as Manuals or Special Reports are designated Specialized Publications. They cover a variety of subjects, including U.S. Air Force history, U.S. foreign policy, ethnic studies, geographical analysis, and survival.

Contact:

Commander, Air University
U.S. Air Force Aerospace Studies Institute
Maxwell Air Force Base, Alabama

3.2.7 AFOAO, Air Force Operations Analysis Office

Technical Coverage: Reliability and accuracy: statistical and mathematical techniques. Space systems: testing, test analysis, and design. Weapon systems: evaluation, costs, logistics, and maintenance.

Mission and Description: The Operations Analysis Office, under the jurisdiction of Headquarters USAF, assists the Air Force in making technological, tactical, and strategic decisions. Its scientific studies, most of which are classified, provide quantitative bases for command and management decisions in such areas of

air warfare as operations, weapons and weapon systems, equipment, training, tactics, strategy, and logistics. The Operations Analysis Office also provides Commanders and their staffs with ready and informal access to scientists with specialized training in air warfare analysis, and keeps the Commands informed of scientific and technical developments pertinent to their missions.

The Office coordinates and exercises general surveillance over the Air Force Operations Analysis program. The program is decentralized and is conducted locally through 19 Field Operations Analysis Offices reporting directly to the Commands to which they are assigned. Twelve of them are in the continental United States, while the remaining seven are located in Hawaii, Alaska, Germany, England, and Japan. Headquarters USAF and interested commands are kept informed of the activities and findings of all Operations Analysis Offices. A flow of scientific and technical information is maintained between the Field Offices, Headquarters USAF, and all relevant research activities in the Air Force.

Status: Studies prepared by the Operations Analysis Office are not limited to a specific field; they may be related to the functions of any Air Force activity. Subject areas are reviewed and revised as necessary to bring into focus new fields that require attention. They may cover the following range of military topics:

- Strategic and tactical warfare (including force composition for general and limited wars, counter-insurgency, guerrilla warfare); exercises and maneuvers, including campaign analysis, gaming, simulation.
- Weapon systems: evaluation and costs; weapon technology and effects; logistics and maintenance; electronic countermeasures and counter-countermeasures.
- Space systems: missiles and missile systems -- testing, test analysis, and design; command and control systems.
- Reliability and accuracy: statistical and mathematical techniques

In addition to the periodic reports, the Operations Analysis Offices issue two types of nonperiodic publications reporting the results of Operations Analysis research. They are categorized by the extent of the research reported. Ninety percent of the titles in each of the following series are classified CONFIDENTIAL or SECRET.

- OPERATIONS ANALYSIS PAPERS are formal reports of studies of broad problems of current Air Force interest. They are thoroughly documented with extensive technical detail and generally include recommendations. Distribution of papers depends on the content of each paper. They frequently receive quite extensive distribution within the Air Force. Occasionally distribution is made to outside agencies.

- OPERATIONS ANALYSIS MEMORANDA are informal reports containing relatively brief analyses of specific problems, summaries of study results, or philosophical discussions of some aspect of present or future plans or strategy. While narrower in scope than papers, they include technical data and recommendations if applicable. Their distribution is usually limited to members of the Air Staff who are assigned primary responsibility for the areas discussed.

Contact:

Technical Director
Operations Analysis Office
Headquarters U.S. Air Force
The Pentagon
Washington, D.C. 20330

3.2.8 AFREIC, Air Force Radiation Effects Information Center

Technical Coverage: Effects of nuclear radiation on materials, components, and systems that might be used in a nuclear-powered airborne weapon system and associated ground support equipment; effects of nuclear bursts, pulsed radiation and space radiation on materials, components, and systems.

Mission and Description: The Radiation Effects Information Center has an active program for locating, procuring, analyzing, evaluating, and disseminating engineering data on radiation effects for use by design engineers and scientists conducting research and development.

The Center seeks out, collects, analyzes, files, and distributes radiation-effects information on aerospace materials. It makes available all pertinent engineering data on radiation effects that may be applicable to nuclear-propelled flight vehicles, as well as the effects of nuclear weapons-burst radiation and space radiation; it defines technical areas in which research should be initiated and calls attention to duplication of research efforts; it performs literature searches. The Center provides answers to technical questions, information concerning current research and development projects, and scientific or technical data or data compilations upon request. It prepares and disseminates state-of-the-art reports.

Status: Areas of concern to REIC include the effects of nuclear radiation on materials, components, and systems that might be used in a nuclear-powered airborne weapon system and associated ground support equipment; the effects of pulsed radiation and space radiation on materials, components, and systems; and information on facilities for generating radiation environments and dosimetry.

Approximately 20,000 documents have been processed into the REIC technical information files. The monthly accessions rate is about 400 items. The collection consists primarily of journals, periodicals, abstract journals, Government reports, project or administrative data, and technical correspondence. The collection includes classified material.

The services of the Center include answering technical inquiries and providing technical advisory service. The Center also publishes engineering state-of-the-art reports, abstract lists, contract summaries, and special reports and memoranda. Complete services are available to Government agencies and their contractors only, but partial services are available to others as need arises.

Contract:

Mr. John Charlesworth (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433

3.2.9 AFEPIC, Air Force Electronic Properties Information Center

Technical Coverage: Nine major categories of materials are covered by AFEPIC: semiconductors, insulators, ferroelectric dielectrics, metals, ferrites, ferromagnetics, electroluminescent materials, thermionic emitters, and superconductors.

Mission and Description: The Electronic Properties Information Center has been organized to collect, index, and abstract the literature on the electrical and electronic properties of materials, and to evaluate and compile the experimental data from this literature.

It is designed to provide ready access to literature and experimental data concerning the electrical and electronic properties of all materials of importance in today's technology. The literature is abstracted and indexed into an automated search system. Data from the literature are evaluated and compiled into series of data sheets. Summary and state-of-the-art reports are also issued. The abstracts identify the materials and describe the experimental data contained in the literature. Requests for specific data are honored.

Status: Literature selected for indexing, abstracting, analysis, and evaluation is found through the regular scanning of the DDC Technical Abstract Bulletin, NASA's Scientific and Technical Aerospace Reports, Ceramics Abstracts, Chemical Abstracts, Metals Review, and similar sources. In addition, an average of forty journals are screened on a current-arrival basis. The collection currently contains more than 15,000 references, mainly on semiconductors and insulator materials. The monthly accessions rate is about 400.

The output from this Center is in the form of commentaries, data sheets, and other special reports that are issued to a regular distribution list, or in answer to a special question addressed to the Center. The most technically promising materials are chosen first for evaluation and compilation into data sheets, with an average of about 30 data sheets in final form for each of the materials. To date, more than 40 series of data sheets have been issued.

Contact:

Mr. R. F. Klinger (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433

Performing organization:

Mr. Emil Shafer
Electronic Properties Information Center
Mail Station E-175
Hughes Aircraft Company
Culver City, California
Telephone: (213) 391-0711, Extension 6596

3.2.10 AFMPDC, Air Force Mechanical Properties Data Center

Technical Coverage: Mechanical properties of structural materials, with primary emphasis on metals, and plastics secondary, including test procedures, material formulation, processing, environments. Statistical evaluation of data.

Mission and Description: The Mechanical Properties Data Center collects and disseminates information and data on the mechanical properties of structural materials for application in aerospace and defense industries. It prepares and distributes evaluated strength data of aerospace materials. It is primarily concerned with design, development, and operation of mechanized systems for storage, retrieval, evaluation, and presentation of complex technical information. These information-system developments are intended for immediate application, with available hardware being used. Emphasis is placed on current practicality rather than sophistication. The actual data content of documents is stored, processed, retrieved, and presented. Sources of information are presented, along with tabular and graphical displays of material properties.

Status: The Center contains approximately 2 million data points, a data point being defined as a single point or value for a given property. Additions are presently made at the rate of about 100,000 data points per month. The sources of these data points include Government reports, journals, periodicals, abstract journals, books, technical and scientific data, and project or administrative data.

The Center provides direct answers to questions concerning mechanical properties such as tensile strength, compression, flexure, creep, and fatigue of metals and reinforced plastics. Curves and tabulated data are used effectively either as reference criteria or operands for design calculations. Data sources are always identified, thereby providing bibliographic information as a by-product of the data presentations. Data sheets, graphs, and inventory reports are disseminated routinely to interested DOD contractors and other groups.

Contact:

Mr. Donald Shinn (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433

Performing organization:

Mr. Albert J. Belfour, Director
Mechanical Properties Data Center
13919 West Bay Shore Drive
Traverse City, Michigan 49684
Telephone: (616) 974-4500

5.6.11 AFDMIC, Air Force Defense Metals Information Center

Technical Coverage: Properties, fabrication, and applications of aluminum, titanium, beryllium, magnesium, tungsten, molybdenum, columbium, tantalum, rhenium, stainless steels, hot-work die steels, low-alloy hardenable steels, nickel-base superalloys, cobalt-base superalloys, and iron-base superalloys.

Mission and Description: The Center collects, processes, and disseminates scientific and technical information on structural metals and closely related aerospace materials; it provides answers to technical questions, information concerning current research and development projects, and scientific or technical data or data compilations upon request. There is no organized loan service. AFDMIC evaluates the accuracy, quality, and significance of information that has already been introduced into the system and prepares state-of-the-art reviews, correlations of information, etc. It also offers technical consultant services.

Status: The Defense Metals Information Center collects, interprets, and disseminates technical information about special metals used in aircraft, missiles, and other military systems. Included in its scope are light metals, refractory metals, high-strength steels, superalloys, coatings, and materials for thermal protection systems.

The collection of AFDMIC, approximately 55,000 items, consists primarily of journals, periodicals, Government reports, industrial literature, technical and scientific data, and technical correspondence. The collection includes classified material. The monthly accession rate is about 400 items.

The services of this center include answering technical inquiries, providing technical advisory service to producers and fabricators of the above-listed metals, and conducting surveys and limited research investigations of these metals. The Center also publishes state-of-the-art reports, technical memoranda, quarterly reviews of recent developments, and monthly lists of selected accessions.

Contact:

Mr. E. Hayes
Office of Director of Defense Research and Engineering
Washington, D.C. 20301
Telephone: (202) Oxford 7-6933

Performing organization:

Mr. Roger J. Runck
Defense Metals Information Center
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
Telephone: (614) 299-3151

3.2.12 AFCGIC, Air Force Ceramics and Graphite Information Center

Technical Coverage: Inorganic nonmetallic materials, metal oxides, sulfides, carbides, borides, nitrides, silicides, intermetallics, metalloid elements and their refractory compounds, glasses and vitreous adhesives, lubricants and sealants, inorganic cements, and carbons and graphites. Composites of these materials, together and with other materials, including coatings. Mechanical testing for high-modulus and brittle materials and composites.

Mission and Description: The Ceramics and Graphite Information Center serves as a focal point for collecting, evaluating, and distributing technical information about inorganic nonmetallic materials and composites thereof. The Center provides critical analyses and state-of-the-art reports regarding property data and materials research, development, selection, and application for aerospace systems and military weapons.

The Center collects, processes, analyzes, and disseminates scientific and technical information on ceramics and graphites, providing a unified source of collated scientific information related to the science and technology of inorganic nonmetallic refractory materials for structural, nonstructural, electronic, and other applications for defense and civilian purposes. It collects, analyzes, evaluates, combines, and disseminates technical information on graphites, ceramics, and related materials. It defines deficiencies in available information and recommends greater or lesser effort in pertinent technical programs as appropriate. Its products, in addition to consulting services, consist of reports summarizing analyzed and evaluated data. Input to the group is from DDC, the scientific literature, foreign technology, and direct contact with the scientific and industrial community.

Status: Collecting is arranged through Government agencies, universities, and industrial sources, the collection being stored by the Aerospace Materials Information Center or other Air Force Materials Information Centers for ready retrieval and evaluation.

Contact:

Mr. Donald Shinn (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433

Performing organization:

Mr. Barry R. Emrich (MAAM)
Materials Application Division
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433
Telephone (513) 253-7111, Extension 53623

3.2.13 AFTPRC, Air Force Thermophysical Properties Research Center

Technical Coverage: Thermophysical properties of all substances and seven properties: viscosity, thermal conductivity, thermal diffusivity, diffusion coefficient, specific heat, thermal radiative properties -- spectral and total (emissivity, reflectivity, absorptivity, transmissivity), coefficient of expansion, and PRANDTL number.

Mission and Description: The Thermophysical Properties Research Center collects, classifies, codes, and disseminates all the world literature on 13 thermophysical properties of all matter. It prepares tables of internally consistent data recognized as "most probable values" of a given property for a material as of a given time.

The Center provides scientific and technical information based on a critical evaluation of previous data and, if necessary, new measurements or calculations in the thermophysical properties field. It provides authoritative and comprehensive source information on the thermophysical properties of all matter, covering the world literature. It also conducts experimental research on new developments to fill in gaps and to reconcile contradictory data on thermophysical properties.

Status: The world's open literature is searched as are all Government reports and academic research, for data, theory, and experimental techniques concerning thermophysical properties used in heat- and mass-transfer calculations for all matter. Approximately 15,000 periodicals are covered through the regular scanning of fourteen abstract journals and the irregular monitoring of eleven additional abstract journals. The present collection contains more than 34,000 items of information. The monthly accession rate is about 500 items.

The major publications and services of TPRC include a retrieval guide to thermophysical properties research literature, a three-volume data book that is updated twice a year, an annual listing of all masters theses in the pure and applied sciences, special research reports and translations, and special consulting and advisory service of Government agencies and industry.

Contact:

Mr. Edward Dugger (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433

Performing organization:

Dr. Y. S. Touloukian, Director
Thermophysical Properties Research Center
Purdue University
2595 Yeager Road
West Lafayette, Indiana
Telephone: (317) 743-3827

3.2.14 AFMDC, Air Force Machinability Data Center

Technical Coverage: Data are being processed for all types of materials and for all material removal operations, including conventional machining and alternate removal processes.

Mission and Description: The Air Force Machinability Data Center collects, evaluates, stores, and disseminates material-removal data and other information for the benefit of industry and Government. Strong emphasis is placed on engineering evaluation to develop optimized material-removal parameters.

Status: AFMDC has a mechanized system in which punch cards are used to store and retrieve all types of material-removal information, including all significant numerical data. The focal concept for acquisition, interrogation, or presentation of information is the specific material (with definite chemical, physical, and mechanical properties) and the specific material-removal operation being used.

AFMDC places strong emphasis on providing specific and detailed answers to technical inquiries concerning material removal. A User File, consisting of important users in the field of material removal, has been developed to receive information products, including machining-data pamphlets and tables on materials of current interest, state-of-the-art reports, technical announcements, and other appropriate items. Services are provided to the aerospace industry, Department of Defense (including all of the military services and their contractors) and other Government agencies, technical institutions, and nonmilitary industries.

Contact:

Materials Information Branch
Materials Application Division
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433
Attention: MAAM

Performing organization:

Dr. John F. Kahles
Air Force Machinability Data Center
Metcut Research Associates, Inc.
3980 Rosslyn Drive
Cincinnati, Ohio 45209
Telephone: (513) 271-9510

3.2.15 AFAMIC, Air Force Aerospace Materials Information Center

Technical Coverage: AFAMIC evaluates adhesives, coatings, lubricants, fibrous materials, oils, polymers, various types of manufacturing procedures, methods of materials evaluation and other materials not specifically covered by the other centers.

Mission and Description: The Aerospace Materials Information Center collects, interprets, organizes into retrievable form, and disseminates technical information on all materials of concern to the Air Force Materials Laboratory in conjunction and coordination with other Air Force Materials Information Centers.

Status: A collection of approximately 27,000 scientific and technical reports on the above-listed materials is now in retrievable form. The monthly accession rate is 450 reports. Although the primary sources of documents are internal and contractor-generated reports, reports from other Government agencies, their contractors, and general industry are also included.

The Center provides coordinated use of all pertinent information sources to the AFML and makes technical replies to inquiries, especailly on subject matter not covered by other information centers. It prepares review reports and handbooks such as the Aerospace Structural Metals Handbook and the Space Materials Handbook.

Contact:

Mr. Edward Dugger (MAAM)
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base, Ohio 45433
Telephone: (513) 255-5607

3.2.16 AFSC, Air Force Systems Command

Technical Coverage: All phases of engineering research and development for materials and operations in the areas of aerospace and weapons.

Mission and Description: Applied research and development is the primary responsibility of the Air Force Systems Command, one of the largest single research and development organizations in the Federal Government. It is responsible for the development and testing of weapon systems from the initial design stage to delivery of the complete system to the using command. Research in the physical, engineering, and life sciences is aimed at solving specific problems in systems development or is directed toward promising areas that could lead to the development of new systems.

Status: The command is entirely too broad to be covered in a document of this scope. Many of the activities are described under the several specialties of the Air Force Materials Laboratory at Wright-Patterson Air Force Base.

Contact:

Deputy Chief of Staff
Research and Development Headquarters
U.S. Air Force
Washington, D.C. 20330

3.3 U. S. Army Sources

3.3.1 AEC, Army Electronics Command

Technical Coverage: Nuclear, plasma, and solid-state physics, geophysics, meteorology, radio communications, automatic data processing, aerospace electronics, combat radar, electronic warfare, detection systems, frequency controls, electronic parts and components.

Mission and Description: The mission of the Army Electronics Command is to coordinate in a single organizational unit the research, development, procurement, and production of Army communications and electronics materiel.

Most of the scientific and technical projects of the Electronics Command are conducted by contract with industrial laboratories or with educational and other nonprofit institutions. To monitor these projects and to conduct its own research, development, and testing, the Command maintains three major installations: the Electronics Laboratories, Fort Monmouth, New Jersey, and two Electronics Research and Development Activities, one at Fort Huachuca, Arizona, and the other at the Army's White Sands Missile Range, New Mexico.

The Laboratories conduct and support research in disciplines related to military electronics and develop materials and techniques for electronic components, equipment, and systems. About 70 percent of the work is performed by contract. The remaining 30 percent is conducted in the Laboratories' own facilities and is about evenly divided between exploratory research and applied development.

Status: The Electronics Laboratories issue a monthly technical newsletter, USAEL R&D Summary, which provides current information on significant developments in the Laboratories' program. Classified projects are discussed in a special classified section of the Summary. The Laboratories also prepare an annual technical filmed report on its current progress and achievements. The Electronics Research and Development Activity at Fort Huachuca, Arizona, issues an annual progress report on its micrometeorological research.

All of these materials are prepared primarily for internal distribution. Inquiries regarding their availability outside the Electronics Command should be directed to the Commanding General.

The Electronics Laboratories issue about 75 technical reports a year. These are formal reports, reporting the findings of the Laboratories' research and development programs, compiled at the completion of a project or task, or of a significant phase of a project. Less than 10 percent of these reports bear a security classification; about half appear eventually as articles in scientific and technical journals. About 50 test reports issued each year contain results of performance, engineering, environmental, evaluation, and comparison tests of equipment developed by the Laboratories' programs. Less than 5 percent are classified.

The Electronics Research and Development Activity (White Sands) issues from 10 to 15 research and test reports each year, of which about 20 percent bear a security classification.

Contractors and grantees of all three Electronics Command installations issue technical and final reports in addition to periodic status reports. Roughly half of the contractors' formal reports make their appearance in the open literature as articles in professional journals.

Status: The Army Electronics Command participates in the tri-service sponsorship of two information centers:

- Power Information Center of the Interservice Group for Flight Vehicle Power. This center, located at the University of Pennsylvania, Philadelphia, Pennsylvania 19104, is operated under contract by the university. It collects and disseminates information on power (except propulsive power) from a variety of sources -- electrochemical, electromagnetic, mechanical, photoelectric, thermoelectric, thermionic conversion, chemical, nuclear, and solar. Services are made available to all Government agencies and to qualified contractors and non-Government organizations on a need-to-know basis. Information is generally presented in the form of briefs on Government-sponsored research and development projects in the field of advanced power. The collections are available to qualified visitors for direct use.

- Electronic Test Equipment Information Center. This center, formerly designated Project SETE, is maintained under contract by New York University, New York, New York 10034. It collects, tabulates, and disseminates technical information concerning research and development on electronic test, checkout, and support equipment. Technical consultation services are provided to the Department of Defense and to other interested Government agencies.

Contact:

Commanding General
U. S. Army Electronics Command
Fort Monmouth, New Jersey 07703

3.3.2 AMC, Redstone Scientific Information Center

Technical Coverage: Aerospace logistics, operations, ballistics, fire control, fuzes, warheads, and related missiles and rockets ordnance.

Mission and Description: To maintain data accumulations on engineering design tests of equipment for which the command is responsible. Tests are conducted at the Redstone Arsenal Test and Evaluation Laboratory. These include reliability, structural, and mechanical tests; simulated environmental tests of missile subassemblies and components; and nondestructive testing of solid-propellant missiles.

Status: The laboratory issues approximately 400 documentary reports each year. More than half bear a security classification. The Information Center is jointly funded by the Army Missile Command and NASA's Marshall Space Flight Center. It is the principal data bank for technical literature on missiles, rockets, rocket motors, and related items at Redstone Arsenal.

The Center prepares technical and scientific data compilations, summaries, and bibliographies in support of AMC and MSFC programs. References to newly acquired information, including report abstracts, accessions, and notes on forthcoming searches, are published weekly.

Contact:

Commanding General
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809
Attention: ASMI-II

Performing organization:

Redstone Scientific Information Center
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

3.3.3 BRL, Ballistics Research Laboratories

Technical Coverage: Ballistic measurements, weapons systems evaluations, operations research, reliability, quality assurance, test-data analysis, probability and mathematical analyses.

Mission and Description: To conduct research in weapons technology and ballistics, weapons systems effectiveness studies, weapons concept evaluation, and military target vulnerability determinations. The Surveillance Group evaluates the reliability and ballistic characteristics of rockets, guided missiles, and other types of ammunition retained in stockpiles. It performs research in mathematical statistics in the design of experiments and analysis of the data.

Status: The research is oriented to contribute to the solution of current problems in weapon development and at the same time to anticipate trends in weapon technology that will meet future Army requirements for general and limited warfare. The Laboratories provide consulting services and technical assistance to allied military organizations and other Government agencies. The research programs are carried out in seven major divisions, with 15 percent being conducted under contract by industry and nonprofit organizations.

Approximately 150 technical reports are issued each year, half of them classified. BRL reports present the results of scientific research; BRL memorandum reports present the results of technical investigations; and BRL technical notes present preliminary, quickly formulated results of investigations.

Contact:

Dr. Keats A. Pullen, STINFO Officer
Scientific and Technical Information Office
U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland 21005

Performing organization:

Mr. O. P. Bruno, Chief
Surveillance and Reliability Laboratory
U. S. Army Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland 21005

3.3.4 NTIAC, Nondestructive Testing Information Analysis Center

Technical Coverage: Nondestructive-test data on materials, acquired through radiography, ultrasonics, electromagnetic, and other NDT methods.

Mission and Description: To collect, maintain, and disseminate data in the field of nondestructive testing. To maintain a staff of nondestructive testing experts to provide assistance in those areas requiring augmented technical support. Stores information in a rapid-retrieval system to disseminate upon request to Government installations and others.

Status: All documents and other source material on nondestructive testing are indexed, abstracted, coded, and filed for reference and use. A register of sequential accession numbers is kept for assigning index identification to items. Abstracts are generally limited to one hundred words or less and are coded to reflect title, author(s), source information, and content. The cards are then filed, and the coded information is put on the master indexing system. The files of NTIAC contain, therefore, descriptor cards, abstracts, and items. Search and retrieval is accomplished by searching the descriptor cards by code, identifying and locating the abstract, and, if the abstract warrants, locating the original item.

In addition to identifying, collecting, abstracting, indexing, and filing the items, NTIAC also prepares critical reviews, monographs, and other publications on the state of the art in selected areas of nondestructive testing.

Periodically, Report Guides to Literature on the various fields of interest in nondestructive testing are published. These guides reflect the new and significant publications in a particular field of interest and consist of copies of abstracts, together with the pertinent descriptors and accession numbers, from the files of NTIAC. The guides, essentially literature searches, provide users with a miniature retrieval system on specific subjects. A Nondestructive Testing Newsletter is published as the volume of news warrants; at present, distribution is limited to DoD installations. Other services include providing brief and detailed answers to technical inquiries; consulting and advisory services; preparation of analyses and evaluations; providing short lists of literature citations in response to specific requests; furnishing locations of hard-to-find bibliographical materials; extensive literature-searching services; and on-site use of NTIAC holdings.

Services and on-site use are available free of charge to all qualified requestors. Documents are not loaned; requestors receive abstract-card copies on which document source information is provided.

Contact:

Mr. D. E. Driscoll, Chief
Materials Testing Laboratory
U. S. Army Materials Research Agency
Watertown, Massachusetts 02172
Attention: AMXMR-TMT-Nondestructive Testing Information Center
Telephone: (617) 926-1900, Extension 655

3.3.5 AWC, Army Weapons Command

Technical Coverage: Engineering research data on cannon, mortars, howitzers, and anti-tank and anti-aircraft weapons, including recoil mechanisms, fire-control equipment, feed mechanisms, optical equipment, and nondestructive-testing equipment.

Mission and Description: Supports and conducts research, development, and engineering to satisfy the need for new and novel weapons and for the improvement and modification of existing weapons. The activities are conducted by three major installations, located at Watervliet Arsenal, Springfield Armory, and Rock Island Arsenal.

Status: The Watervliet Arsenal is responsible for the development, procurement, and testing of the Army's cannon, mortars, and recoilless rifles. Weapons are developed from new concepts, through service testing of components, to release of prototypes for production. A variety of pilot production facilities are maintained, including equipment for metalforming, fabricating, cutting, and heat-treating.

Research conducted in the Arsenal's Benet Laboratories consists of investigations in metallurgy and physics on a macroscopic as well as microscopic level, including research on composites and metallic whiskers. Research on high-pressure materials and on metallurgical processes and treatments is directed toward improving the properties of materials employed in weapons for which the Arsenal is responsible, or to developing new and unique weaponry concepts.

The Springfield Armory is the principal Weapons Command installation for the development of small-caliber weapon systems, automatic weapons, aircraft armament, weapons dynamics, and auxiliary items such as feed mechanisms and gun chargers.

The Armory supports research in heat-resistant and erosion-resistant materials, and surface-finishing materials peculiar to small arms. Processes for the preservation and treatment of leather, wood, and other nonmetallic materials used in small arms and small arms accessories are investigated. Research is also conducted in such areas as rates of fire and ultrasonic cleaning processes.

The Rock Island Arsenal is responsible for Weapons Command research and production engineering in mounts, recoil mechanisms, loaders, carriages, and wagons, for artillery and anti-tank and anti-aircraft weapons. It conducts research in elastomers, corrosion prevention, power-transmission fluids, friction and wear characteristics, gasket materials, greases, and other nonmetallic materials. The Arsenal also develops packing techniques for materials other than ammunition and investigates metal-cutting and related processes.

Research and engineering documents of more general interest are issued by the Command as Technical Reports. These include final reports of research and engineering projects, or of completed phases of such projects. Springfield Armory issues about 7 Technical Reports a year; Watervliet Arsenal produces about 25 annually, of which approximately 10 percent are classified. About one-fourth of the Technical Reports of the latter installation are eventually published as articles in scientific journals or trade magazines. Rock Island Arsenal produces an average of 33 Technical Reports per year, some of which are presented at conferences as papers and which appear in technical journals.

Contact:

Mr. K. A. Herbst, Chief
Standardization and Technical Service Office
Rock Island Arsenal
Rock Island, Illinois 61201
Attention: AMSWE-RDT

3.3.6 AMC, Army Mobility Command

Technical Coverage: Data on high-performance helicopters, advanced V/STOL aircraft, propulsion systems, radiation-protection devices, tactical land vehicles, rail motive power, high-speed amphibians, aerial delivery equipment, parachute systems, etc.

Mission and Description: Encompasses design and development of equipment and maintenance engineering, including methods and techniques for testing and test evaluation. The three major units of the Command are the Mobility Equipment Center, the Aviation Material Command, and the Tank-Automotive Center.

Status: Research and development functions for the Mobility Equipment Center are accomplished through the Center's subactivity at Fort Belvoir, Virginia -- the U. S. Army Engineering Research and Development Laboratories (USAERDL), the principal Army facility for research and development in engineering materiel and in engineering methods and techniques. The Laboratories are responsible for the development of new equipment for the use of mobile battle groups as well as for the modernization of old equipment to meet new Army requirements. Approximately 65 percent of its research and development funds are used for contracts to conduct work outside the laboratories.

The research and development functions are accomplished through the mutual efforts of the Aviation Materiel Command Headquarters and the U. S. Army Transportation Research Command, a subactivity located at Fort Eustis, Virginia. Research and exploratory and advanced development are principal responsibilities of the Transportation Research Command.

A large portion of this work is being performed in conjunction with the National Aeronautics and Space Agency, using the facilities at the Ames Research Center, Moffett Field, California. Other areas of investigation include propulsion, human-factors engineering, environmental factors, detection and vulnerability, stability and control, drop gliders, aircraft structures, etc., utilizing research aircraft and models where appropriate.

The Tank-Automotive Center is charged with research, development, procurement, quality assurance, industrial mobilization planning, cataloging and standardization, maintenance engineering and field assistance, and integrated materiel inventory management of the Army's tactical and general-purpose vehicles and their components. The Center conducts or monitors research and development in vehicular design, suspension, power plants and auxiliary equipment, and environment. Most research, development, and engineering is conducted in conjunction with other Government agencies or is performed by industry under contract. Mathematical models and high-speed computer techniques are used to determine optimum vehicular design and to predict performance characteristics.

Contact:

Mr. Raymond K. Braman, Maintenance Directorate
U. S. Army Mobility Command
Tank-Automotive Center
Warren, Michigan 48090
Attention: SMOTA-M (NMP)

3.3.7 AMC, Army Munitions Command

Technical Coverage: Information on nuclear and non-nuclear projectiles, rocket and missile warheads, mechanical fuze timers, mines, mine fuzing, pyrotechnics, propellant-actuated devices, toxic chemical munitions, flame weapon systems, and incendiary devices. Studies are also conducted in numerical analysis, mathematical statistics, probability, and operations-research methodology.

Mission and Description: The mission of the Command includes design and development; product, production, and maintenance engineering; procurement, production, and industrial mobilization planning; cataloging and standardization; wholesale inventory management, stock control, and supply control; new equipment training, development of related military occupation specialty information, and design of pertinent training devices; and providing technical assistance.

Status: The Command's special functions include operation of the U. S. Army Metrology and Calibration Center for controlling all Army operations pertaining to common-type test and measuring equipment; operation of the Department of Defense Plastics Technical Evaluation Center for collection, maintenance, and exchange of data on plastic materials of military interest; operation of the U. S. Army Explosives Ordnance Disposal Center for the development and control of explosives-ordnance disposal procedures for all Army munitions; and control of the disposal of radioactive material within the Army.

Picatinny Arsenal is the Army Munitions Command's commodity center for nuclear munitions and is the research and engineering center for conventional ammunition. Of the Arsenal's total research and development activity, approximately 45 percent is conducted at the Arsenal, 20 percent by other Government agencies, and 35 percent by private industry.

The Feltman Research Laboratories, located at the Arsenal, conduct basic and applied research in the physical and engineering sciences as they relate to explosives, pyrotechnics, propellants, packaging, and materials.

Edgewood Arsenal is the Army Munitions Command's commodity center for chemical and biological materiel. Its in-house research and development projects are supplemented by an approximately equal number of grants and contracts. The scientific activities of the agency are conducted or sponsored by the Army Chemical Research and Development Laboratories and the Army Biological Laboratories.

Frankford Arsenal is the Army Munitions Command's commodity center for small-caliber munitions and propellant-actuated devices. Its responsibilities include the development, engineering, and procurement of small-caliber munitions; propellant-actuated devices; artillery ammunition components, such as cartridge cases, projectiles, and mechanical time fuzes; and fire-control systems in support of the U. S. Army Weapons Command. Frankford Arsenal also performs research in

metallurgy, optics, surface finishes, corrosion prevention, lubricants, material degradation, and technology pertinent to the miniaturization of ammunition.

Contact:

Commanding General
U. S. Army Munitions Command
Picatinny Arsenal
Dover, New Jersey 07801
Attention: TIS-Weapons Data Index

3.3.8 PLASTEC, Plastics Technical Evaluation Center

Technical Coverage: Plastic materials, with emphasis on plastics in a structural weapons systems, electrical and electronic applications, packaging, and mechanical devices.

Mission and Description: To collect, exchange, collate, develop, and evaluate technical data on plastic materials of interest to the Department of Defense. Distribute these data and evaluations to DoD activities, their designees, or other organizations with demonstrable defense-supporting interests upon request. Render technical advice and assistance on plastics to DoD activities upon request.

Status: Files of research and development projects in plastics are maintained, together with the names of personnel involved. Less than 10 percent of the information in the Center's collections is classified. Technical advice and assistance is rendered to all Department of Defense activities. Special reports are prepared on request, bibliographies are compiled, and the information supplied is carefully evaluated. The Center issues two series of publications: PLASTEC Reports, which are formal state-of-the-art surveys, directories, guides, and data sheet compilations; and PLASTEC Notes, consisting of informal memorandums.

Contact:

Mr. Harry E. Pebly, Jr., Chief
Plastics Technical Evaluation Center
Picatinny Arsenal
Dover, New Jersey 07801
Attention: SMUPA-VP3
Telephone: (201) 328-4222

3.3.9 ATEC, Army Test and Evaluation Command

Technical Coverage: Testing capabilities as noted below. Test data are not maintained in a bank, but become the property of the developing command for which the test was conducted.

Mission and Description: Engineering design and production tests are performed for Army commodity commands. Check tests, confirmatory tests, evaluations surveillance tests, and renovation tests are conducted as required. The Command also conducts and participates in troop tests under field conditions to determine the suitability of weapons, equipment, clothing, and other materiel for Army-wide use.

Seventeen test boards, proving grounds, and other field installations are under the jurisdiction of the Test and Evaluation Command. This includes six test boards, nine proving grounds and environmental centers, the White Sands Missile Range, the General Equipment Test Activity, the Engineer Test Unit, and the Research and Engineering Field Evaluation Agency.

Test capabilities and areas of technical content are as follows:

- Airborne, Electronics, and Special Warfare: Airborne equipment; aircraft for air drop and transport of troops, supplies, and equipment; field army communications equipment, including power supplies, shelters, and security equipment; field army surveillance systems; special warfare equipment.
- Armor Board: Armored weapons, automotive and engineer materiel and associated equipment; radiation-detection instruments.
- Artillery Board: Field artillery weapons and equipment for firepower, target acquisition, control, and ground mobility.
- Aviation Board: Aircraft and allied Army aviation equipment; avionics equipment for field army use.
- Infantry Board: Infantry equipment and associated items; clothing and rations for individuals; antipersonnel mines and related equipment; clothing for parachutists; hand-held and crew-served weapons; chemical and biological warfare equipment.
- General Equipment Test Activity: Nontactical surface transportation vehicles; transportation for difficult environments; quartermaster-type materiel and other equipment for general Army use.
- Aberdeen Proving Ground: Army weapons and weapons systems; ammunition and ammunition components; combat and other automotive vehicles; materiel test procedures and methods; ballistic instrumentation; foreign materiel.
- Dugway Proving Ground: Agents, munitions, and protective equipment for chemical, biological, and radiological warfare; physical, chemical, and biological properties of such agents; collection and diffusion of gaseous, aerosol, and particulate materials; meteorology; ecology; epidemiology.
- Electronics Proving Ground: Avionics, electronic equipment for signal communication, combat surveillance, meteorological observations, automatic data processing, and electronic warfare.
- Erie Proving Ground: Artillery weapons; combat vehicle weapons; field weapons systems.
- Jefferson Proving Ground: Ammunition, munition components, projectiles, propellants, cartridge cases, primers, fuzes, mines, grenades.

- Yuma Proving Ground: Aerodynamics (retardation devices, flow phenomena, stability), controlled-impact test facilities and techniques, air delivery equipment, packaging for air delivery, geodetic survey materiel, weapons and ammunition.
- Arctic Test Center: Arctic and subarctic environmental testing procedures and techniques.
- Tropic Test Center: Tropical research and testing (techniques, equipment, instrumentation), tropical deterioration, exposure testing, storage and packaging of chemicals, storage of toxic gases, soil slope surveys.
- Yuma Proving Ground: Desert environmental testing techniques; protective coatings and packaging.
- White Sands Missile Range: Rocket engineering tests; guided missile systems; aerial weapon interceptor systems; electronic and optical tracking stations and equipment.

Status: Most test and evaluation Command installations are concerned solely with the testing of various types of materiel. A few conduct research in methodology and in subjects related to their testing and evaluation activities. Inquiries regarding such research should be directed to the Commanding Officer at the installation conducting the research.

The principal type of publication issued by the Test and Evaluation Command is the test report. Test reports may take several forms:

(1) Formal Test Reports are issued upon the completion of the testing or evaluation of an item or at the completion of a major phase of a test. This is the only type of report issued by the Command that receives wide distribution.

(2) Equipment Failure Reports provide a rapid means of disseminating information concerning individual failures discovered in equipment undergoing test.

(3) Firing Reports are detailed data records on a round-by-round performance during a firing program.

(4) Interim Reports are information or progress reports prepared as a result of significant testing incidents, actions, or period of testing. Pertinent sections of both Firing Reports and Interim Reports will be included in the Formal Test Report when a project has been completed.

(5) Letter Reports are concise reports providing for quick, official communication of test results without the delay of formal publication.

The six Test Boards of the Test and Evaluation Command issue between 500 and 1,000 test reports each year. The percentage of such reports bearing a security classification differs greatly from Board to Board. Some test activities, for

instance, issue few classified test reports, whereas half the test reports of the Infantry Board bear a security classification. The Command's other testing centers issue approximately 1,000 test reports annually. The range of percentage of classified reports is also large.

The Dugway Proving Ground publishes proceedings of symposia held at the installation, and the staff of the Proving Ground prepares occasional articles for publication in scientific and technical journals.

Contact:

Mr. G. A. Gustafson, Acting Chief
Testing Analysis & Operations Office
U. S. Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland 21005
Attention: AMSTE-TA-A

3.3.10 ACRREL, Army Cold Regions Research and Engineering Laboratory

Technical Coverage:

- Basic and Applied Research: Physical, mechanical, and structural properties, and behavior of snow, ice, and frozen ground; geology, geophysics, geography, and meteorology as related to cold-regions research; cold-regions environments and technology; cold-regions atmospheric physics; effects of explosives; cold-room research.
- Experimental Engineering: Civil, mechanical, and other branches of engineering as related to cold-regions research; tunneling, drilling, and excavations; mechanics of ice; snow and ice control and removal; snow structures; trafficable surfaces; subsurface explorations; foundation engineering.
- Military Construction: Structures, pavements, and utilities in permafrost and seasonal frost areas; construction criteria for cold-regions application; wintertime construction techniques; frost protection for structures; frozen-ground engineering; dynamic properties and creep of frozen soils; heat transfer; effects of soil freezing and thawing; additives for reducing frost susceptibility of soils; cold-regions materials.
- Photographic Interpretation: Basic matter/energy relationships; atmospheric transmission; image recording and processing; development of methods and techniques of image analysis; definitions of limitations; determination of reliability; determination of application of methods and systems to problems in engineering, earth, and military sciences, as in guerrilla detection in tropical forests and other environments; detection of radioactive contamination of vegetation; detection of submarines and crevasses; sea-ice sensing.

Mission and Description: To conduct research and engineering investigations of snow, ice, and frozen ground for the purpose of supporting and improving U. S. military capabilities in the cold regions. The program is carried out by the four technical divisions described below:

- The Research Division, consisting of an Environmental Research Branch and a Materials Research Branch, is responsible for the Laboratory's basic research in the physical and mechanical properties of snow, ice, and frozen ground and their relationship to climatic and meteorological phenomena in polar environments.
- The Experimental Engineering Division conducts research, development, and investigations; provides consultations and specialized assistance to improve military systems, construction, and operations. The Division is made up of two branches: the Applied Research Branch and the Construction Engineering Branch.
- The Photographic Interpretation Research Division performs research in methods and techniques of using various energy forms to obtain information about surface and subsurface features in all environments.
- The Technical Services Division provides technical support and specialized consulting services, conducts instrumentation research, and manages the publication, information, and liaison services. The Division consists of the Measurements Systems Research Branch and the Liaison and Technical Publications Branch.

Status: The Cold Regions Research and Engineering Laboratory and its predecessor organizations have issued between 400 and 500 scientific and technical publications since 1945. Basic lists of these publications are available to qualified requestors. About 15 percent of these publications represent the work of contractors. All contractors' reports, however, are prepared for publication by the Laboratory and issued in one of the agency's three report series:

- Research Reports are either theoretical studies or reports of laboratory or field investigations. About 20 are issued each year, of which 10 percent bear a security classification.
- Technical Reports are generally engineering-type reports, covering field or laboratory work of an engineering nature. About 20 are prepared each year, all of them unclassified.
- Special Reports are prepared principally for record purposes and usually cover portions of an investigation that will be reported more fully in one of the other two report series. About five are issued each year, approximately 40 percent of which are classified.

- Cold Regions Science and Engineering Series consists of monographs summarizing existing knowledge and providing references for professional engineers responsible for design or construction in the cold regions.

About one-half of all reports issued by the Cold Regions Research and Engineering Laboratory appear eventually in condensed form as articles in scientific and technical journals.

Contact:

Colonel Dimitri A. Kellogg, Director
U. S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755
Attention: AMXCR-TL

3.3.11 AHEL, Army Human Engineering Laboratories

Technical Coverage: Scientific and technical information in the two areas of research noted below:

- Systems Research: Human-factors engineering analyses of military vehicles, missile and weapons systems, munitions, communications, and electronic systems and devices; systems concept evaluation and feasibility studies; prototype development; training and personnel selection for operation and maintenance of military systems.
- Supporting Research: Man-machine interactions; sensory perceptual aspects of fire-control systems; physical, psychological, and psychophysiological capabilities and limitations of human operators in man-machine complexes; experimental physchology; human output in military tasks (speed, quality, quantity); environmental aspects of human operation of military systems; human-factors engineering aspects of normal and unusual military situations and environments; psychological and physiological effects of blast and noise.

Mission and Description: To provide assistance to the Army Materiel Command in resolving human-factors engineering problems, so that the operation and maintenance of Army materiel will conform to the capabilities and limitations of the soldier. In addition to performing the required research, the agency gives courses in human-factors engineering for personnel of other Army agencies, describing research areas, research methodology, and the contributions made by human-factors engineering to the efficient operation and maintenance of weapons systems and devices.

Status: The Systems Research Laboratory conducts applied research on human factors affecting the performance of current and future Army systems and devices, for the purpose of attaining ease of operation and maintenance and minimizing the time required for operation and maintenance training. The Laboratory has three

branches, each of which is concerned with design man-machine relationships as they affect the operation and maintenance of materiel for which the Army Materiel Command has development responsibility. Systems research is usually initiated at the concept-evaluation or feasibility-study stage of item development and generally ends after the development prototype is evaluated. However, each branch maintains liaison with the appropriate commodity command to ensure the orderly application of human-factors engineering principles throughout the subsequent production, procurement, test, evaluation, and user supply phases of the systems and devices.

The Supporting Research Laboratory determines human-factors problem areas and conducts fundamental research for their solution in three of its branches. The Laboratory's research in general man-machine interactions has as its objective the establishment of a body of knowledge delimiting man's psychophysiological capabilities in the use of military equipment and systems. The Fire Control Branch is concerned with human-factors engineering in fire-control systems and devices for simple hand-held weapons as well as for weapons with complex electronic control systems. The Applied Psychophysiology Branch determines the physical, psychophysiological, and psychological capabilities and limitations of the human operator in the man-machine complex and develops information about the speed, quality, and quantity of human output in military tasks. The Environmental Branch studies the effects of both normal and unusual situations and environments on the performance of personnel using military equipment.

The Engineering Research Laboratory provides photographic, instrumentation, and fabrication services to the other two laboratories. Its Acoustical Research Branch collects and analyzes noise and blast data and interprets the effects of these phenomena on Army personnel.

The Human Engineering Laboratory issues approximately 50 research reports each year, of which about 10 percent bear a security classification and 5 percent appear eventually as articles in professional journals or as chapters in books. Research reports are issued either as Technical Memorandums, which receive a wide distribution, or as Technical Notes, which are seldom distributed outside the agency. In addition, a cumulative listing of reports, **MILESTONES, A DIRECTORY OF HUMAN ENGINEERING LABORATORIES PUBLICATIONS**, is published annually.

Contact:

Commanding Officer
U. S. Army Human Engineering Laboratories
Aberdeen Proving Ground, Maryland 21005

3.3.12 ACCL, Army Coating and Chemical Laboratory

Technical Coverage: Chemical cleaning and corrosion; paint, varnish, and lacquer; automotive chemicals, fuels, and lubricants.

Mission and Description: The Laboratory is the primary Army facility for research, development, and evaluation of protective coating, cleaners, fuels and lubricants, and chemicals for automotive use. Its facilities include infrared and ultraviolet spectrophotometers, gas-chromatography equipment, light-scattering instruments, low-temperature cabinets, humidity and salt-spray cabinets, accelerated weather machines, and an exposure site with a 1,000-to-10,000-panel capacity. It provides chemical services to elements of the Army Materiel Command and consultation services to other military agencies in its fields of specialization.

Research conducted by the Coating and Chemical Laboratory is devoted almost exclusively to applied research in the materials field, all but a small part of which is unclassified. Contracts, accounting for approximately 45 percent of the Laboratory's research effort, are placed with universities in direct support of the in-house program or to perform tasks that cannot be accomplished in the Laboratory.

Status: A prime objective of the Laboratory's research and testing is to provide the Army with procurement documents (specifications, standards, and handbooks). It prepares, revises, or amends an average of 25 such documents each year and is the Army agency responsible for revisions of Federal Test Method Standard 141 on paints, varnishes, lacquers, and related materials and Federal Test Method Standard 791 on lubricants, liquid fuels, and related products. Its testing, evaluation, and proofing activities include a continuing project in qualification testing that has established close to 50 Qualified Products Lists for use as sources of qualified materials by the Army, its contractors, and other procurement agencies.

An average of three patent disclosures per year are prepared by the Laboratory on patentable materials or processes, including such items as paint-stripping composition, solvent carbon looseners, a stop-leak composition, and a process for inhibiting corrosion of cooling systems. About two out of every three patent disclosures are eventually approved and issued as patents by the U. S. Patent Office.

Between 30 and 35 technical reports are issued each year by the Laboratory, reporting results of its research and development activities. Contractors produce one or two technical reports per year. Less than five percent of all Coating and Chemical Laboratory reports bear a security classification.

About one-third of the Laboratory's technical reports serve as the basis for articles that appear in scientific and technical journals.

Contact:

Technical Director
U. S. Army Coating and Chemical Laboratory
Aberdeen Proving Ground, Maryland 21005

3.3.13 ANL, Army Natick Laboratories

Technical Coverage: A data bank is not maintained. However, technical information is available in the specialized areas listed under Status.

Mission and Description: To conduct research and development in the physical, life, and earth sciences and in engineering to meet military requirements in assigned areas. Assigned development areas include air-drop equipment; body armor, clothing, footwear and headgear, organic materials, and textiles; containers; food and food service equipment; field support equipment, including printing and composing equipment; fungicides and insecticides; materials-handling equipment; petroleum, oils, and lubricants; handling and dispensing equipment; and tentage and equipage.

Research in physical and biological sciences, in environmental phenomena, and in human factors to be considered in development is conducted by the research elements. Technological research leading to the development of end items is conducted by the product divisions. Research and development are integrated in the sense that research sets up many of the criteria for the design of materiel and also serves development by seeking solutions to "bottleneck" problems, many of which represent knowledge gaps that must be bridged before developmental progress can be resumed.

Status: Technical information is generated in the areas listed below.

- Materials: Camouflage materials; clothing materials; materials for use in armor; polymeric materials, including films, foams, and structural plastics; protective finishes applicable to clothing; containers, metal items; and paper-based materials.
- Technologies: Food technology, textile technology, fuel-handling technology, applied microbiology (insecticides and fungicides), packaging technology, rubber technology, radiation preservation technology.
- Engineering: Mechanical systems and devices for transporting petroleum, oils, and lubricants, general supplies, and general support equipment; individual load-carrying equipment; space heating equipment; laundries; printing and reproduction equipment; manufacturing processes for food, clothing, tentage, and mechanical equipment.
- Basic and Applied Research: Food deterioration and measures for preventing it; protection problems related to insects; human factors involved in the man-machine-environment complex characterizing modern military operations; problems relating to energy absorption, transfer, and storage; studies on the properties, behavior, and modification of materials; novel concepts for implementing military systems; engineering research on processes; and radiation preservation of food.

The work of the Natick Laboratories is described in formal reports on progress, in one-time reports on special problems and their solutions, in technical journal articles, in general magazine articles, and in news releases.

Contact:

Mr. Dale H. Sieling, Scientific Director
U. S. Army Natick Laboratories
Natick, Massachusetts
Attention: AMXRES-Q

3.3.14 HDL, Harry Diamond Laboratories

Technical Coverage: Systems research in fuzing, ranging, guidance, and detection; instrumentation, measurement, and simulation; electronic and electrical components; nuclear weapons effects; and basic research in electromagnetic properties of plasma, nonlinear circuits, and lasers.

Mission and Description: To conduct research and development in the physical and engineering sciences to meet Army requirements for fuzes and other ordnance specialities, with emphasis on electronic and electrical devices. The Laboratories provide consulting and engineering services in these areas, fabricate models and prototypes, and conduct development tests, including destructive testing of prototypes. About 30 percent of the work is performed under contract by outside organizations.

In addition to work on fuzes, which includes the development, maintenance engineering, and prototype production of proximity fuzes, time fuzes, command fuzes, and other types of fuzes, the research and development effort of the agency is concentrated in the general areas noted under Technical Coverage.

Status: The Harry Diamond Laboratories issues a total of about 110 technical documentary reports a year. About 30 percent of these bear a security classification. There are three report series:

- Technical Reports present results of research and development projects. They are prepared at the conclusion of a project or whenever a significant amount of information has been developed. Approximately 100 Technical Reports are produced each year, of which 15 percent appear eventually as articles in technical journals or the trade press.
- Notes on Development Type Material are limited to descriptions of the military, physical, or operating characteristics of items developed in the laboratory. An average of three titles are issued annually.
- Technical Progress Reports present periodic summaries of the agency's research and development projects. Four or five are prepared each year for higher authority or for sponsors of projects. They are not widely distributed outside the agency.

About 80 technical papers reporting the scientific and technical activities of the Harry Diamond Laboratories appear each year as articles in the trade press or scientific journals, or are presented orally at scientific meetings and symposia. Papers presented at meetings are usually published later as proceedings. The agency occasionally acts as host to symposia or sponsors symposia itself on such subjects as impact fuzes, microminiaturization, and fluid amplification.

Contact:

Director, Programs and Plans Office
Harry Diamond Laboratories
Connecticut Avenue & Van Ness Street, N. W.
Washington, D. C. 20315

An additional information service at the same location is the ADRES, Army Data Retrieval Engineering System Services.

Engineering data, such as standard and commercial drawings, specifications, standards, and package data sheets, can be automatically retrieved from ADRES. It contains more than 200,000 documents and is drawn on by 15 industry contractors and 60 in-house stations. The data come from in-house Army sources and are stored in microfilm cartridges. The output forms are either visual displays or hard copies.

The data are obtainable in approximately one week if they are in-house, or in three to four weeks if they must be compiled.

Contact:

Mr. W. C. Staymates, Section Chief
AMXDO-EDB (712)
Harry Diamond Laboratories
Connecticut Avenue & Van Ness Street, N. W.
Washington, D. C. 20315

3.3.15 ANDL, Army Nuclear Defense Laboratory

Technical Coverage: Nuclear radiation. residual radiation, shielding, radiological defense, and radiation effects.

Mission and Description: To conduct research and field experiments in the nuclear-weapons-effects areas of initial radiation, residual radiation and fallout, shielding, and thermal radiation phenomena; to provide technical information and assistance in the fields of radiological and nuclear defense and health physics; and to provide environmental monitoring and other radiological safety support. With the exception of projects carried out by contractors (about 20 percent), the Laboratory's research and testing projects are conducted in its facilities at Edgewood Arsenal, where it maintains and operates an accelerator, or at Government test sites.

Most of the research is directed toward the solution of problems of interest to all the Military Services. The balance of the program is devoted largely to research and testing aimed at solving problems in the nuclear-weapons-effects area unique to the Army. A small part of the Laboratory's effort is devoted to program support of the Atomic Energy Commission and the Office of Civil Defense and to maintaining effective relationships with other countries in areas of mutual interest under Mutual Data Exchange Agreements.

Status: The Evaluations Division correlates, evaluates, and interprets data resulting from experimental and theoretical studies in the field of nuclear weapons effects and radiological warfare, and determines the significance and applicability of research and development data to problems of military interest.

The Nuclear Chemistry Division conducts basic and applied research in nuclear radiation chemistry, radiochemistry, physical chemistry, and general chemistry to resolve problems in the fields of nuclear weapons effects, radiological warfare, and waste disposal.

The Nuclear Physics Division conducts experimental and theoretical research in the field of nuclear physics, with emphasis on the development of techniques for prediction, interpretation, and application of nuclear phenomena.

The Nuclear Testing Division plans and conducts field tests in nuclear-weapons effects, develops radiation measurement, waste disposal, and radiation protection techniques, and operates radiation facilities to support projects of the laboratory.

Results of in-house research performed by the Nuclear Defense Laboratory are reported in from 50 to 60 technical documents annually. There are three series of documents:

- Technical Reports are final reports of completed major tasks.
- Technical Memorandums are used for reporting uncompleted work or minor projects and receive a limited, special distribution.
- Special Publications are proceedings of symposia held at the Laboratory or compilations of information produced as a result of committee action.

Contact:

Mr. Luther M. Hardin, Chief
Evaluations Division
U. S. Army Nuclear Defense Laboratory
Edgewood Arsenal, Maryland 21010

3.3.16 Army Libraries, General

Each of the Army Laboratories described in the preceding sections maintains its own library of technical reports, books, journals, and periodicals of interest, including those published by the laboratory. Information regarding the availability of technical reports can be obtained directly from the laboratory concerned.

3.3.17 Defense Logistics Studies Information Exchange, Army Logistics Management Center

Bibliography Services:

The mission of the Defense Logistics Studies Information Exchange is to collect, store, and disseminate information about logistics and related material for the Department of Defense. The principal method for disseminating this information is an Annual Bibliography of Logistics Studies and Related Documents, published on 1 January, with supplements 1 April, 1 July, and 1 October.

These bibliographies comprise citations of completed, in-process, and planned logistics studies and related material. Most citations contain an abstract of the content of the study, and each publication is indexed.

The published bibliographies are distributed automatically to the military departments and other defense agencies that perform, or have responsibility for the supervision of, logistics research. Other Government agencies and Government-certified civilian organizations can obtain copies upon request to the Exchange.

The Bibliography contains more than 1,500 items in the logistics field, with distribution to more than 330 activities. Requests for information may be transmitted by correspondence or by telephone. The Exchange does not furnish or lend documents. The perpetual inventory of logistics studies will be made available at the Exchange to properly authorized personnel of the defense community.

Contact:

U. S. Army Logistics Management Center
Defense Logistics Studies Information Exchange
Fort Lee, Virginia 23801
Telephone: (703) 734-4392

(For Air Force and DSA Studies:
Mr. Robert W. Bryant)

(For DOD and Navy Studies:
Mr. William B. Whichard)

(For Army Studies:
Mr. Leon T. Scarbrough)

3.4 Department of Defense Sources

3.4.1 ARPA, Advanced Research Projects Agency

Technical Coverage: Ballistic missile radiation analysis, ballistic missile defense, seismic information and analysis, and remote-area conflict information.

Mission and Description: The Advanced Research Projects Agency (ARPA) is responsible for advanced research and development projects for the Department of Defense.

Major subject areas are research and engineering in nuclear-test detection, defense against ballistic missiles, remote-area conflicts, the behavioral sciences, and command and control. All sizable projects are conducted by contracts with industry, other Government agencies, or nonprofit institutions. The Research and Engineering Support Division of the Institute for Defense Analyses provides technical support to the Agency in all its areas of interest.

Objectives of each project are defined by the Advanced Research Projects Agency, but the contract is usually monitored by another Department of Defense component, such as the Office of Naval Research, the Army Materiel Command, or the Air Force Systems Command. Some contracts involving more than one service are handled through the Office of the Secretary of Defense and are monitored directly by the Advanced Research Projects Agency. When such a project has advanced to the stage where results require exploitation, or when the military application of a project answers a specific need, the project is generally turned over to one of the three Military Departments.

To maintain an efficient exchange of information in the performance of its interagency functions, the Advanced Research Projects Agency supports four centers for collecting, evaluating, and disseminating information in major research areas of interest to the Agency. Principal subject areas are defense against ballistic missiles, remote-area conflict, and seismic data analysis and techniques. In addition to reports and data generated by the Agency's own programs, sources of information include foreign literature, journals, monographs, news reports, patents, unprocessed data, and all reports produced under Government sponsorship in pertinent subject fields. Information is disseminated in the form of technical summaries, state-of-the-art reports, and special evaluation studies. Because of the sensitive, highly specialized nature of the information, it is made available

on a need-to-know basis only, to other military agencies, to certain nonmilitary Government agencies, and to research institutions engaged in similar research and development. The four information centers are operated under contract.

Status: The Advanced Research Projects Agency issues a technical journal reporting research and development in the field of defense against ballistic missiles -- Journal of Missile Defense Research. This quarterly journal, which began publication in October 1963, is classified SECRET, and its distribution is based on need-to-know Qualified Government agencies and contractors wishing to be placed on the primary distribution list should request application forms from the Technical Information Office, Advanced Research Projects Agency, Washington, D.C., 20301. Secondary distribution to qualified Government agencies and contractors is handled by the Defense Documentation Center.

Most other publications of the agency take the form of technical reports, including special studies and bibliographies, prepared by the agency's contractors. A large percentage of these bear a security classification and have a limited distribution. Technical reports are forwarded to the Defense Documentation Center. Unclassified reports and those suitable for wide distribution are released by the Center and sold to the public by the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia, 22151.

Contact:

Mr. Fred A. Koether
Advanced Research Projects Agency
Room 2B-263, The Pentagon
Washington, D. C., 20301
Telephone: (202) 697-8904

3.4.2 BDIAC, Battelle-DEFENDER Information Analysis Center

Technical Coverage: Ballistic missile defense, penetration aids, decoy technology, electromagnetics, electronic countermeasures, flight mechanics, vehicle dynamics, nuclear effects, and re-entry systems' vulnerability.

Mission and Description: Battelle-DEFENDER Information Analysis Center (BDIAC) is a center for the collection, review, and analysis of scientific and technical information resulting from, and pertinent to, the Advanced Research Projects Agency (ARPA), Project DEFENDER, a coordinated program of basic and applied research to provide the basis for possible systems of defense against ballistic missiles and other exoatmospheric weapons.

Project DEFENDER, which was established in 1958, is concerned with advanced research that stresses the exploration of radically new techniques and the study of novel system concepts in the area of ballistic missile defense.

The Center collects, processes, and analyzes information in all disciplines concerning research in defense against ballistic missiles; provides functional information system to monitor existing and proposed work; performs analyses and undertakes studies of critical system problems; prepares state-of-the-art reports, technical summaries, compendiums, and annotated accessions lists; and provides information services to the DoD ballistic missile defense community.

Status: Battelle scientists and engineers, at the request of ARPA, conduct technical studies in ballistic missile defense and penetration aids. On the basis of this continuing participation by Battelle specialists, technical consultation services are readily available to ARPA on pertinent subjects such as decoy technology, electromagnetics, electronic countermeasures, flight mechanics, vehicle dynamics, nuclear effects, and re-entry systems' vulnerability. Research reports, state-of-the-art reports, and topical reports are issued to ARPA and are available through the Defense Documentation Center.

BDIAC collects, analyzes, indexes, and stores the classified and unclassified scientific and technical reports produced by and for the Government in R&D projects pertinent to the Project DEFENDER. Special files based on detailed indexing have been developed to enable rapid access to information in the collection, and personal assistance is provided to cleared visitors to the Center in using the files and the report collection.

The Center prepares and issues a monthly annotated accession list of reports added to the system during the month and, on the request or approval of ARPA, issues other publications such as special bibliographies. BDIAC services do not include secondary distribution of reports.

BDIAC facilities are accessible to personnel of ARPA and other Government agencies. Visit clearances are to be directed to the Battelle Security Office. In addition, ARPA-approved Government contractors may have access to BDIAC. A visit clearance from the Security Office of the visitor's company, bearing the approval of the visitor's Contracting Officer, should be directed to the Battelle Security Office as early as possible in advance of the anticipated visit.

Contact:

Mr. Fred A. Koether
Advanced Research Projects Agency
Room 2B-263, The Pentagon
Washington, D. C., 20301
Telephone: (202) 697-8904

Performing organization:

Mr. Robert S. Kohn, Director
Battelle-DEFENDER Information Analysis Center
Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201
Telephone: (614) 299-3151, Ext. 2671

3.4.3 BAMIRAC, Ballistic Missile Radiation Analysis Center

Technical Coverage: Ballistic missile phenomena, with primary emphasis on optical radiation.

Mission and Status: To collect, process, and disseminate information on the theory and technology associated with ballistic missile phenomena that may be useful in the design of defense systems. To analyze and evaluate theoretical and experimental results from the radiation measurements programs, with primary emphasis on the optical radiation emanating during the launch, mid-course, and re-entry regimes of missile flight. To conduct semiannual AMRAC symposia and publish and distribute proceedings.

In addition to its data collection and dissemination activities, the Ballistic Missile Radiation Analysis Center at the University of Michigan conducts a semi-annual symposium on the subject of antimissile research. Technical information presented at this symposium is distributed promptly in the form of proceedings to a mailing list of several hundred addressees.

Contact:

Mr. Fred A. Keother
Advanced Research Projects Agency
Room 2B-263, The Pentagon
Washington, D. C., 20301
Telephone: (202) 697-8904

Performing organization:

Mr. D. J. Lovell, Director
Institute of Science and Technology
University of Michigan
P. O. Box 618
Ann Arbor, Michigan 48107
Telephone: (313) 483-0500, Ext. 349

3.4.4 DASA, Defense Atomic Support Agency

Technical Coverage: Nuclear-weapon-effects research testing and safety mechanisms; training and evaluations of test results.

Mission and Description: The Defense Atomic Support Agency (DASA) is staffed jointly by all three Services and by civilians. It was established in 1946 as the Armed Forces Special Weapons Project and was given its present designation in 1959. It is responsible for consolidated management and direction of the Department of Defense nuclear-weapon-effects and nuclear weapons test program, and for providing staff advice and assistance in these areas to the Secretary of Defense, the Joint Chiefs of Staff, and other DoD components, as appropriate.

The Defense Atomic Support Agency acts as the Department of Defense coordinating agency in carrying out nuclear-weapon-effects research. It is responsible for incorporating military requirements and effective safety mechanisms

into proposed nuclear weapons (the Atomic Energy Commission is responsible for the weapons' nuclear components). The Agency also supervises nuclear-weapon-effects tests for all three military Departments and compiles information on weapons effects resulting from tests and theoretical studies. It analyzes and evaluates this information and disseminates it to appropriate agencies for use in future weapon-effects programs and in the preparation of operational plans. Its responsibilities in the training program range from 1-day briefing courses, through specialized training for technical operation of nuclear weapon systems, to 2-year technical courses culminating in a graduate degree.

Status: Most of the activities of the Defense Atomic Support Agency are classified. Field and laboratory activities are conducted by three subordinate organizations. The testing and data-collection program are the responsibility of the DASA Weapons Test Division, located at Sandia Base, Albuquerque, New Mexico; the Agency's Field Command, also at Sandia, supervises the National Stockpile Sites. A second subordinate unit, Joint Task Force EIGHT, plans and conducts overseas nuclear tests in the event such tests are required. A third unit, the Armed Forces Radiobiology Research Institute, a nuclear reactor facility located at the National Naval Medical Center, Bethesda, Maryland, conducts advanced studies and research on the biomedical effects of radiation.

Most publications issued over the name of the Defense Atomic Support Agency have been prepared by other organizations. Most are classified. Technical reports suitable for wider distribution are forwarded to the Defense Documentation Center for secondary distribution. Unclassified reports suitable for public release are sold by the Clearinghouse for Federal Scientific and Technical Information.

Reports of nuclear weapons tests supervised or coordinate by the Defense Atomic Support Agency are published by the Atomic Energy Commission's Division of Technical Information Service Extension, Post Office Box 62, Oak Ridge, Tennessee, 37381, although they are generally prepared by the organization conducting the test. Unclassified weapon-test reports suitable for open publication are sold by the Clearinghouse for Federal Scientific and Technical Information.

Contact:

Director, Technical Information
Defense Atomic Support Agency
The Pentagon
Washington, D. C., 20301

3.4.5 DASA Data Center

Technical Coverage: Effect of nuclear explosions on electromagnetic propagation; effect of electromagnetic pulse on electrical and electronic material; air-blast field predictions; blast scaling; blast loading and response, blast simulation techniques; hardened instrumentation; ionospheric instrumentation; computer programs used in NWER studies.

Mission and Description: The Center was established in 1961 by DASA to serve as a central collection point and reference center for all technical information pertinent to the effects of nuclear explosions. Its services are available to all responsible agencies and individuals conducting scientific investigations into the nature of nuclear weapon effects and their implications for present and future military systems. The Center enables rapid access to data from a wide variety of sources; announces, through its own publications, projected data-collection programs, theoretical investigations, and experiments; frees other agencies from the responsibility for servicing requests for data; and forms a permanent archive of these data.

The DASA Data Center acquires information from many organizations engaged in research studies related to the NWER (Nuclear Weapons Effects Research) program. In addition to the collection of experimental data from past nuclear and non-nuclear test programs, the Center regularly receives weapons test and NWER reports generated by scientific groups under contract with DASA and other DoD and government agencies. The Division of Military Applications of the Atomic Energy Commission has authorized release of AEC reports to the Center, and these supplement the DoD report collection. Unclassified data from various foreign laboratories are also collected to aid in determining the nature of close-in and worldwide disturbances in the geophysical environment induced by nuclear detonations.

Status: The Center provides critical reviews of data and analyzes special technical problems for DASA/DoD. Guides to the available experimental data are prepared, with evaluations of the data and military system implications. Surveys of test facilities, summaries of special instrumentation developments, and state-of-the-art reviews are also prepared in response to the needs of qualified users.

Computer Program Library: The Center maintains and continuously updates a Computer Program Library of basic nuclear-weapon-effects computer programs and related documentation. The Center collects and evaluates certain programs that may be released to authorized users upon request. In cases where the programs are extremely large and complex or are still in development, the Library maintains basic information on the program but refers inquiries to the organizations developing the program. Program areas include EM blackout, geomagnetics, fluid dynamics, blast-wave propagation, and ionization. Information on new computer programs and advanced computer program work is regularly announced in Data Center publications.

In addition to direct contacts and communications with the scientific community, Data Center information is disseminated via formal publications. The majority of these documents are classified, and distribution is controlled by Headquarters, DASA.

The Bibliography is a bimonthly compendium of abstracts of recent pertinent reports and descriptions of data deposited at the Center. Subject and author indexes are periodically included.

The Review is a quarterly technical journal for articles concerning current NWER studies and related topics of interest to DASA and DoD. This publication, designed to provide informal communication between researchers, may include articles, letters, and memoranda classified S/RD.

Special Reports are prepared to disseminate detailed information of current interest. Typical examples of Special Reports are summaries of projected measurements prior to an experimental program and early evaluations of such programs, surveys of test facilities, instrumentation developments, advanced computer program work, and symposia and conference proceedings.

Special bibliographies, literature surveys, and special studies of an interim nature are published when requested or in anticipation of special needs, such as those of DASA working groups.

Contact:

Colonel J. D. Brown, USA
Defense Atomic Support Agency
The Pentagon
Washington, D. C., 20301
Telephone: (202) 697-4227

Performing organization:

Mr. Warren W. Chan, Manager
DASA Information & Analysis Center
TEMPO, General Electric Company
816 State Street
Santa Barbara, California 93102
Telephone: (805) 965-0551

3.4.6 WSEG, Weapons Systems Evaluation Group

Technical Coverage: Weapons systems evaluations and studies.

Mission and Description: The Weapons Systems Evaluation Group is composed largely of civilians from the Weapons System Evaluation Division of the Institute for Defense Analyses, the DoD-supported non-profit corporation, which also provides support to the Advanced Research Projects Agency. The Group analyzes and evaluates weapons systems under projected conditions of war and studies the influences of weapons systems on strategy, organization, and tactics. These services, most of which are classified, are performed for the Joint Chiefs of Staff and other Department of Defense offices concerned with operations analysis.

Status: Publications of the Weapons Systems Evaluation Group are largely special studies prepared for Department of Defense offices concerned with operations analysis. Most of these studies bear a security classification. A few unclassified studies are released for general distribution and sold to the public by the Clearinghouse for Federal Scientific and Technical Information.

Contact:

Director, Technical Information
Weapons Systems Evaluation Group
The Pentagon
Washington, D. C., 20301

3.4.7 DSA, Defense Supply Agency

Technical Coverage: Documentation in all areas of Department of Defense interest.

Mission and Description: The Defense Supply Agency (DSA), with headquarters at Cameron Station, Alexandria, Virginia, 22314, contributes to the technical information program through the issuing of publications related to the standardization and specification of Defense equipment and supplies and through its field activity, the Defense Documentation Center for Scientific and Technical Information. The scientific documentation activities of the Defense Documentation Center, which serves all three Military Departments and their contractors, are the most extensive of all the agencies in the Department of Defense.

Status: Most technical publications issued by the Defense Supply Agency -- with the exception of those originating in its field activity, the Defense Documentation Center -- represent the work of other DoD activities and research and development programs. They are related largely to the standardization of equipment and supplies. Many of these publications, like the following example, are sold by the Superintendent of Documents of the U. S. Government Printing Office:

Department of Defense Index of Specifications and Standards.
A consolidated edition of the Index of Military Specifications and Standards, issued separately by the three military Departments until July 1963; subscription price includes two parts in looseleaf form, with cumulative supplements ($15 per year, $5 additional for foreign mailing).

Contact:

Defense Documentation Center
Defense Supply Agency
Building 5, Cameron Station
Alexandria, Virginia 22314
Telephone (202) 698-1864

3.4.8 IAC, Information Analysis Center

Technical Coverage: Shock and vibration, chemical propulsion, counter-insurgency, hibernation, entomology, remote-area conflict.

Mission and Description: The Department of Defense supports a number of Centers for Analysis of Scientific and Technical Information -- more often referred to as Information Analysis Centers. Centers are operated by the

sponsoring military organizations or are contractor-operated under the management supervision of one of the Armed Services, in some cases with the support and participation of the other Services or Government agencies.

Each Information Analysis Center is responsible for specific subject matter. The subject area may be oriented to a single scientific or engineering discipline, to a military undertaking of special DoD interest, or to a specific large weapon system requiring an interdisciplinary approach.

Status: Annual reports, directories, and other formal publications of Department of Defense Information Analysis Centers receive secondary distribution by the Defense Documentation Center. Unclassified documents on which there are no distribution limitations are offered for sale by the Clearinghouse for Federal Scientific and Technical Information.

There are 21 centers for Information Analysis in operation. Those not described elsewhere in this document under the appropriate military branch are described below.

- The Shock and Vibration Information Center is operated by the Naval Research Laboratory, Washington, D. C. It specializes in information on environmental factors (shock, vibration, temperature, pressure, and radiation) as they affect new and developmental equipment of Government agencies and their contractors. Emphasis is on methods of mitigating or preventing adverse effects.
- The Chemical Propulsion Information Agency is a component of the Applied Physics Laboratory of Johns Hopkins University, Silver Spring, Maryland. Administered by the Bureau of Naval Weapons, it has the participation of the Army, Navy, Air Force, Advanced Research Projects Agency, and the National Aeronautics and Space Administration. It collects and disseminates information on all phases of chemical rocketry. It serves the entire rocket community and supplies the Interagency Chemical Rocket Propulsion Group with information in specific areas to aid managerial decisions and to minimize duplication in Government research and development.
- The Counterinsurgency Information Analysis Center was established in 1964 at the Special Operations Research Office of American University, Washington, D. C. Sponsored by the Army with the participation of the Advanced Research Projects Agency, it is under the management supervision of the Army Research Office. Its objective is a rapid-response system for the effective sorting and retrieval of raw data and completed studies on the social, psychological, and economic aspects of counterinsurgency and remote-area conflict.

- The Hibernation Information Exchange, sponsored by the Office of Naval Research Branch Office, Chicago, specializes in information on natural hibernation and on all related torpidities and dormancies in living creatures, including sleep and hypothermia. Its collections of books and data, both United States and foreign, are available for use by all recognized specialists.
- The Military Entomology Information Service, operated by the Armed Forces Pest Control Board under the management of the Army Medical Research and Development Command, is located at the Forest Glen (Maryland) section of the Walter Reed Army Medical Center. It maintains entomology information by geographic areas of active or probable military interest. Its services are made available to organizations and individuals whose fields of interest coincide with those of the Control Board.
- The Remote Area Conflict Information Center, also at Battelle Memorial Institute, Columbus, Ohio, is sponsored by the Advanced Research Projects Agency. It collects, stores, and disseminates information on remote-area conflict and counterinsurgency, with emphasis on the physical and engineering sciences. (The Counterinsurgency Information Analysis Center emphasizes the social, psychological, and economic aspects of the subject.)

Contact:

Director, Technical Information
Defense Information Analysis Center
The Pentagon
Washington, D. C., 20301

or submit inquiries directly to the Centers.

3.4.9 DDC, Defense Documentation Center

Technical Coverage: Documentation on scientific and technical information.

Mission and Description: The Defense Documentation Center for Scientific and Technical Information (DDC) is a field activity of the Defense Supply Agency of the Department of Defense. It makes available from one central depository thousands of research and development reports produced each year by U. S. military organizations and their contractors.

The Center is under the direction of a civilian Administrator and Deputy Administrator and employs about 500 civilian personnel. In addition to the headquarters Field Service office at Alexandria, Virginia, the agency maintains six Field Service offices located in areas of high concentration of Defense industry, which provide local liaison and services to Government agencies, contractors, and grantees.

The primary mission of the Defense Documentation Center is to provide the efficient interchange of military research and development information among defense and other U. S. Government agencies and their contractors and grantees. This is accomplished by: (1) receiving, storing, and announcing practically all reports, with the exception of Top Secret documents and a few reports in other highly sensitive areas, that formally record scientific and technical results of research, development, test, and evaluation activities conducted by the Department of Defense and its contractors; (2) providing timely release of these documents on request, without charge, to registered organizations; and (3) providing bibliographic services essential to the maximum use of the technical documents in its collections. At present, the Center services about 1-1/4 million requests annually from approximately 1,000 Army, 700 Navy, 2,000 Air Force, and 300 other Federal agencies, and about 2,000 military contractors and grantees. It also serves all agencies of the executive branch and their contractors and grantees, as authorized.

Status: Government and non-Government organizations that qualify for DDC services receive the Technical Abstract Bulletin twice each month and are entitled to request reports from the agency's collections that lie within their fields of interest and the security level of their work. DDC users may request bibliographies of reports in appropriate subject fields and may avail themselves of the special services provided by the Field Service offices whose addresses are given below.

Since DDC was created to serve the military, all components of the Department of Defense are entitled to its full services upon official request. Services are now extended to all Government agencies of the executive branch.

Prime contractors, subcontractors, potential contractors, and grantees participating in the research and development programs of the Government can be served only after application has been made to the sponsoring agency, and the sponsor has approved a Field-of-Interest Register (FOIR) and forwarded the FOIR to DDC. If the release of classified documents is involved, the contractor must execute a Facility Clearance Register to be authenticated by the cognizant security office. The sponsoring agency notifies DDC of changes in contract or security status as they occur. When requirements exceed authorized need-to-know, the contractor may request the sponsor to extend the Field-of-Interest Register.

DDC Field Service Offices. Engineers and scientists working on military research and development projects are invited to make use of the special assistance available at any of the DDC Field Service offices, conveniently located in U. S. defense-industry areas. Each of these offices maintains bibliographic data, including abstracts of DDC reports. Trained personnel furnish assistance in literature searches within visitors' approved fields of interest. Microfilm copies of DDC reports (including all current reports) are available for immediate review. Reader-printers enable readers to reproduce copies of desired pages while

reviewing microfilmed documents. Professional assistance is furnished on problems connected with DDC procedures and on the use of the Technical Abstract Bulletin, its indexes, and other reference aids issued by the agency. Telex lines provide rapid communication with DDC headquarters; all seven Field Service offices have access to the headquarters computer for bibliography searching. Representatives of the offices explain and interpret DDC service to new and potential users in their geographic areas.

Addresses and phone numbers of the Field Service offices are given below. The Headquarters Reference Service at Alexandria, Virginia, serves as a field office for the Washington, D. C., area.

New York Area:

DDC Field Service Office
346 Broadway, Room 801
New York, New York 10013
Telephone: (212) 962-5858

Huntsville Area:

Redstone Scientific Information Center
DDC Field Service Office
Building 4484, Room 230
Redstone Arsenal, Alabama 35808
Telephone: (208) 876-1027

Dayton Area:

DDC Field Service Office
Area B, Building 47
Wright-Patterson AFB, Ohio 45433
Telephone: (513) 253-7111, ext. 35212

San Francisco Area:

DDC Field Service Office
International Science Center
452 De Guigne Drive
Sunnyvale, California 94086
Telephone: (408) 245-4501

Los Angeles Area:

DDC Field Service Office
Los Angeles AF Station
AF Unit Post Office
Los Angeles, California 90045
Telephone: (213) 643-0236

Boston Area:

DDC Field Service Office
Building 1210
Laurence G. Hanscom Field
Bedford, Massachusetts 01730
Telephone: (617) 274-6100, ext. 2055

Washington Area:

DDC Field Service Office
Cameron Station
Alexandria, Virginia 22314
Telephone: (202) 698-1864

3.4.10 HEIAS, Human Engineering Information and Analysis Service

Technical Coverage: Human factors engineering and analysis.

Mission and Description: Document acquisition; abstracting and coding of documents; preparation of indexing or categorizing schemes; and dissemination of human factors information in the form of user products such as an annual annotated bibliography of the literature, special bibliographies covering specific topic areas, and critical reviews of topic areas.

Status: Brief answers to inquiries are provided on a consulting basis in the fields of coverage. The most common form of dissemination consists of annotated bibliographies. Data extractions are made from a library containing 28,000 documents on the subject, upon request.

Contact:

Mr. F. H. Wright
Army Research Office
Washington, D. C., 20315
Telephone: (202) 694-3513

Performing organization:

Dr. Paul G. Ronco, Director
Human Engineering Information & Analysis Service
Tufts University Systems Building
Medford, Massachusetts 02155
Telephone: (617) 776-2100, ext. 336

3.4.11 SVIC, Shock and Vibration Information Center

Technical Coverage: Mechanics, mechanical engineering, shock and vibration.

Mission and Status: To serve the Department of Defense, the National Aeronautics and Space Administration, and their contractors by the collection, correlation, and dissemination of needed information on the environmental factors of shock and vibration.

Contact:

Code 104
Office of Naval Research
Washington, D. C. 20360

Performing organization:

Dr. W. W. Mutch, Director
U. S. Naval Research Laboratory
Washington, D. C. 20390
Telephone: (202) 574-2220

3.4.12 The Pentagon Library

Library Services:

Libraries serving the three Military Departments of the Department of Defense are described under other sections of this document covering the scientific information available. There is no large central library under the jurisdiction of DoD Headquarters. The former War Department Library was consolidated in 1944 with several other military libraries in the Washington, D. C. area and renamed the Army Library. Located in the Pentagon, the Army Library serves Department of Defense Headquarters, the Army, and all other DoD components in the Pentagon, as well as the general public.

3.5 Atomic Energy Commission Sources

3.5.1 AEC Division of Technical Information

Technical Coverage: Nuclear science and related sciences

Mission and Description: The Division of Technical Information plans, directs, and operates a comprehensive nuclear technology information program to meet the needs of the Atomic Energy Commission, its contractors, other Government agencies, industry, and the world technical community. It establishes AEC standards, policies, and procedures for the reporting and dissemination of technical information developed through AEC research and development. Principal activities of the Division are divided between the Headquarters office and the Division of Technical Information Extension.

Status: Headquarters activities include management of AEC systems for exchanging, processing, controlling, and publishing technical information, as well as liaison with other Government technical information activities. A special publications program includes the preparation and publication of technical books, handbooks, monographs, periodic technical progress reviews, and proceedings of scientific meetings. An exhibits group is responsible for the planning and administration of an exhibits program to inform U.S. students, teachers, and the lay public of the fundamentals of nuclear technology and its applications. The exhibits group is also responsible for the preparation of educational booklets and brochures; for AEC participation in domestic exhibits sponsored by professional societies, industrial groups, and Government organizations; and for the management of technical information centers at foreign exhibitions and scientific conferences.

Contact:

Division of Technical Information
Headquarters, Atomic Energy Commission
Germantown, Maryland

3.5.2 AEC Division of Technical Information Extension

Technical Coverage: Nuclear research and development

Mission and Description: The Division of Technical Information Extension performs numerous publishing, cataloging, and reference functions, including the acquisition, organization, reproduction, and dissemination of technical information in support of AEC research and development, civilian application of weapons, and international cooperation activities.

Status: The principal guide to the unclassified world literature on atomic energy, Nuclear Science Abstracts, is prepared by DTIE, as are Abstracts of Classified Reports and Research and Development Abstracts. The Extension operates the AEC Reference Center and provides editorial and technical writing services to participants in the AEC technical information program. It also furnishes illustrative, photographic, and copy preparation services.

Complete details of AEC's technical information services will be found in TID-485 (4th Rev.), November 1962, Technical Information Services of the United States Atomic Energy Commission, available without charge from the Division of Technical Information Extension.

Contact:

Division of Technical Information Extension
P.O. Box 62
Oak Ridge, Tennessee 37831
Attention: DTIE Information

3.5.3 AEC Research and Development Divisions

Technical Coverage: See description by division under Status, below.

Mission and Description: To maximize the application of atomic energy to scientific and industrial progress by conducting and sponsoring basic research in nuclear science and in other related sciences and by developing the peaceful uses of atomic energy. Additional contributions to scientific and industrial progress are made by the AEC program for disseminating technical information and its programs for industrial participation, international cooperation, and education and training.

As the national defense and security demands, these divisions manufacture nuclear and thermonuclear weapons, including the production of fissionable material and other nuclear substances, and develop reactors for specific military applications. They also control the release of classified atomic energy information and render technical support to U. S. efforts toward achieving international control of atomic energy.

The divisions protect the public from potential atomic-energy hazards, exclusive of civilian defense aspects, through their licensing and regulatory activities, through research on the biological effects of radiation contributing to improved radiation protection standards, and through research into the characteristics and effects of radioactive fallout.

Status: The mission objectives are accomplished through research and development in the areas described below by the Divisions indicated.

The Division of Research conducts and sponsors research in areas of the physical sciences related to the atomic energy program, including physics, mathematics, chemistry, metallury, materials, and controlled thermonuclear reactions. Particular attention is given to the design and construction of complex equipment and special research facilities.

The Division of Biology and Medicine directs research in the fields of medicine, biology, and environmental studies related to the atomic energy program, including the biological applications of radioisotopes. It develops criteria for the design of civil defense construction and administers a program covering all phases of the development and testing of radiation detection instruments. In the Division's Civil Effects Test Program, neutron and gamma radiation from nuclear weapons is analyzed to correlate physical data on radiation doses with medical data collected by the Atomic Bomb Casualty Commission.

The Division of Isotopes Development encourages industrial production and distribution of radioisotopes. This Division also has a development program in high-intensity radiation, designed to increase U.S. knowledge of the interaction of radiation and matter, and a program on radioisotope source design. Studies in ionizing radiation include the productive use of radioactive wastes from an expanding nuclear-power economy.

The Division of Reactor Development is responsible for the development of nuclear reactor systems and associated chemical-processing and waste-disposal operations, including various types of reactors and reactor components for ship propulsion, military purposes, aeronautical and space missions, generation of electric power, and other civilian purposes.

The Division of Military Applications produces, tests, and stores nuclear weapons. Emphasis in research and development is on compact, immediately ready, and more rugged weapons for use in advanced weapon systems. Some laboratory effort is devoted to the detection of nuclear explosions underground and in outer space.

The Division of Peaceful Nuclear Explosives directs the program commonly known as Plowshare to develop peaceful uses for nuclear explosives. Peaceful applications under study include excavation, mining, water-resource development, oil recovery, and scientific research in physics, chemistry, and seismology.

The Division of Raw Materials is responsible for the discovery and extraction of ores yielding fissionable or potentially fissionable materials. Exploration is conducted in part through contractual arrangements with the U.S. Geological Survey, the Bureau of Mines, and private industry.

The Division of Production is responsible for the production of special nuclear materials, including the preparation of feed materials and the conduct of related process development.

The Division of Operational Safety develops and recommends policies, guides, and requirements for the protection of Government and AEC contractor personnel, the public, and property from hazards resulting from AEC operations, including industrial health, safety, fire protection, and radiation protection.

Contact:

Division of Technical Information
Headquarters, Atomic Energy Commission
Germantown, Maryland

3.5.4 AEC Data Centers

Technical Coverage: See description of individual centers under Status, below.

Mission and Description: The specialized information and data centers are supported either wholly or partially by the Atomic Energy Commission. Although these centers are operated primarily to serve the technical community in their respective fields of activity, many of their publications are available to the public. Inquiries regarding services or publications should be directed to the specific center of interest. General questions regarding AEC Information Centers or Services should be directed to U.S. Atomic Energy Commission.

Status: The following centers are in operation:

Nuclear Safety Information Center, Oak Ridge National Laboratory, P.O. Box Y, Oak Ridge, Tennessee. The Nuclear Safety Information Center was organized in 1963 to assist in coordinating the national effort in nuclear safety research and development. Initial activities were limited to six specific areas: (1) containment of nuclear facilities; (2) fission-product release, transport, and removal; (3) nuclear instrumentation, control, and safety systems; (4) radioactive effluent control, monitoring, movement, and dosage; (5) reactor transients, kinetics, and stability; and (6) meteorological considerations in nuclear safety. Services will include preparation of review reports and memoranda, interpretation and evaluation of information on specific subjects, and answering of technical inquiries.

Research Materials Information Center, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee. The Research Materials Information Center was organized in 1963 to serve as a clearinghouse for technical data (degree of purity, impurity atoms, crystalline form, etc.) on availability, characteris-

tics, uses, and methods of production of very pure materials used in solid-state research; organic compounds and pure radioactive isotopes are not included. No attempt is made to list materials available in regular, large-scale commercial production. The Center plans to issue periodic bulletins.

Radiation Shielding Information Center, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee. The Radiation Shielding Information Center was established in 1962 to assist in solving radiation problems related to reactors, nuclear weapons, and space. Initially the Center will provide information on shielding against radiation from reactors. The Center collects, evaluates, and disseminates shielding information by means of bibliographies, monographs, newsletters, and answers to inquiries. It plans to evaluate critically the various computer codes oriented toward shielding problems.

Reactor Physics Constants Center, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois. The Reactor Physics Constants Center was established in 1956 to gather and evaluate reactor-physics data and to publish a compilation of selected data. The Center covers physical data on reactor constants (nuclear-physics data pertinent to diffusion lengths, migration lengths, Fermi age, slowing-down constants, etc.). Services include special nonperiodic publications, newsletters, answers to technical inquiries, and technical evaluations, which compare theoretical and experimental results.

Reactor Cross Section Evaluation Group, Brookhaven National Laboratory, Upton, Long Island, N.Y. The Reactor Cross Section Evaluation Group, established in 1960, issues analyses and evaluations of reactor cross-section data based on all available information, published and unpublished. The Center covers thermal cross sections, resonance parameters, cross-section curves, and angular distributions for elements and isotopes. Services include special nonperiodic state-of-the-art reviews, correlations, and newsletters. The Center also answers technical inquiries and supplies information on available cross-section data on request.

Neutron Cross Section Compilation Group, Brookhaven National Laboratory, Upton, Long Island, N.Y. The Neutron Cross Section Compilation Group, operating since about 1954, gathers, reviews, and systematically files all obtainable data on the neutron cross sections of materials. A reference index is maintained for the convenience of users. Compilations of data are published at nonperiodic intervals.

Neutron Cross Sections, Lawrence Radiation Laboratory, University of California, Box 808, Livermore, California. The Lawrence Radiation Laboratory collects, collates, evaluates, interprets, and publishes experimental data on measurements of neutron cross sections for all reactions with neutron energies

between 0.001 and 15 Mev. Differential as well as integral cross sections for all isotopes are covered. Services include periodic publication of answers to technical questions, and technical consultant services to Government-sponsored activities.

Charged Particle Cross Section Information Center, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee. This Center collects and evaluates data on the nuclear cross section of charged particles, continuing the Los Alamos project, started in 1955, which culminated in the issuance of two reports on the light elements (LA 214 and LA 2424). LA 2424 is available from the Office of Technical Services, U.S. Department of Commerce, Washington, D.C., 20230, price $2.50. The field ranging from manganese to zinc will be presented in a forthcoming volume. The series will be completed throughout the periodic table, and material on the light elements will be brought up to date for new editions of the reports already published.

Nuclear Data Project, National Academy of Sciences-National Research Council, 2101 Constitution Avenue, Washington, D.C., 20418. The Nuclear Data Project, established in 1948, collects, evaluates, and publishes information on nuclear-energy levels (experimental), information in basic nuclear physics that cannot be organized by other nuclear classifications, and all data relating to nuclear structure. Specifically, it covers low-energy basic nuclear physics, nuclear masses, spins, levels, moments, half lives, decay schemes, reactions, and istopic abundances. Services include answers to technical inquiries and special non-periodic publications. Publications issued by the Project include two sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402: Nuclear Data Tables, 1960 (Parts 1-4, $7.00), and Radiations from Radioactive Atoms in Frequent Use, 1959 (55 cents); and two available from the National Academy of Sciences-National Research Council, Printing and Publication Office, Washington, D.C., 20418: Nuclear Theory Index Cards, 1962 ($6.00 the set) and Nuclear Data Sheets, 1962 ($20.00 on card stock, $17.00 on paper).

3.5.5 AEC Engineering Materials

Services:

Engineering materials, including specifications, bills of materials, design criteria, parts lists, photographs, and approximately 50,000 unclassified drawings relating to design, engineering, and construction phases of the atomic energy program are made available to AEC contractors and other qualified requesters. Engineering materials may describe anything from a small device to a complete reactor. Data associated with a particular piece of equipment, component, mechanism, or process are assembled into "packages." An Engineering Materials List (TID-4100) identifies, describes, and announces the availability of these materials, and looseleaf supplements are issued at irregular intervals. The

list and its supplements are distributed without charge to AEC contractors, organizations, and individuals that have a need for them by the Division of Technical Information Extension, Box 62, Oak Ridge, Tennessee.

Blueline prints may be purchased from Oak Ridge Reproduction Service, P.O. Box 363, Oak Ridge, Tennessee, at 6 cents per square foot. Photographically produced copies may be purchased from Cooper-Trent Incorporated, Wilson Boulevard, at Danville Street, Arlington 1, Virginia, and from Rapid Blue Print Company, 818 Santee Street, Los Angeles California.

3.6 National Aeronautics and Space Administration Sources

3.6.1 STAR, Scientific and Technical Aerospace Reports

Technical Coverage: Scientific and technical information on aerospace research and developments.

Mission and Description: NASA's two journals are Scientific and Technical Aerospace Reports (STAR) and International Aerospace Abstracts (published by AIAA with NASA support). These publications cover 34 subject fields in space science and technology. These subject fields, described below, are representative of the areas in which NASA makes information available to the scientific community.

AERODYNAMICS: Aerodynamics of bodies, combinations, internal flow in ducts, and turbomachinery; wings; rotors; control surfaces.

AIRCRAFT: Fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, specific types of complete aircraft (including ground-effects machines, STOL, and VTOL), flight tests, operating problems (including sonic boom), safety and safety devices, economics, stability and control.

AUXILIARY SYSTEMS: Fuel cells; energy-conversion cells; solar cells; auxiliary gas turbines; hydraulic, pneumatic, and electrical systems; actuators; inverters.

BIOSCIENCES: Aerospace medicine, exobiology, radiation effects on biological systems, protective clothing and equipment, physiological and psychological factors.

BIOTECHNOLOGY: Life support system, human engineering, crew training and evaluation, piloting.

CHEMISTRY: Chemical analysis and identification (including spectroscopy).

COMMUNICATIONS: Communications equipment and techniques, noise, radio and communications blackout, modulation telemetry, tracking radar and optical observation, wave propagation.

COMPUTERS: Computer operation and programming, data processing.

ELECTRONIC EQUIPMENT: Electronic test equipment and maintainability, component parts (including electron tubes, tunnel diodes, and transistors), integrated circuitry, microminiaturization.

ELECTRONICS: Circuit theory; feedback and control theory.

FACILITIES, RESEARCH AND SUPPORT: Airports, lunar and planetary bases and associated vehicles, ground-support systems, related logistics, simulators, test facilitiies (including rocket-engine test stands, shock tubes, and wind tunnels), test ranges, tracking stations.

FLUID MECHANICS: Boundary-layer flow, compressible flow, gas dynamics, hydrodynamics, and turbulence.

GEOPHYSICS: Aeronomy, upper- and lower-atmosphere studies, oceanography, cartography, geodesy.

INSTRUMENTATION AND PHOTOGRAPHY: Design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; telescopes and cameras.

MACHINE ELEMENTS AND PROCESSES: Bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; reliability; drafting; materials fabrication, handling, and inspection.

MASERS: Application of masers and lasers.

MATERIALS, METALLIC: Cermets, corrosion, physical and mechanical properties of materials, metallurgy, applications in structures.

MATERIALS, NONMETALLIC: Corrosion, physical and mechanical properties of materials (including plastics), elastomers, hydraulic fluids.

MATHEMATICS: Calculation methods and theory, numerical analysis.

METEOROLOGY: Climatology, weather forecasting, visibility studies.

NAVIGATION: Guidance, autopilots, star and planet tracking, inertial platforms, air-traffic control.

NUCLEAR ENGINEERING: Nuclear reactors and nuclear heat sources used for propulsion and auxiliary power.

PHYSICS, GENERAL: Acoustics, cryogenics, mechanics, optics.

PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR.

PHYSICS, PLASMA: Magnetohydrodynamics.

PHYSICS, SOLID-STATE: Semiconductor theory, superconductivity.

PROPELLANTS: Fuels, igniters, oxidizers.

PROPULSION SYSTEMS: Air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion systems.

SPACE RADIATION: Cosmic radiation, solar flares, solar radiation, Van Allen radiation belts.

SPACE SCIENCES: Astronomy and astrophysics, cosmology, lunar and planetary flight and exploration, theoretical analysis of orbit and trajectory.

SPACE VEHICLES: Launch vehicles, manned space capsules, clustered and multistage rockets, satellites, sounding rockets and probes, operating problems.

STRUCTURAL MECHANICS: Structural element design and weight analysis, fatigue, thermal stress, impact phenomena, vibration, flutter, inflatable structures, structural tests.

THERMODYNAMICS AND COMBUSTION: Ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; combustion theory.

GENERAL: Subjects related to industrial applications and technology and to basic research; defense aspects; law and related legal matters; legislative hearings and documents.

Status: Scientific and Technical Aerospace Reports are devoted to unclassified report literature on the science and technology of aeronautics and space. Abstracts are arranged by the 34 major subject areas. Each issue is indexed by subject, corporate source, author, report number, and NASA accession number. NASA and NASA-contractor reports are included, together with reports of other Government agencies, universities, and research organizations in the U.S. and abroad. Foreign-language reports and English translations issued in report form are also included. Journal articles prepared by NASA and NASA contractors are announced and indexed for reference purposes.

A classified counterpart (CSTAR), issued semi-monthly, abstracts and indexes classified reports. It receives a very limited distribution.

Unclassified Scientific and Technical Aerospace Reports are sold by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402 ($33 a year; $39 for foreign mailing, $2.25 per single issue, $2.50 for foreign mailing). Indexes are issued quarterly and sold on an annual subscription basis ($30 a year; $35 for foreign mailing). The fourth quarterly volume is a cumulative index for the entire year.

International Aerospace Abstracts is a companion publication to STAR, sponsored by NASA and published twice a month by the Institute of Aeronautics and Astronautics. It covers books, periodicals, conference proceedings, and other "published" media in aeronautics and space science and technology. Coverage is worldwide and includes works in original languages and in translation. The subject headings and the indexing systems used in this publication are identical to those used in STAR. Abstracts are arranged by 34 major subject headings and indexed by subject, author, corporate source, publication number when applicable, and NASA accession number.

NASA's Scientific and Technical Information Facility is operated under contract by Documentation, Inc. It was established to acquire, organize, process, and report worldwide space information and to accomplish high-speed retrieval and dissemination of this information.

The Facility automatically receives and catalogs significant scientific and technical documents that result from NASA, or NASA-supported, investigations. It also receives documents obtained through interagency agreements and NASA exchange agreements with domestic and foreign organizations (150 organizations in 40 countries). Items of value are promptly abstracted, indexed, and entered into the announcement and searching systems.

To provide for subsequent retrieval of the abstracts and the information that they describe, all documents selected for the collection are indexed in depth. A printed index is prepared as part of the abstract journal, Scientific and Technical Aerospace Reports (STAR), to permit retrieval of the information on a broadly decentralized basis. The Facility also compiles the indexes for International Aerospace Abstracts.

At the same time, magnetic tapes are prepared to permit computer-based retrieval at the Facility and at field locations. NASA centers and contractors having the necessary computer facilities are supplied with tapes containing indexes for both abstract journals so that they may perform their own literature searches. In the printed index, documents are analyzed to determine four or five significant index points; with the computer tape index, the index entries number about 15 to 20 for each document.

The Facility is responsible for announcing new publications in STAR and its classified conterpart, CSTAR; filling document requests from qualified requesters; maintaining document distribution records; and serving generally as a comprehensive document processing, sotrage, and reference center for scientific information of interest in NASA programs. The Facility also produces such NASA-generated information products as microfilm reproductions, special bibliographies prepared by computer on request, NASA Tech Briefs, declassification lists, and other lists and indexes to meet NASA's documentation needs.

NASA also supports as part of its documentation program developmental studies of new techniques in information technology to improve the efficiency and economy of its information system.

Contact:

Scientific and Technical Information Division
National Aeronautics and Space Administration
Washington, D.C. 20546
Attention: Code ATSD

3.6.2 NASA, Field Data Sources

Technical Coverage: Scientific and technical information in the aerospace field.

Mission and Description: The planning and direction of NASA programs are vested in Headquarters. However, field centers and installations are responsible for execution and administration of these programs, primarily through research, development, and manufacturing contracts. These centers can be contacted directly for technical data and information.

The Ames Research Center, Moffett Field, California, directs basic and applied research in the physical and life sciences relating to the advancement of aeronautics and space technology. Space research includes aerodynamics of space vehicles, space-environment physics, space-vehicle flight control, and such life sciences as exobiology (investigations of extraterrestrial life), environmental biology, and biotechnology using bio-satellites. Aeronautical research embraces subsonic and supersonic aircraft.

The Electronics Research Center, Cambridge, Mass., is responsible for research in the fundamentals and applications of electronics to guidance, control, navigation, instrumentation, data processing, communications, and tracking as they relate to manned and unmanned aeronautical and space flight.

The Flight Research Center, Edwards Air Force Base, California, makes flight evaluation tests of research aircraft such as the X-15 and conducts research on supersonic flight.

The George C. Marshall Space Flight Center, Huntsville, Ala., is concerned with research and development of launch vehicles used in launching manned and unamanned spacecraft and associated guidance and control systems.

The Goddard Space Flight Center, Greenbelt, Md., specializes in space research with unmanned satellites, research and development of meteorological and communications satellites, and tracking and data-acquisition operations.

The Jet Propulsion Laboratory, Pasadena, California, operated under contract by the California Institute of Technology, develops spacecraft for unmanned lunar and planetary space exploration, operates a worldwide deep-space tracking and control network, and carries on a broad-scale program of supporting research, both fundamental and directed.

The John F. Kennedy Space Center, Cocoa Beach, Florida, plans, constructs, and operates NASA facilities and equipment for major launchings and provides or arranges for supporting services and activities. It is responsible for assembling and launching Apollo-Saturn spacecraft for the manned lunar landing and subsequent programs and for other facets of these programs, including elements of vehicle design and use.

The Langley Research Center, Hampton, Virginia, directs research in aeronautical and space structures and materials, in aerodynamics and re-entry vehicles, and in plasma physics.

The Lewis Research Center, Cleveland, Ohio, is responsible for research in propulsion and power plants for space vehicles, including nuclear and electrical propulsion devices.

The Manned Spacecraft Center, Houston, Texas, has management responsibility for developing and operating manned space vehicles. It serves as the test center for all spacecraft, subsystems, and assemblies required in manned space flight. It also devises and conducts the astronaut training program.

The Michoud Plant, Michoud, Lousiana, houses the manufacturing operations for Saturn and other large boosters and vehicle stages. From Michoud, Saturn vehicles are transported by barge to the nearby Mississippi Test Operations installation for static tests and then by sea to Cocoa Beach, Florida, for launching.

Mississippi Test Operations, Bay St. Louis, Mississippi, serves as static test site for Saturn and other large launch vehicles.

The Nuclear Rocket Development Station, Jackass Flats, Nevada, a joint NASA-Atomic Energy Commission facility, was established to advance nuclear systems technology, particularly through Project Rover, the U. S. nuclear rocket propulsion effort.

The Pacific Launch Operations Office, Lompoc, California, supervises the launch complexes of the Pacific Missile Range at Point Arguello, used for polar-orbiting spacecraft and deep-space probes. Upper-atmosphere sounding rockets are also launched at the Range.

Plum Brook Station, Sandusky, Ohio, operated by the Lewis Research Center, studies the problems of nuclear propulsion systems and related problems.

The Space Nuclear Propulsion Office, Germantown, Maryland, in conjunction with the Atomic Energy Commission, directs research and development leading to nuclear and electrical propulsion systems for space vehicles. It is also responsible for the non-nuclear components of these systems.

Wallops Station, Wallops Island, Virginia, provides launch facilities and services for other NASA installations conducting suborbital, orbital, and space-probe experiments with solid- and liquid-propelled rocket test vehicles, ranging from small rockets to the Scout four-stage solid fuel rocket. The station also develops techniques for collecting and processing experimental data.

The Western Operations Office, Santa Monica, California, serves all operational interests of NASA in the West, including the negotiation and management of research and development contracts with the aerospace industry.

Status: The following technical publication series are used to report the results of NASA's research, development, and testing programs.

Technical Reports (TR's). Each publication in this series is the final report of a completed NASA research project or presents some other information considered of current interest and lasting importance to aeronautics or space science. NASA Technical Reports are intended for the widest possible distribution. They do not contain security-classified information or information on which there are other distribution limitations. About 50 are published each year. They are sold either by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402, or by the Clearinghouse for Federal Scientific and Technical Information, 5285 Port Royal Road, Springfield, Virginia 22151.

Technical Notes (TN's). This series presents results of completed segments of continuing research projects or results of smaller research programs. They are not as complete as Technical Reports; the information in several Technical Notes may eventually be combined in a single Technical Report. Technical Notes are intended for wide general distribution and do not contain classified material or information restricting their distribution. Approximately 600 are published annually. They are sold by the Clearinghouse for Federal Scientific and Technical Information.

Technical Memorandums (TM's). Technical information requiring a limited distribution for security or other reasons is usually presented in the form of Technical Memorandums. Reports in the series may contain unconfirmed or preliminary data, classified informantion, proprietary infromation, or information intended for a specific audience. If the information contained in a declassified

Technical Memorandum is considered to be of general interest at the time it is declassified, it may be reissued in the form of a Technical Report or Technical Note. About 150 Technical Memorandums are issued each year. Unclassified Technical Memorandums suitable for public distribution are sold by the Clearinghouse for Federal Scientific and Technical Information.

Contractors Reports (CR's). Scientific and technical information generated by a NASA contract or research grant generally appears in the form of a report issued by the contractor or grantee. While there is no standard format for such reports, those which merit release under NASA auspices are issued in the uniform Contractors Report (CR) series. The decision to issue a report in the CR format is made by the appropriate program office at NASA headquarters, which also determines the distribution. As the Technical Memorandum series does, Contractors Reports sometimes contain classified, proprietary, or unconfirmed information, and their distribution is restricted accordingly.

Technical Reprints (RP's). Much of the scientific and technical information generated under NASA or NASA-supported programs is published in the form of journal articles and proceedings in non-NASA publications. Reprints of such papers that have not appeared previously as Technical Reports or Technical Notes are issued in the Technical Reprint series. Because of prior journal publication, Technical Reprints do not receive an automatic distribution by NASA, but are made available on an individual request basis.

Special Publications. NASA uses the term "Special Publication" to cover scientific and technical publications falling outside the scope of the report series described above. In many cases Special Publications present highly technical information, either for a broad interdisciplinary audience or a selected lay audience. They contain information generated by NASA activities but do not ordinarily report results of individual NASA-programmed scientific efforts. They may be prepared by any of the NASA field installations, by the Scientific and Technical Information Division at NASA headquarters, or by NASA contractors and grantees.

Special Publications include, but are not limited to, proceedings of scientific meetings sponsored or co-sponsored by NASA, technical reviews, state-of-the-art monographs, formal bibliographies, glossaries, and handbooks or other compilations of tables, charts, and data. The series also includes reports issued by the Technology Utilization Division, presenting innovations of poetntial value to industry.

In 1964 more than 50 Special Publications were being offered for sale to the public by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402.

Contact:

Scientific and Technical Information Division
National Aeronautics and Space Administration
Washington, D.C., 20546
Attention: Code ATSD
(Or contact the field activities at the addresses given.)

3.6.3 NASA Headquarters and Field Libraries

Library Services:

NASA Headquarters and each NASA field installation maintain libraries varying in size and scope to serve particular reference and bibliographic needs. The library at NASA headquarters is a specialized technical reference facility of domestic and foreign publications and reports in aeronautics and the space sciences dating from 1918. It does not attempt to duplicate the holdings of other collections in the history and technology of space, nor is the report collection intended to be comprehensive.

The complete NASA report collection is maintained at the Scientific and Technical Information Facility in Bethesda, Maryland, where reports are processed for announcement in NASA's abstract journal, Scientific and Technical Aerospace Reports.

Prior to April 1962, report indexing for NASA was performed by the library at Langley Research Center, Va. An 800,000-card catalog on microfilm covering this collection of more than 100,000 documents is maintained at each NASA center and at the headquarters' library for literature searches.

Although NASA libraries are operated primarily for NASA employees, the agency makes its unclassified publications accessible to the scientific community and the public through automatic distribution of NASA publications to about 50 public libraries located throughout the United States.

Contact:

Chief Librarian
NASA Scientific & Technical Information Facility
Bethesda, Maryland

3.6.4 NASA Regional Technical Report Centers

Library Services:

Eleven regional technical-report centers are maintained at research and university libraries located in major scientific, industrial, and educational areas throughout the United States. The primary mission of these centers is to make available to the general public unclassified reports issued or distributed

by NASA, the Atomic Energy Commission, the Department of Defense, and other Government agencies. Reports are supplied by the Clearinghouse for Federal Scientific and Technical Information.

Funds for the operation of the centers were originally provided by the National Science Foundation. Although financial support for servicing the report collections was withdrawn in July 1964, the report centers at the 11 institutions listed below continue to receive copies of Government reports, including those of the National Aeronautics and Space Administration, and provide related reference services to the regional areas they serve.

Carnegie Library, Pittsburgh, Pennsylvania
Columbia University, New York, New York
Georgia Institute of Technology, Atlanta
Library of Congress, Washington, D.C.
Linda Hall Library, Kansas City, Misouri
Massachusetts Institute of Technology, Cambridge, Massachusetts
Southern Methodist University, Dallas, Texas
The John Crerar Library, Chicago, Illinois
University of California at Berkeley
University of Colorado, Boulder, Colorado
University of Washington, Seattle, Washington

Contact: For additional information, contact the chief librarian at the institutions listed above.

3.6.5 NASA Research in Progress Center

Services:

A primary source of information on current research conducted by NASA contractors and grantees is the Science Information Exchange, Smithsonian Institution, Washington, D.C., 20560. Grantees and research contractors of NASA are required to supply the Exchange with brief summaries of all research projects as they are intitiated. These summaries and the accompanying data identify the work being done in a particular subject field, the people doing it, and the supporting groups or agencies. The type of information supplied depends on the status of the inquirer, as described in the bulletin on the Smithsonian Institution (No. 13, NSF 62-8, available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C., 20402).

Contact:

Scientific and Technical Information Division
National Aeronautics and Space Administration
Washington, D.C., 20546

Attention: Code ATSD

3.6.6 NASA Technological Information Utilization Activity

Services:

An improtant byproduct of the space program is the variety of scientific and engineering devices, materials, processes, and techniques developed by NASA employees and contractors that are made available for nonspace uses. The Technological Utilization Division at NASA headquarters locates, records, and analyzes all such devices and techniques of potential value to industry and makes the pertinent information available in the shortest possible time. An Industrial Applications Advisory Committee, composed of representatives from various industries, assists the Division by recommending methods for identifying and evaluating technological innovations with high industrial potential.

Technological Utilization Officers, located at each of the major NASA centers, report promising technological innovations to the Division. After evaluation at one or more of seven research institutes throughout the United States, information on these devices and techniques is disseminated in the form of NASA Tech Briefs -- concise looseleaf write-ups distributed without charge by the Scientific and Technical Information Division to Federal and State Government agencies, research institutions, universities, regional technical report centers, NASA depository libraries, the technical and trade press, and other interested organizations and institutions.

Contact:

Technological Utilization Division
National Aeronautics and Space Administration
Washington, D.C. 20546

4. GUIDE TO CONTRACTOR RELIABILITY AND MAINTAINABILITY DATA SOURCES

Table 1 presents information concerning the characteristics of the data maintained by 94 of the 118 contractors. In this table, the headings used in the survey questionnaire are combined to display the type data available from each contractor.

Table 2 lists the 118 organizations who answered and returned the survey questionnaire and tabulates their responses. An example of the questionnaire used and a tabulation of the number of responses to each question are presented in Appendix A.

Tables 1 and 2 provide a quick means of determining the availability of the data maintained by the 94 contractor companys. In some cases, the data may be obtained only through Government agencies for official use. The companys that make their data available to other Government agencies and contractors are indicated in the last column of Table 2.

4.1 Description and Use of Table 1

The Table 1 headings were taken from the survey questionnaire and grouped to provide the following information concerning contractor data characteristics:

(1) Data utility during the three phases of system acquisition

(2) The conservative or optimistic nature of the data

(3) The applicability of the data for multicontractor systems

(4) The currency of the data

The first column of Table 1 is an alphabetical listing of the 94 contractor companies that maintain partial or complete data banks. It is noted that the same column heading appears more than once. The multiple listing of these headings is necessary because the same data are used to evaluate more than one characteristic.

Three types of information are represented under the "Data Utility" heading of Table 1, as follows:

(1) The applications from which the data are derived, such as aircraft, ground equipment, etc.

(2) The type of data collected by classification, i.e., electrical, servo, mechanical, or hydraulic types

(3) The phases of the system acquisition, such as development, production, and operational test data

The assumptions made under the heading of "Conservative vs. Optimistic Nature of Data" are based on empirical information obtained during the data source survey: test data are more optimistic than operational data (meaning that the test data indicates a lower failure rate than do the operational data.

Therefore, environmental, production, and development test data are listed in the "Optimistic" subsection, and operational data are listed in the "Conservative" subsection.

The column headed "Applicability of Data to Multicontractor Systems" provides a means of determining which contractors collect data on the system level. The data collected by contractors is marked with an "X". If the column is not marked, the data is primarily collected at the parts testing level rather than at the system level.

The column headed "Currency of Data" provides a basis for evaluating data that will be current if (1) a mandatory reporting system is used; (2) the data are classified and stored by some nomenclature such as equipment type, function, or application; and (3) operational data, by virtue of its nature, is current. It can be assumed that data collection systems utilizing mandatory reporting systems and classifications of stored data will, in general, maintain data that are more current than systems that do not employ these techniques.

The column headed "Data Bank Status", indicates whether the organization maintains a complete data bank or a partial data bank.

4.2 Description and Use of Table 2

The first column of Table 2 lists, alphabetically, the contractors that answered and returned the survey questionnaire. The second column indicates whether or not the organization maintains a data bank. If the organization did not have a fully operational data bank, the word partial was inserted in the column. For the purpose of this Data-Source Guide, a complete data bank is defined as one that has its data organized and classified so that a user can retrieve necessary data quickly and accurately. A partial data bank is one that has not yet organized and classified all of its data, or one that must be supported by supplementary data to meet the user's needs.

The remaining Table 2 headings are questions taken from the survey questionnaire. Table 2 can be cross-referenced with Exhibit 5 of Appendix A to obtain the name and address of the person to be contacted for more detailed information.

TABLE 1
CONTRACTOR-DATA CHARACTERISTICS

Data Source	Data Utility: Aircraft	Human Engineering	Reliability	Missile	Computer	Shipboard	Vehicle	Space	Electronic	Applications	Electrical	Servo	Mechanical	Hydraulic	Operational Flight Data	Non-operating Storage Data	Environmental Test Data	Bench Test Data	Conservative vs. Optimistic Nature of Data: Assumed to be Optimistic: Environmental Test Data	Production Test Data	Development Test Data	Assumed to be Conservative: Operational Flight Data	Applicability of Data to Multi-Contractor Systems: Collects Data on Complete Systems	Data Available to Government Agencies	Data Available to Others	Currency of Data: Number of Years	Collected Operational Data	Type	Source	Application	Data Collection Methods
[illegible] Corporation									X									X						X	X						X
Aerojet, General Corporation, [illegible] Division					X			X			X		X		X		X	X	X		X	X		X	X		X	X			X
Aerojet, General Corporation, [illegible] Facility [illegible]	X	X	X	X		X		X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X		A	X	A
Aerojet, General Corporation, [illegible] Model				X				X	X	X	X	X	X	X			X	X	X	X	X			X	X			X	X	X	X
Aerojet, General Corporation, [illegible]	X	X	X	X							X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X				X
Aerojet, General Corporation, [illegible]		X		X	X					X	X	X		X	X	X	X	X	X	X	X	X	X				X				
Aircraft Armaments Corporation								X			X		X					X			X			X	X			X			X
Air Force (AFSC)		X						X			X				X							X	X	X		X	X	X		X	
Air [illegible] Systems Division	X	X		X	X			X	X		X				X		X	X	X		X	X	X	X	X		X	X	X		X
Aircraft Products Corporation						X		X			X				X		X	X	X	X	X	X					X	X			X
Allen-Bradley Corporation								X					X		X	X						X	X			X	X				X
Allison Division										X		X					X	X	X		X			X	X					X	X
Allison Division										X		X					X	X	X		X			X	X					X	X
National Corporation	X									X		X			X			X			X	X		X	X		X	X			X
Army, Picatinny Arsenal		X	X	X				X		X		X			X	X	X	X	X	X		X	X	X	X	X	X	X	X		X
Army, Watervliet Arsenal		X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Astrodata Incorporated		X	X					X			X				X		X		X							X		X			X
Avco Manufacturing Corporation				X							X		X	X	X		X	X	X	X	X		X				X				X
Beckman Instruments, Incorporated		X	X					X	X		X		X		X		X	X	X		X	X					X	X	X		X
Bendix Systems		X	X			X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X		X
Bendix Corp. Ellipse - Pioneer	X	X	X	X	X			X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X		X	X	X		X
Bendix Corp., Friez Instrument Division		X							X		X							X			X			X	X		X		X		X
Bendix Corp., [illegible] Division		X								X							X						X	X	X		X	X			
Boeing Company, Aerospace Group	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X
Boeing Company, Wichita Division	X							X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X	X	X		X
Borg-Warner Corp., Fesco Products	X							X					X	X	X		X	X	X	X	X	X		X	X	X	X	X			X
Borg-Warner Corp. York Division										X	X		X		X	X	X	X	X	X	X	X						X		X	X
Brewster Corporation		X	X	X	X	X		X	X		X	X	X		X	X	X	X	X	X	X	X	X			X	X		X	X	X
Collins Radio Co., Cedar Rapids	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X		X	X	X	X	X	X	X	X
Collins Radio Co., Dallas Div.		X						X	X		X			X	X			X			X	X		X			X	X	X		X
Consolidated Electrodynamics Corporation	X	X	X			X		X	X	X	X				X		X	X	X	X	X	X				X	X	X	X	X	X
Douglas Aircraft Company	X		X	X					X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X
Electronic Communications, Inc.	X	X	X			X		X	X	X	X				X		X	X	X	X	X	X				X	X	X	X	X	
Erie Technological Products			X					X			X						X	X	X	X	X					X					X
Fairchild C & I Corporation	X	X	X	X	X	X		X	X			X					X		X	X	X	X		X		X	X		X		X
Fairchild Hiller	X	X	X	X	X			X	X	X	X		X		X			X	X	X	X	X		X	X	X	X	X	X		X
Garrett Corporation	X	X	X	X	X	X	X			X	X	X	X	X	X			X		X	X	X		X	X		X	X			X
General Dynamics, Convair Div.	X	X	X	X	X			X	X	X	X	X	X	X	X	X		X		X	X	X		X	X		X	X	X	X	X
General Dynamics, Electronics Division	X	X	X			X		X	X	X	X	X	X				X			X				X			X		X	X	X
General Electric Company, MSD		X		X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X
General Motors Corp., AC Elec.				X					X	X	X	X	X			X		X	X	X	X	X		X	X	X	X	X	X	X	X
General Motors Corp., Allison Div.	X								X				X	X	X		X	X	X	X	X	X			X	X	X		X		X
General Precision, Aerospace Grp.	X			X				X			X	X			X		X	X	X	X	X	X			X	X	X	X			X
General Precision, Librascope Group						X	X			X	X	X	X	X	X							X			X			X			
General Precision, Link Group			X						X	X	X	X	X	X	X	X		X		X	X	X	X	X	X			X	X	X	X
General Signal Corporation	X	X		X				X	X	X	X				X		X	X	X	X	X		X	X		X	X	X	X	X	X

(continued)

TABLE 1 (continued)

Data Source (they have maintaining (full or partial) data bank)	Data Utility: Aircraft	Ground Equipment	Laboratory	Missiles	Satellites	Shipboard	Undersea	Type	Function	Application	Electrical	Servo	Mechanical	Hydraulic	Operational Field Data	Nonoperating Storage Data	Environmental Test Data	Bench Test Data	Conservative vs. Optimistic Nature of Data: Assumed to be Optimistic: Environmental Test Data	Production Test Data	Development Test Data	Assumed to be Conservative: Operational Data	Applicability of Data to Multi-Contractor Systems: Subsystem Data or Complete Systems	Data Available to Government Agencies	Data Available to Others	Currency of Data: Mandatory Form	Collects Operational Data	Classified by: Function	Application	Data Bank Status: Maintain Data Bank	Maintains Data Bank
Goodyear Aerospace Corporation	X										X				X							X					X				X
B.F. Goodrich Company	X		X					X	X	X		X	X	X	X	X	X	X	X	X	X			X	X		X		X	X	X
Grumman Aircraft Corporation	X							X			X	X	X	X	X		X	X	X	X		X	X	X	X		X	X		X	
Hercules Incorporated				X					X			X			X	X	X	X	X	X	X	X		X		X	X		X	X	
Hewlett Packard	X	X	X			X					X				X		X	X	X	X	X	X				X	X				X
Honeywell, Incorporated								X		X	X		X			X	X	X	X	X	X			X	X			X		X	
Hughes Aircraft Company		X				X					X				X			X			X	X	X			X	X			X	
IBM	X	X	X	X	X			X			X				X	X	X	X	X	X	X	X	X	X		X	X	X		X	
ITT		X				X		X			X		X		X							X	X	X	X	X	X	X		X	
Jay Manufacturing Company		X				X		X			X				X		X	X	X	X	X	X					X	X			X
Kaman Aircraft Corporation	X					X		X				X	X	X	X		X	X	X		X	X		X	X	X	X	X		X	
Lear Siegler, Inc. Astrionics Division	X							X			X	X			X	X	X	X	X		X	X					X	X			X
Lockheed Aircraft Corporation	X		X					X			X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	
LTV Aerospace Corporation	X										X	X	X	X	X	X		X		X	X	X	X	X	X	X	X			X	
Martin and Company	X	X		X	X			X			X				X	X	X	X	X	X	X	X		X	X	X	X	X		X	
Martin Company, Orlando		X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Martin Company, Denver		X		X				X			X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	
Martin, Incorporated	X	X		X		X			X	X	X	X			X		X	X	X	X	X	X	X	X	X	X	X	X		X	
McDonnell			X					X	X	X			X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	
Melpar Microwave Corporation								X			X				X	X	X	X	X	X	X	X		X	X	X	X	X		X	
NASA - MSFC	X	X	X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Naval Air Development Center	X							X				X			X							X	X	X	X		X	X		X	
Naval Air Technical Services Facility	X	X						X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	
Naval Training Device Center		X				X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	
North American, Autonetics	X	X		X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	
North American, Rocketdyne				X								X	X	X	X		X	X			X	X		X	X	X	X			X	
North American, S&ID	X	X	X	X	X			X			X	X	X	X	X	X	X				X	X	X	X	X	X	X	X		X	
Northrop, Norair	X								X		X	X	X	X	X			X			X	X	X	X	X		X	X		X	
Nuclear Corporation of America		X	X								X		X		X	X		X		X		X		X	X		X			X	
Raytheon Co. Space & Inf. Div.			X			X	X	X	X		X				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Raytheon Co. Submarine Signal Division							X	X			X		X	X	X		X	X	X	X	X	X	X			X	X	X			X
Reliability Inf. Retrieval System											X	X	X	X	X	X						X		X	X		X			X	
Ryan Aeronautical Company	X							X			X		X		X	X		X		X		X		X	X		X			X	
Sanders Associated, Incorporated	X	X									X		X		X		X	X	X	X	X	X		X		X	X			X	
Sandia Corporation								X			X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X		X	
Servo Corporation of America		X			X	X			X	X	X	X						X	X	X	X			X	X		X			X	
Sperry Rand Manufacturing Co.				X					X			X				X	X	X	X	X	X	X	X		X	X	X	X		X	
Sylvania Electronic Systems		X	X			X		X		X	X		X		X			X		X	X	X	X	X	X	X	X	X		X	
Texas Instruments								X			X						X	X	X	X	X			X	X		X			X	
TRW, Incorporated	X	X	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
United Aircraft Corp, Norden Div.	X	X				X				X		X	X	X		X		X	X	X		X		X	X	X	X		X	X	
Universal Match Corporation			X			X					X	X		X				X	X	X	X					X			X		X
United Control	X			X				X			X				X			X			X	X		X	X		X	X		X	
Varian Associates, Tube Div.	X	X				X					X				X			X			X	X		X	X		X			X	
Walter Kidd and Company	X			X	X			X					X	X	X		X	X	X	X	X	X		X	X		X	X			X
Westinghouse, Aerospace Division	X							X			X				X		X	X	X	X	X	X	X	X		X	X	X		X	
Westinghouse, Surface Division						X				X	X				X			X		X	X	X	X			X	X		X	X	
Westinghouse, Undersea Division	X						X				X		X	X	X		X	X	X	X	X	X				X	X	X		X	
Weston Instruments, Incorporated	X										X					X	X	X	X		X	X		X	X		X			X	

TABLE 2 (continued)

Data Source	Maintain Data Bank	Data Collected by: Mandatory Form	Data Collected by: Review of Eng. Reports	Data Collected by: Questionnaire	Source of Data: Production Testing	Source of Data: Environmental Testing	Source of Data: AGREE Testing	Source of Data: Life Testing	Source of Data: Incoming Testing	Source of Data: Reliability Demonstration Testing	Source of Data: Maintainability Demonstration Testing	Data Classified by: Type	Data Classified by: Function	Data Classified by: Application	Nonoperating Failure Data	Collect Reliability or Maintainability Data: Servo Mechanisms	Collect Reliability or Maintainability Data: Mechanical Parts	Collect Reliability or Maintainability Data: Hydraulic Parts	Data Source Used For Prediction: MIL-HDBK-217A	Data Source Used For Prediction: MIL-M-23513A	Data Source Used For Prediction: NAVMIPS Assoc.	Data Source Used For Prediction: In-House Data	Data Source Used For Prediction: MIL-STD-756A	Provide Stress Analysis	Use "K" Factors
Engineering Societies Library	No																								
Erie Technological Products	Yes					X		X				X										X			
Fairbanks Morse Inc.	No				X							X	X				X					X		X	
Fairchild C & I Corporation	Yes		X		X	X		X		X		X										X		X	
Fairchild Hiller	Yes	X				X		X	X	X	X	X	X	X			X		X	X		X	X	X	X
Garrett Corporation	Yes	X			X					X	X			X		X	X	X	X			X	X	X	X
General Dynamics - Convair Division	Yes	X			X				X	X		X	X	X	X	X	X	X	X			X	X	X	X
General Dynamics - Electronics Division	Partial	X								X		X	X	X		X	X		X	X	X	X	X	X	X
General Electric Company	Yes	X			X	X		X		X		X	X		X	X	X	X	X			X	X	X	X
General Motors Corp. - AC Electronics	Yes	X			X	X		X	X	X		X	X	X		X	X		X	X	X	X	X	X	X
General Motors Corp. - Allison Division	Yes	X	X		X	X		X	X	X	X		X			X	X	X				X		X	X
General Precision - Aerospace Group	Yes	X			X	X	X	X	X	X	X	X				X			X		X	X		X	X
General Precision - Librascope Group	Yes															X	X	X	X	X	X	X	X	X	X
General Precision - Link Group	Partial		X		X					X			X	X		X	X	X	X			X		X	X
General Signal Corporation	Yes				X	X				X		X	X	X					X				X	X	X
General Time	No																X		X					X	
Globe Industries, Inc.																			X						X
Goodyear Aerospace Corporation	Partial		X																X		X		X	X	X
Grumman Aircraft Corporation	Yes		X		X	X						X				X	X	X	X			X	X	X	X
Hercules, Inc.	Yes	X			X	X		X	X	X	X		X		X							X	X	X	-
Hewlett Packard	Partial	X	X		X	X				X									X			X	X		X
Honeywell, Inc.	Yes		X			X		X		X		X			X		X		X			X		X	
Hughes Aircraft	Yes	X	X							X	X								X	X		X	X	X	X
IBM	Yes	X			X	X		X	X	X		X			X				X			X		X	X
ITT	Yes	X										X					X		X	X	X		X	X	
Joy Manufacturing Co.	Partial				X	X		X		X		X										X		X	
Kaman Aircraft Corporation	Yes	X				X		X				X				X	X	X	X				X	X	X
Lear Siegler Inc. - Astronics Division	Partial		X			X				X		X			X	X			X			X		X	X
Lear Siegler Inc. - Power Equipment Div.	No															X	X		X	X	X	X		X	X
Lockheed Aircraft Company	Yes	X	X		X	X	X		X	X		X					X	X				X			X
LTV Aerospace Corporation	Yes	X	X		X						X				X	X	X	X	X				X		X
Mallory & Co.	Yes	X	X		X	X		X		X		X			X							X		X	
Martin Co. - Orlando	Yes	X	X		X	X		X	X	X		X	X	X	X	X	X		X			X		X	X
Martin Co. - Denver	Yes	X			X	X		X	X			X				X	X	X				X	X	X	X
Melpar, Inc.	Yes		X		X	X	X			X	X		X			X			X		X		X	X	X
3M Company	Yes	X			X	X		X				X	X	X	X		X					X		X	
Narda Microwave Corporation	Yes	X	X		X	X		X				X			X							X			
NASA - MSFC	Yes	X	X			X		X	X			X	X		X	X	X	X							
Naval Air Development Center	Yes											X										X			X

A

TABLE 2 (continued)

Relia- ...ability	Data Source Used For Predictions					Provide Stress Analysis	Use "K" Factors	Derate Parts	Collect Operational Field Data	Oper. MTBF Within 25% of Pred.	Oper. MTTR Within 25% of Pred.	Applications From Which Data Dervied							Normal Users of these Data					Use AGREE Tests	AGREE Comparison With Predictions	AGREE Comparison With Oper. Failure Rates	Data Bank Available to	
Hydraulic Parts	MIL-HDBK-217A	MIL-M-23313A	NAVHIPS 93820	In-House Data	MIL-STD-756A							Aircraft	Ground Equipment	Laboratory Test	Missiles	Satellites	Shipboard	Underseas	Management	Reliability	Engineering	Quality Control	Purchasing				Government	Commercial
				x										x					x									
				x		x			x	Higher	Higher						x				x	x						
				x		x		x	x	Lower		x	x	x	x	x	x	x	x	x	x	x					x	x
	x	x		x	x	x	x	x	x	Higher	Lower	x	x	x	x	x			x	x	x	x	x				x	x
x	x			x	x	x	x	x	x	Higher		x	x	x	x	x	x	x	x	x	x	x	x				x	
x	x			x	x	x	x	x	x	Higher		x	x	x	x	x			x	x	x	x	x				x	
	x	x	x	x	x	x	x	x				x	x	x			x			x				x				
x	x			x	x	x	x	x	x				x		x	x			x	x	x							
	x	x	x	x	x	x	x	x	x	Higher					x				x	x	x	x					x	x
x				x		x	x	x	x			x							x	x	x						x	x
	x		x	x		x	x	x	x	Higher		x			x				x	x	x	x		x	Lower	Lower	x	x
x	x	x	x	x	x	x	x	x	x	Higher							x	x		x	x						x	
x	x			x		x	x		x	Lower	Higher			x						x	x						x	x
	x				x	x	x	x	x			x	x		x				x	x	x	x					x	x
	x					x		x												x	x							
	x						x	x																				
	x		x		x	x	x	x	x	Lower		x							x	x	x	x						
x	x			x	x	x	x	x	x	Lower	Higher	x							x	x	x						x	x
				x	x	x	x	x	x						x				x	x	x	x	x				x	
	x			x	x		x	x	x	Higher		x	x	x			x		x	x	x	x	x					
	x			x		x		x												x	x	x	x				x	x
	x	x		x	x	x	x	x	x	Higher			x				x		x	x	x		x					
	x			x		x	x	x	x	Higher		x	x	x	x	x			x	x							x	
	x	x	x		x	x		x	x	Lower	Lower		x				x		x	x	x	x	x				x	x
				x		x		x	x				x				x				x	x						
x	x				x	x	x	x	x	Lower	Higher	x					x			x	x						x	x
	x			x		x	x	x	x	Higher		x								x	x			x		Same		
	x	x	x	x		x	x	x	x			x							x	x	x							
x				x			x	x	x			x		x					x	x	x	x	x	x			x	x
x	x				x		x	x	x			x								x	x	x					x	x
				x		x			x	Higher		x	x		x	x			x	x	x	x					x	x
	x			x		x	x	x	x	Lower		x	x	x	x	x	x	x	x	x	x	x					x	x
x				x	x	x	x	x	x	Higher	Higher		x		x				x	x	x	x					x	x
	x		x		x	x	x	x	x			x	x		x					x	x						x	x
				x		x			x					x						x	x						x	x
				x				x	x																		x	x
x									x			x	x	x	x	x				x	x		x				x	x
				x			x		x	Lower	Higher	x															x	x

(continued)

TABLE 2

SURVEY RESPONSES

Data Source	Maintain Data Bank	Data Collected by: Mandatory Form	Data Collected by: Review of Eng. Reports	Data Collected by: Questionnaire	Source of Data: Production Testing	Source of Data: Environmental Testing	Source of Data: AGREE Testing	Source of Data: Life Testing	Source of Data: Incoming Testing	Source of Data: Reliability Demonstration Testing	Source of Data: Maintainability Demonstration Testing	Data Classified by: Type	Data Classified by: Function	Data Classified by: Application	Nonoperating Failure Data	Collect Reliability or Maintainability Data on: Servo Mechanisms	Collect Reliability or Maintainability Data on: Mechanical Parts	Collect Reliability or Maintainability Data on: Hydraulic Parts	Used For Predictions: MIL-HDBK-217A	Used For Predictions: Mil-Handbook	Used For Predictions: Nonelectronic Parts	Used For Predictions: Inertial Parts	Used For Predictions: MIL-STD-756	Provide Stress Analysis	Use "K" Factor
Admiral Corporation	Yes		X							X	X								X		X			X	X
Aerojet General Corp. - Astronics Div.	Yes					X		X				X					X				X	X		X	X
Aerojet General Corp. - Corp. Rel. & Q.C.	Yes	X	X		X	X		X	X			X		X	X		X	X				X	X	X	X
Aerojet General Corp. - El Monte	Yes		X		X	X		X				X	X	X		X	X	X				X		X	X
Aerojet General Corp. - Sacramento Plant	Yes	X	X		X	X		X							X	X	X	X				X		X	X
Aerojet General Corp. Space General Corp.	Yes	X			X	X		X						X	X		X		X			X			X
Aerospace Industries Association of America	No																								
Airborne Accessories Corporation	Yes									X		X					X		X					X	X
Air Force (APCS)	Partial	X										X													
Air Force Logistics Command (AFLC)	No					X				X	X														
Air Force (OAR)	No																								
Air Force Space Systems Division	Yes					X		X				X	X												
American Bosch Arma Corporation	Partial		X			X		X	X	X		X							X	X	X		X	X	X
American Motors Corporation	Yes											X			X		X					X			
American Society for Testing & Materials	No																								
Ampex Corporation	Yes					X		X		X			X				X		X			X		X	
Amphenol Corporation	Yes									X		X													
Army - Picatinny Arsenal	Yes	X			X	X						X	X		X				X			X		X	X
Army - Redstone Arsenal	Yes				X	X		X		X	X	X	X	X	X	X	X	X	X			X		X	X
Astrodata, Inc.	Yes	X			X				X			X			X				X	X		X	X		
Avco Mfg. Corporation	Yes		X		X	X		X		X							X	X	X				X		
Beckman Instruments Inc.	Yes		X			X		X		X		X	X				X		X			X		X	X
Bell Aerosystems	Yes	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Bendix Corporation - Eclipse-Pioneer	Yes		X		X	X	X	X		X	X	X	X			X	X	X	X	X	X	X	X	X	X
Bendix Corp. - Friez Instrument Division	Partial	X	X		X	X		X		X			X						X					X	X
Bendix Corp. - Radio Division	Yes	X						X											X	X	X	X	X	X	X
Bendix Corp. - Red Bank Division	No																		X			X	X	X	X
B.F. Goodrich Co.	Yes		X		X	X		X		X	X	X	X	X	X		X	X				X		X	X
Boeing Co. - Aerospace Group	Yes		X		X	X		X	X	X	X		X	X	X	X	X	X	X			X		X	X
Boeing Co. - Wichita Division	Yes	X			X					X		X	X	X		X	X	X	X			X		X	X
Borg-Warner Corp. - Pesco Products	Yes	X	X		X			X				X					X	X	X			X		X	
Borg-Warner Corp. - York Division	Yes		X					X	X					X	X		X					X			X
Cessna Aircraft Company	No																			X			X		X
Clevite Corporation	Yes	X	X		X	X	X	X	X	X	X	X	X		X	X	X		X			X		X	X
Collins Radio Co. - Cedar Rapids	Yes	X			X	X	X	X		X	X	X	X	X		X	X		X	X	X	X	X	X	X
Collins Radio Co. - Dallas Division	Yes		X				X	X		X	X	X	X					X	X	X	X	X		X	X
Consolidated Electrodynamics Corporation	Yes				X	X		X	X	X	X		X		X	X	X		X			X		X	X
Curtiss-Wright Corporation	No		X							X	X					X			X			X			X
Douglas Aircraft Co.	Yes	X	X			X			X	X			X			X	X	X				X			
Electronic Communications Inc.	Partial	X			X	X				X		X	X	X					X	X	X	X	X	X	X

TABLE 2
SURVEY RESPONSES

Predict Reliability or Maintainability Data on:			Data Source Used For Predictions											Applications From Which Data Derived							Normal Users of these Data							
Servo Mechanisms	Mechanical Parts	Electronic Parts	MIL-HDBK-217A	MIL-M-23313A	NAVSHIPS 93080	In-House Data	MIL-STD-756A	Provide Stress Analysis	Use "K" Factors	Derate Parts	Collect Operational Field Data	Oper. MTBF Within 25% of Pred.	Oper. MTTR Within 25% of Pred.	Aircraft	Ground Equipment	Laboratory Test	Missiles	Satellites	Shipboard	Undersea	Management	Reliability	Engineering	Quality Control	Purchasing	Use AGREE Tests	AGREE Comparison with Predictions	AGREE Comparison with Oper. Failure Rates	Data Bank Available to: Government	Data Bank Available to: Commercial
			x		x			x	x	x												x	x	x		x	Same		x	x
	x				x	x		x	x	x	x	Higher						x				x	x						x	x
	x	x				x	x	x	x	x	x	Higher	Higher	x	x	x	x		x		x	x	x						x	x
w	x	x				x		x	x	x							x					x	x						x	x
x	x	x				x		x	x	x	x			x	x	x	x				x	x	x	x					x	x
		x	x			x			x	x	x				x		x	x			x	x	x			x				
	x		x					x	x	x												x	x	x					x	x
											x				x						x								x	
																x	x										Higher			
							x				x			x	x		x	x				x	x		x				x	x
			x	x	x		x	x	x	x	x								x			x	x							
	x					x					x										x	x	x	x	x					
	x		x			x		x		x												x	x						x	x
											x			x							x	x	x	x		x			x	x
			x			x		x	x	x	x				x	x	x				x	x	x	x					x	x
			x			x		x	x	x	x				x	x	x				x	x	x	x	x				x	x
			x	x		x				x					x	x					x	x	x	x	x					
	x	x	x				x			x	x						x					x	x						x	x
	x					x		x	x	x	x				x	x						x	x		x				x	x
	x	x	x		x	x	x	x	x	x	x	Higher	Lower	x	x				x			x	x		x	x	Lower	Higher	x	
	x	x	x	x	x	x	x	x	x	x	x	Higher		x	x	x	x	x				x	x	x		x	Lower	Lower	x	x
			x					x	x	x											x	x							x	x
			x	x	x	x	x	x	x	x												x				x	Lower		x	x
			x			x	x	x	x	x	x	Higher		x								x	x							
	x	x				x		x	x	x	x	Higher	Higher	x		x					x	x	x	x	x				x	x
	x	x	x			x		x	x	x	x	Higher	Higher	x	x	x	x	x	x		x	x	x	x	x				x	x
	x	x	x			x		x		x	x	Higher		x							x	x	x						x	x
	x	x	x			x		x		x	x			x							x	x	x						x	x
	x					x			x		x	Lower										x	x	x						
				x			x		x	x	x			x																
	x		x			x		x	x	x	x	Higher	Higher		x	x	x		x		x	x	x	x					x	x
	x		x	x	x	x	x	x	x	x	x	Higher	Higher	x	x	x	x	x	x	x	x	x	x	x		x	Lower	Lower	x	x
		x	x	x	x	x		x	x	x	x	Higher	Higher		x							x				x	Lower	Lower	x	
	x		x	x	x	x		x	x	x	x											x	x	x					x	x
			x			x				x	x	Higher	Higher									x	x	x						
	x	x				x					x	Higher		x		x	x				x	x	x	x					x	x
			x	x	x	x	x	x	x	x	x			x	x	x				x		x	x	x						

(continued)

TABLE 2 (continued)

Data Source	Maintain Data Bank	Data Collected by: Mandatory Form	Data Collected by: Review of Eng. Reports	Data Collected by: Questionnaire	Source of Data: Production Testing	Source of Data: Environmental Testing	Source of Data: AGREE Testing	Source of Data: Life Testing	Source of Data: Thermal Testing	Source of Data: Reliability Demonstration Testing	Source of Data: Maintainability Demonstration Testing	Data Classified by: Type	Data Classified by: Function	Data Classified by: Application	Nonoperating Failure Data	Collect Reliability or Maintainability Data: Servo Mechanisms	Collect Reliability or Maintainability Data: Mechanical Parts	Collect Reliability or Maintainability Data: Hydraulic Parts	Data Source Used For Predictions: MIL-HDBK-217A	Data Source Used For Predictions: MIL-M-23313A	Data Source Used For Predictions: NAVSHIPS 93929	Data Source Used For Predictions: In-House Data	Data Source Used For Predictions: MIL-STD-756A	Provide Stress Analysis	Use "K" Factor
Naval Air Technical Services Facility	Yes	X	X				X			X	X	X	X	X	X	X	X	X				X			
Naval Training Device Center	Yes	X						X		X	X			X	X	X			X		X		X	X	X
North American - Autonetics	Yes	X	X		X	X	X	X	X	X	X	X			X	X	X	X	X			X	X	X	X
North American - Rocketdyne	Yes	X			X	X		X		X						X	X	X				X			
North American - S & ID	Yes	X	X			X		X		X		X			X	X	X	X	X	X	X	X	X	X	X
North American - Aviation/Columbus	Yes	X			X					X	X	X				X	X	X	X			X	X	X	X
Northrop - Normair	Yes		X							X			X			X	X	X	X			X	X	X	X
Omnite Manufacturing Co.	No																								
Otis Elevator Co.	No																		X		X				X
Radio Corp. of America	Yes		X		X										X		X		X			X		X	X
Raytheon Co. - Space & Information Division	Yes	X	X		X	X		X	X			X	X						X			X		X	X
Raytheon Co. - Submarine Signal Division	Partial	X	X		X	X		X	X	X	X	X					X	X	X	X	X	X		X	
Reliability - Information Retrieval System	Yes														X	X	X	X							
Research Triangle Institute	No																		X						
Ryan Aeronautical Co.	Partial					X						X							X			X		X	X
Sanders Associates, Inc.	Yes	X			X	X		X		X							X		X					X	X
Sandia Corporation	Yes	X			X	X		X	X			X			X		X					X		X	X
Servo Corporation of America	Yes		X	X	X	X		X	X	X	X		X	X		X			X	X	X		X	X	X
Shallcross Mfg. Co.	Yes				X	X		X				X			X							X			X
Sperry Rand Corp. - Sperry Utah	No														X				X				X	X	X
Stackpole Carbon Co.	No				X	X		X														X			
Sylvania Electronic System	Yes	X	X		X			X		X	X	X		X			X		X	X	X	X	X	X	X
Texas Instruments	Partial				X	X		X		X		X													
TRW Inc.	Yes	X			X	X		X	X	X			X		X	X	X	X	X	X		X		X	X
United Aircraft Corp. - Norden Division	Yes	X	X		X	X							X			X	X		X			X	X	X	X
United Control	Yes		X				X			X		X							X					X	X
United States Testing Co.	No																								
Universal Match Corporation	Partial	X	X		X	X		X		X				X			X		X		X		X	X	X
U.S. Dept. of Commerce - Bureau of Standards	No																								
Varian Associates - Eimac Division	No				X	X		X	X	X		X			X				X			X		X	X
Varian Associates - Tube Division	Yes		X				X															X	X		X
Walter Kidde & Co.	Partial		X		X	X			X	X		X					X	X	X			X		X	X
Westinghouse Marine Division	No				X	X			X	X				X					X		X		X	X	X
Westinghouse D&S Division	Yes		X		X	X		X	X	X		X							X	X		X	X	X	X
Westinghouse - Research & Dev. Center	No											X	X	X	X	X	X	X	X				X	X	X
Westinghouse - Surface Division	Yes	X			X					X	X			X					X		X	X	X	X	X
Westinghouse - Underseas Division	Yes	X	X		X	X		X		X	X						X	X	X				X	X	X
Weston Instruments, Inc.	Yes		X			X	X	X											X			X	X	X	X
Worthington Corp.	No																								

A

TABLE 2 (continued)

Reliability or Availability	Data Source Used For Predictions					Provide Stress Analysis	Use π_E Factors	Derate Parts	Collect Operational Field Data	Oper. MTBF Within 25% of Pred.	Oper. MTTR Within 25% of Pred.	Applications From Which Data Derived						Normal Users of These Data					Use AGREE Tests	AGREE Comparison with Predictions	AGREE Comparison With Oper. Failure Rates	Data Bank Available to	
Hydraulic Parts	MIL-HDBK-217A	MIL-M-23313A	NAVSHIPS 93820	In-House Data	MIL-STD-756A							Aircraft	Ground Equipment	Laboratory Test	Missiles	Satellites	Shipboard	Underseas	Management	Reliability	Engineering	Quality Control	Purchasing				Government	Commercial
x				x		x	x	x	x	Higher	Higher	x	x						x	x	x	x	x	x		Lower	x	x
	x		x		x								x						x	x	x	x					x	x
x	x			x	x	x	x	x	x			x	x		x		x	x	x	x	x	x					x	x
x				x					x						x				x	x	x	x	x				x	x
x	x	x	x	x	x	x	x	x	x	Higher	Higher	x	x	x	x	x				x	x						x	x
x	x			x	x	x	x	x	x	Higher	Higher	x			x					x	x						x	
x	x			x	x	x	x	x	x	Higher	Higher	x								x	x			x		Lower	x	x
									x																			
	x		x				x	x																				
	x			x		x	x	x	x	Lower	Higher		x	x					x	x	x						x	x
	x			x		x		x	x	Higher				x			x	x		x						x	x
x	x	x	x	x		x				Higher								x	x	x	x	x	x				x	x
x									x															x				
	x																											
	x			x		x	x	x	x			x								x								
	x					x	x	x	x			x	x						x	x	x	x					x	
				x		x	x	x	x										x		x	x					x	
	x x	x			x	x		x	x				x			x	x			x	x	x	x				x	x
				x			x	x	x	Lower	Lower				x				x	x	x	x				x	x
	x				x	x	x	x	x	Lower			x		x				x	x	x							
				x				x						x						x	x	x						x
	x x	x	x	x	x	x	x	x	x				x	x			x		x	x	x						x	x
																				x		x					x	x
x	x x			x		x	x	x	x			x x	x	x	x	x	x	x	x	x	x						x	x
	x			x	x	x	x	x	x			x x					x		x	x	x	x					x	x
	x					x		x	x			x x	x		x				x	x	x			x			x	x
	x		x		x	x	x	x						x			x			x	x							
	x			x		x	x	x	x	Higher		x x			x	x				x	x						x	x
				x	x		x	x	x								x			x	x	x					x	x
x	x			x		x	x	x	x			x			x	x				x	x						x	x
	x		x		x	x	x	x	x	Lower			x				x			x	x	x						
	x x			x	x	x	x	x	x			x								x	x	x					x	
	x				x	x	x	x	x															x				x
	x		x	x	x	x	x	x	x								x			x								
	x				x	x	x	x	x									x	x	x	x	x						
	x			x	x	x	x	x	x	Higher		x							x	x	x			x	Lower	Lower	x	x

5. GUIDE TO GOVERNMENT AND CONTRACTOR PUBLISHED RELIABILITY AND MAINTAINABILITY HANDBOOKS

This section presents descriptions of fifteen Government and eighteen contractor published Reliability and Maintainability handbooks.

5.1 Government Documents

5.1.1 NAVWEPS OD-29304

Title: Guide Manual for Reliability Measurement Program

Publication Date: 15 May 1965

Scope: A complete technical manual on the common disciplines of reliability measurements useful during the operational phase of programs. Reliability evaluations are updated as additional information becomes available throughout the life of the system.

The total of accrued information becomes a historical file of actual experience. This file has been found useful in the evaluation of concepts for future-generation systems with respect to the projected reliability, logistic, and related parameters of candidate hardware for new programs.

The purpose of the manual is to establish common disciplines that will provide (1) a practical means of measuring system reliability during the research and development phase, (2) a uniform reliability measurement directly related to the reliability requirements, (3) uniform reliability appraisals for subsystems that can be combined into meaningful reliability projections for entire systems, and (4) basis for measuring reliability status on incentive contracts.

Description: The purposes of this document are accomplished by developing the concepts of a reliability measurement system by analysis and reporting, combined with an integrated data feedback system for acquiring accumulations of data. These data are processed by electronic computers. Outputs are provided on current failure rates and reliability indexes at all equipment levels for each anticipated environmental condition during the mission.

Requirements for the program are discussed in detail on characteristics and elements of measurements to be considered and applied. Reliability analysis and reporting are correlated with the statistical model. Mission and system analyses data are factored into the integrated test plan before final evaluation of the plan.

Subsystem statistical-model concepts are developed by means of stress levels from mission profiles, component failure rates, and test data. Subsystem criteria on monitoring reliability achievement are derived from MIL-Q-21549B definitions.

Operating assumptions are established for the reliability of components by: (1) consideration of constant failure rates, (2) addition of stress effects, (3) interactions, or independence of parts, and (4) consistency of failure rates. The mathematics and details of these considerations are expanded and further defined.

Outputs from the total measurement program are discussed in detail, including statistical and failure analysis, review of the test plan, status and summary reports requirements, and follow-up reporting formats.

5.1.2 NAVSHIPS 0900-002-3000

Title: Reliability and Maintainability Training Handbook

Publication Date: 11 December 1964

Scope: A complete training manual in all phases of reliability and maintainability, including technical and managerial considerations. Problem statements, definitions, and program implementation are determined as functions of R&D equipment programs, ship-building activities, and Fleet improvement efforts.

Research and development plans are reviewed from the standpoint of proposed technical approaches and systems optimization. The purpose of models, construction of models, and logic block diagrams are covered in detail. A chapter is devoted to probability theory. The application of probability theory in reliability predictions is emphasized. Apportionment, stress-strength analysis, and maintainability, including data acquisition and statistical techniques, are covered.

The handbook can be used as a text for course material under training programs. An outline is provided for three levels of training, consisting of (1) a top management course (3 hours, 50 minutes of instruction), (2) an intermediate-level course (16 hours), and (3) a technical-level course (40 hours).

Description: The handbook represents a departure from the contents of text materials currently available. It has been designed specifically for Ship Systems Command management and technical needs. Features are as follows:

- The point of view and language are for those who deal with contractors, as well as those in Ship Systems Command, who must design for the required reliability and maintainability.
- The text fully recognizes the current limitations of the "MTBF" approach, particularly for structural components, and also for many mechanical and electronic components. However, it presents the other approaches available for quantitative treatment.

- A number of techniques that do not appear in Government specifications, but which industry has found effective, are presented.
- Emphasis is placed on contract management, and methods for designing for required reliability, rather than just predicting, controlling, and measuring it.
- Reliability and maintainability are treated together wherever they are logically managed, designed, or analyzed together.
- While the text content includes more "system effectiveness" than some courses by that name, it concentrates on just the reliability and maintainability contributions to system effectiveness, to avoid dilution.
- Cost-effectiveness analysis approaches, to determine economically achieveable reliability and maintainability, are presented in some detail.
- Shipbuilding and ships GFE and CFE examples are used wherever the information was obtainable, and a shipbuilder's critique was obtained on all text material.

5.1.3 NAVSHIPS 94324

Title: Maintainability Design Criteria Handbook for Designers of Shipboard Electronic Equipment

Publication Date: April 1962

Scope: Discusses the philosophy of shipboard maintainability to provide the electronic design engineer with an appreciation of the problems Naval personnel must overcome to maintain operational readiness. Covers the probability concepts associated with maintainability prediction and measurement, the shipboard environments in which maintenance and repair are accomplished, the education and aptitude of personnel performing the tasks, and the human-engineering considerations best resolved early in the equipment design stage. Specific hardware and circuit designs are analyzed for advantages and disadvantages of repair difficulty, tool requirements, human-error potential, and safety hazards.

Description: Gives explanation, definitions, ground rules, procedures, and mathematical expressions for predicting equipment Maintainability Index (MI) values. Provides tables listing various tasks associated with repair or replacement of equipment and the corresponding time elements.

Describes shipboard environment, including sketches of hatches, superstructure, passageways, and other shipboard characteristics. Supplies criteria for area dimensions that limit body movements for various body positions. Tables include Navy technicians rates and grades, average age, education, and years of experience.

Gives extensive coverage to specific design considerations and human-engineering data. Details design guides for accessibility, mounting provisions, physical dimensions, weight, color coding, test or checkout equipments, human eye and movement tolerances, and the maintainability advantages and disadvantages of a number of electrical equipment designs.

Provides important miscellaneous maintainability design guides on illumination characteristics, spare-part-availability curves and tables as related to number of standardized parts in the design, suggestions for preventive maintenance provisions, and safety information on insulation or dielectric breakdown.

5.1.4 NAVSHIPS 94501

Title: Bureau of Ships Reliability Design Handbook

Publication Date: 29 March 1963

Scope: Provides the designer with information and guidance in the following areas:

(1) Quantitative evaluation of the design, so that progress toward reliability goals can be determined

(2) Reliability design techniques and data that can be used to achieve a high degree of equipment reliability

(3) General reliability information that, although covering peripheral areas of the designer's main activity, is important to his tasks and responsibilities

General: The handbook is subdivided into five parts:

(1) Reliability concepts

(2) Reliability evaluation tools for design engineering

(3) Design engineering tools for reliability

(4) Electronic parts and special designs

(5) Reliability programs and general design guides

Each part explains in detail reliability design criteria, mathematical formulas, circuit schematics, tables, graphs, design approaches (good and bad), human-engineering effects, test approaches, and evaluation methods for designs and programs applicable to the subject being discussed.

5.1.5 NAVMAT INST 4000.20

Title: Integrated Logistic Support Planning Procedures

Publication Date: 19 August 1966

Description: The Integrated Logistic Support Planning Procedures (ILS) document is designed for use in planning for effective logistic support of weapons

systems and equipments. The objective of this instruction is to achieve maximum material readiness with optimum cost-effectiveness.

Integrated logistic support is defined as a composite of the elements necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle. Logistic elements include all resources necessary to maintain and operate an equipment or weapons system. They are categorized as follows: (1) planned maintenance, (2) personnel, (3) logistic information and data, (4) spares and repair parts, (5) support and test equipment, (6) facilities, and (7) contract maintenance.

The procedures established in NAVMAT INST 4000.20 will provide a logical step-by-step logistic support acquisition process that can be subjected to management appraisal and control techniques. The process requires that decisions made during the concept formulation, contract definition, and development phases of the weapons system and equipment acquisition process take into account the logistic implications of those decisions. When a design resulting from this early stage of the process has been completed and approved as acceptable from the point of view of logistic-support considerations, as well as potential combat capability considerations, it becomes the foundation and coordinating document for all subsequent logistic-support action. This procedure is accomplished by subjecting the design to a formal engineering analysis conducted to identify, validate, and document the logistic support required for the fleet to maintain and operate the equipment as designed.

The result of this engineering analysis is a document designated as the "Plan for Maintenance," which is the consolidated single source of design-related data for use with nondesign-related data such as equipment population and distribution in requirements determination, acquisition, and distribution of logistic support. This controlled sequential process insures that support is planned for every design facet requiring such support, and that each element of logistic support is being procured to fill a support need identified and verified by engineering analysis. This assurance of coordinated action is the heart of integrated logistic support.

The ILS processes include:

- Early and effective expression of logistic-support requirements in the fundamental program documents, such as Specific Operational Requirements, Technical Development Plans, Requests for Proposals, equipment specifications, proposals, proposal evaluations, and source-selection studies.
- Designation of an "Acquisition Manager," who is charged not only with the responsibility for development and production of Navy equipment, but is also responsible for design and development of the related logistic-support package. In other words, he is not only responsible for equipment performance at the time of delivery; he is also responsible for

planning an integrated logistic package that will ensure performance in the Fleet for the programmed period of utilization at the designated fleet operating sites, and at the prescribed level of equipment readiness, utilization, and availability.

- Development of an integrated logistic support plan for each end item of Naval equipment procured or destined for procurement. The scope and detail of the plan will vary depending on the end item and the acquisition phase and will be compatible with advance procurement plans established in accordance with SECNAV Instruction 4200.18B and NAVMAT Instruction 3200.31A.
- Designation and identification of an Integrated Logistic Support Assistant to the Acquisition Manager. This Assistant will be responsible for planning, development, acquisition, integration, and execution of the Integrated Logistic Support Plan. The Instruction requires development of quantitative and qualitative use and logistic-support planning factors and related integrated logistic-support requirements to satisfy these factors.
- A documented analysis of logistic-support requirements, based on a maintenance-engineering analysis of the design characteristics of the end item, its systems, subsystems, and major components and assemblies.
- An overall plan to maintain equipment that will define the maintenance and repair concept for each level of maintenance and will document the technical, economic, and military rationale or justification for the maintenance concept established.
- The merging of maintainability, reliability, and human-factors requirements into the ILS planning process to develop an integrated plan.

The scope of actions required by this Instruction can be summarized as follows:

- The integrated logistic support planning procedures shall be applicable to all system and equipment acquisitions as well as subsequent engineering change or retrofit programs.
- While the provisions of this guide are mandatory, it is not intended that Acquisition Managers rigidly adhere in every acquisition to the scope or degree of detail specified herein. The provisions are intended only as a comprehensive outline of an ILS planning process. The Instruction contains most of the considerations that must be included. This "outline" is considered applicable regardless of whether the acquisition is for a relatively simple equipment requiring little or no military design or for a highly complicated system that requires all the formalized phases associated with R&D programs.

- The application of NAVMAT INST 4000.20 is, therefore, governed by the provision that the Acquisition Manager will "tailor" each planning process to "fit" appropriately a particular acquisition in terms of complexity, sophistication, and resources justifiable and available.

5.1.6 Director of Defense Research and Engineering Report OEM-1

Title: Survey of Studies and Computer Programming Efforts for Reliability, Maintainability, and System Effectiveness

Publication Date: September 1965

Scope: This report represents a preliminary survey of efforts underway, or recently completed, for computer programming or techniques that are adaptable to computer operations.

General: The methods and techniques listed are in the areas of system analysis for reliability, maintainability, availability, system effectiveness, cost-effectiveness, system simulation, circuit analysis, and failure mode and effects analysis. Fifty-three references are included in the document.

5.1.7 NAVMAT Instruction 4000.15

Title: Management of Technical Data and Information

Publication Date: 20 November 1965

Description: This manual prescribes management procedures and implementing principles to be followed in effecting, within the Department of the Navy, established policies for improved management of technical logistics data and information. It reflects all current policy issuances from higher authority affecting this area of operation throughout the Department of Defense. It further reflects Navy policy issuances still in effect and supports those ongoing Navy programs that are to be continued and intensified.

The manual provides (1) detailed directions whereby data requirements are identified and selected to suit intended uses, (2) procedures for data acquisition and control, and (3) techniques to keep to a practical minimum the essential data required by the Navy from defense contractors.

Provisions of the manual apply to technical logistics data requirements of all Navy Bureaus, Commands, and field activities incident to their participating in or supporting the definition, design, development, engineering procurement, production, test, maintenance, and follow-on logistics management of Navy weapons systems (aircraft, missiles, ships, submarines), subsystems, equipments, items, parts, and logistic supply support programs.

The Navy Technical Data Office (NTDO) has been established in the Office of Naval Material to plan, implement, review, and monitor the intra-Navy application of policies and procedures that give effect to the technical data and

5.1.8 MIL-HDBK-217A

Title: Reliability Stress and Failure Rate Data for Electronic Equipment.

Publication Date: 1 December 1965

Scope: A complete technical handbook on reliability engineering for electrical and electronic parts up to the complexity of electric motors; includes environmental effects, design considerations, application, failure modes, failure rates, operating factors, mathematical concepts, probability tables, probability graphs, preferred parts list, and other data necessary to reliability, design, and test engineers.

General: The principal sections of the handbook are as follows:

- Reliability fundamentals
- Rules for establishing failure-rate values
- Part failure characteristics
- Procedural routine for failure-rate summation
- Electron tubes
- Semiconductor devices
- Resistors
- Capacitors
- Transformers, magnetic amplifiers, inductors, and coils
- Rotary electrical devices
- Relays and switches
- MINUTEMAN part failure rates
- Micromodule reliability
- Wire and cables
- Low-population parts

Sections of the handbook are also devoted to:

- FARADA program
- IDEP program
- Other data sources
- Reliability models
- MIL-STD-756A techniques
- NAVSHIPS 93820 techniques
- Description of ARINC Research techniques
- How to make predictions
- Parts manufacturers by class
- Microelectronics
- Hybrid circuits
- Integrated circuits
- Reliability calculations
- Redundancy techniques
- Degradation factors
- Tolerant circuit design

5.1.9 MIL-STD-756A

Title: Reliability Prediction

Publication Date: 15 May 1963

Scope: Establishes procedures for making quantitative reliability predictions of aircraft, missiles, satellites, electronic equipments, and subdivisions of these equipments during the conceptual phase and the detail design phase of development.

Description: Classifies reliability prediction procedures into two types:

(1) Type I: Feasibility Prediction Procedure. Utilized when design is not finalized. Employs functional complexity. An active element (tube or transistor) parts count. Identifies the steps to be taken in sequence to accomplish the prediction:

(a) Define the product

(b) Establish the reliability

(c) Establish functional complexity

(d) Compute the reliability of the product

(2) Type II: Design Prediction Procedure. Utilized when design has been finalized. Employs total complexity; i.e., a count of all parts. Identifies the steps to be taken to accomplish the predictions:

(a) Define the product

(b) Establish the reliability

(c) Determine the part population for each functional block

(d) Determine appropriate stress factors for each part

(e) Assign applicable failure rates to each part

(f) Compute reliability for each functional block

(g) Compute the reliability of the product

Each step is briefly explained, and general guidance on the basic segments of each step, assumptions required, information sources, and suggested derating environmental factors is provided.

For Type I, Step (c), a chart provides reliability mean-time-between-failures values based on the quantity of electron tubes, transistors, diodes, etc., expected to be used in a given electronic equipment or subsystem.

Required Documentation:

- Establishes the minimum requirements for reliability-prediction reports. Timing to be established by the procuring activity.
- In the event that prediction results are lower than the specified or required reliability, alternative solutions to achieve conformance must be presented in sufficient detail to permit evaluation. No timing specified.

Referenced Documents:

- MIL-STD-721 - Definitions for Reliability Engineering
- MIL-STD-280 - Definitions of Terms for Equipment Divisions
- MIL-HDBK-217 - Reliability Stress and Failure-Rate Data for Electronic Equipment

5.1.10 NAVSHIPS 93820

Title: Handbook for the Prediction of Shipboard and Shore Electronic Equipment Reliability

Publication Date: April 1961

Scope: Describes methods of performing basic reliability predictions for certain Naval electronic equipment and illustrates sample applications based on the degree of accuracy required of the prediction and the amount of detailed information available for the system. Provides sample calculations, presents a number of electronic part failure-rate tables based on actual measured results, and uses the data in the sample calculations.

Description:

(1) Explains and/or defines common reliability terms and the use of probability theory to predict system or component success ratios. Explains some of the reasons for making reliability predictions and approaches to making them.

(2) Discusses the basic mathematics of reliability prediction and gives simple examples, using reliability equations as applied to the functional operation of the equipment. Identifies and explains, with examples, four methods used in making reliability predictions. The application of each method is based, in general, on the following:

(a) The accuracy of the available failure-rate data

(b) The degree of knowledge of the specific equipment to be used and its application in the system

(c) The specific environmental conditions and operating times to which the equipment is expected to be exposed

(d) The accuracy required of the prediction, and the man-hours available to perform the prediction tasks

The four prediction methods are identified as follows:

Method A: System Prediction from Typical Equipment Failure Rates. Where the proposed system approximates in design and function one of the ten typical equipments listed, Method A may be used to provide a reasonable estimate of equipment reliability.

Method B: Equipment Prediction from the Active Element K Factor. Where the proposed system approximates in design and function one of the ten typical equipments listed in Method A, but does not have the same number of active elements (tubes or transistors) as the typical equipment, Method B may be used. Each type of equipment has associated with it a constant called an "active element K factor." This constant is then multiplied by the number of active elements in the equipment to obtain the failure rate.

Where the circuit types are known, the Method B prediction can be refined by use of failure rates for specific functional circuits. Average failure rates are given for 38 electron-tube circuit types and 14 transistor circuit types, together with a brief description of each circuit. Where only a portion of the circuit types are known, the two Method B prediction methods can be combined.

Method C: Equipment or Circuit Prediction from Average Parts Failure Rates. Where the type and number of parts (including active elements) in an equipment or circuit are known, reliability can be predicted by using Method C. The number of parts in each parts category is multiplied by the average parts failure rates, and the products are then combined. Adjustment-type failures are also accounted for with this method, but no circuit analysis is required.

Method D: Equipment or Circuit Prediction from Parts Rates with Severity Functions. Where detailed design and application information is available, Method D can be used to predict the reliability. It is the most accurate of the four, but also the most time-consuming since a circuit analysis must be performed to determine the stress (severity of application) on each tube, resistor, and capacitor in the design.

(3) Presents failure-rate tables for IFF, TACAN, Radar Indicator, Search Radar, Radio Direction Finder, Communication Receiver, Active Sonar, Transceiver (containing both tubes and transistors), and Communication Transmitter.

Part failure rates for various capacitors, connectors, counters, motors, inductors, diodes, and electron tubes are tabulated. All failure-rate tables are based on measured data and, in some cases, extrapolated on the basis of percent of applied full load power or electrical parameters. These data are subsectioned to be easily applied to the corresponding prediction method being applied.

5.1.11 FARADA

Title: Failure Rate Data

Publication Date: Updated Periodically

Scope and General: See Section 2.1.3.

5.1.12 IDEP

Title: Interagency Data Exchange Program

Publication Date: Updated Periodically

Scope and General: See Section 2.1.4.

5.1.13 MSFC Astrionics Division

Title: Components Failure Physics Analysis

Publication Date: 15 May 1963

Scope: Covers Failure Physics Stress analysis, including definitions of equipment Therbligs , Failure Stressors, Failure stresses, failure Mechanisms Failure Modes, and Failure Therbligs. Failure rates and the determination of K-factor modifiers are included.

General: Analysis of the various basic component parts is presented under systematic criteria. The assumption is made that the Failure Stressor creates a Failure Stress of sufficient magnitude to cause a failure. Consideration is given to the likelihood of Failure Stresses. In cases where the likelihood of certain failure stresses is very remote, these stresses are not included in the analyses.

Results of the analyses are recorded in the Failure Physics Stress Analysis tables. Each table is accompanied by a written explanation which shows the considerations and processes used. These analyses result in the determination of failure Therbligs associated with each component part. The Failure Therbligs are assigned a proportion of the generic failure rate, in proportion to their likelihood of contributing to failure (see Section 2.5). It is noted that a knowledge of failure Therblig failure rates is necessary to properly conduct failure-effect analysis, reliability estimates, and component-part-application studies.

A failure Therblig failure-mode program was introduced at the beginning of the task to support the MSFC Astrionics Division Failure Effects Analysis Program. By making failure rates available for each of the failure Therbligs, more useful and valid failure data were obtained. The improvement in validity is achieved by considering only those failure rates associated with actual failures.

The first step provides for the performance of failure physics stress analyses on each of the basic component part types. These analyses are valuable, since detailed information for each component and each environmental stressor are made available. The information is recorded in tabular form. Each table is supplemented by a text discussion that explains the analytical steps taken and the considerations upon which the analyses are based. The precise meanings of the terms employed in the failure physics analysis tables are defined.

This study recognizes that varying degrees of severity found in the environment surrounding the component parts have a pronounced effect on their reliability. To provide a tool for failure-effects analysis, K-factors are derived that permit correction of environmental severity differences. A basic condition of computer laboratory environment is established. K factors for the conditions encountered in the S-I and S-IV vehicles are determined. This program is supported by failure data from which the failure Therblig failure-rate apportionments have been made. A discussion covering this data and the methods of calculation employed is included in this report, with mathematical derivations included in Appendix A.

The failure Therblig failure-mode program is by nature a continuing one. This report presents the initial accomplishments. The exact status of the program is not known because of the lack of recent documentation.

Generic failure rates included in this study are associated with the following hardware:

- Accelerometers
- Ceramic capacitors
- Glass capacitors
- Mica capacitors
- Paper or film capacitors
- Tantalum capacitors
- Subminiature circuit breakers
- Industrial circuit breakers
- Mechanical pressure strain gages
- Precision variable potentiometers
- General purpose relays (coil mechanism)
- General purpose relays (switch mechanism)

Fixed composition insulated resistors
Metal film resistors
Silicon semiconductors, transistors, and rectifiers
Manual switches
AC induction tachometers
Thermocouples
Electric signal transducers
Pressure transducers
Variable-resistance potentiometer transducers
Subminiature transformers
Power transformers
Vacuum receiving tubes
Thyratron electron tubes

Analysis and data is provided on the following factors:

Wear coefficients for sliding under adhesive wear conditions
K_{op} failure-rate modifiers
Failure Stressor applications
Reported relay failures
Failure Therblig failure rate tabulations
Failure Mode failure percentages
Failure Stressors versus installation environment

5.1.14 Rome Air Development Center

Title: RADC Reliability Notebook

Publication Date: 30 October 1959

Scope: Reliability services, program management, prediction mathematics, testing, and environmental factors in the areas of mechanical, electrical and electronic design, and hardware.

General: Concepts of the RADC Reliability Notebook are intended to cover the scope of the RADC reliability program. Each item handled in this notebook reflects the state of the art at the time of publication or revision. The notebook is issued in looseleaf form for flexibility of revision. As advances are made in the field of reliability, the notebook is revised accordingly. The Reliability Notebook does not attempt to cover all factors affecting reliability. Only the more significant factors are considered or those known to be significant and of current interest. Maintainability is not covered to any great extent or in detail. A program is now underway to revise and reorganize the original publication.

The revised RADC Reliability Notebook will include two volumes and will be organized into two sections: Section I of volume I, entitled Reliability Management, will provide guidelines for system project officers and reliability managers who are responsible for directing and monitoring system and equipment reliability programs. It will be designed to aid management decisions throughout the system life cycle. It will discuss the merits, shortcomings, and cost of available reliability practices and techniques. Section I is to be a guide for preparing, specifying, evaluating, directing, monitoring, and improving system or equipment reliability. Section II of Volume I, entitled Reliability Engineering, will contain detailed descriptions of reliability methods and techniques. It will be designed for use by project engineers in evaluating methods and techniques, and for use by the reliability engineers who will apply them.

Sections I and II of Volume I of the Reliability Notebook will reflect the Air Force's needs in ground, airborne, missile, and space applications. They will be developed so as to be compatible with the reliability data and failure-rate curves of Volume II. The reliability practices, methods, and techniques specified in Section I are described in Section II and can be cross-referenced.

5.1.15 Rome Air Development Center

Title: Dormant Operating and Storage Effects on Electronic Equipment and Part Reliability -- Technical Report No. RADC-TR-66-348

Publication Date: Second Interim Report, dated October 1966

Scope: Non-operating failure rates and factors, failure analysis, design considerations at the parts level, and mathematical models.

General: Over 78 billion part-hours of storage information were collected from all sources. The data were processed and presented as non-operating failure rates for part classes and subclasses, as well as for printed-circuit boards and systems.

A thirteen-month data collection, analysis, and failure-mechanism-detection program was conducted to determine electronic part and equipment failure rates in storage and in dormant operating conditions. The program employs data from an extensive literature search and experimental test programs on parts and equipment with known storage histories. A quantity of data from contractors under Air Force cognizance is included.

Test data from the storage programs are said to have been statistically analyzed to determine significant performance drift trends with non-operating time. Part failures that occurred during storage were dissected in the laboratory, and failure mechanisms were isolated. Case histories of these analyses are

information program. Counterpart offices, with a similar span of interest and with like responsibility within their own organizations, carry on the work of this program in their Command, the Office of Naval Research, and in each of the Material Bureaus. Project Offices and major Procurement Offices at subordinate levels make optimum use of Data Managers and Data Management Officers, as appropriate, in support of this program.

5.2 Contractor Documents

5.2.1 ARINC Research Corporation, Publication 317-02-2-647

Title: Avionics Reliability and Maintainability Prediction by Function

Publication Date: July 1966

Description: This report was prepared by ARINC Research Corporation under USAF Contract 30(602)-3387. Technical direction of the reliability investigation was provided by the Engineering Division, Rome Air Development Center, Griffiss Air Force Base, New York. The maintainability investigations were also conducted under the direction of RADC's Engineering Division.

This technical report presents the results of a broad investigation that seeks to advance the state of the art of the data analysis techniques used to predict system reliability and maintainability. Principally, this study was directed toward development of a reliability prediction-by-function technqiue for avionic equipment and units. As a result of the large-scale data-collection and analysis program carried out during this study, a series of equations were formulated that permit the prediction of mean time between failures through a knowledge of selected performance parameters. These parameters represent quantities that are generally known early in the design cycle, enabling reliability predictions by function to be made long before parts population and stress data, the basis of existing prediction techniques, become available.

As a result of this study, the development of maintainability prediction-by-function techniques for avionic equipment was determined to be feasible. Predictions in terms of shop mean time to repair, based on general design characteristics, were shown to be possible.

The feasibility of drawing useful reliability design guidelines from engineering and data analysis also was established. It was determined that design criteria can be formulated to benefit the circuit designer.

5.2.2 ARINC Research Corporation, Publication 267-02-6-420

Title: Maintainability Prediction - Theoretical Basis and Practical Approach

Publication Date: 31 December 1963

Description: ARINC Research Corporation, under a series of Air Force Contracts, performed a long-term study of methods for procuring maximum value from airborne

electronic equipment. The study covered by this report revises an earlier version of the maintainability prediction technique.

This report not only summarizes the theory behind the maintainability prediction technique, but also introduces several refinements. The most significant of these is the prediction of initial delay.

The introduction of this latter technique permits predictions of the distribution of total system downtime due to malfunctioning equipment. It uses measurable aspects of the equipment to predict the probability of occurrence of certain Elemental Activities. The probabilities and the observed times required for their performance are combined, according to a series of combinatorial relationships, to produce larger and larger categories of maintenance time, and finally, a distribution of total system downtime.

The technique, developed for airborne electronics equipment, is applicable primarily to equipments and systems used under the Air Force general maintenance policy and only at the flight-line level. However, the research approach and the basic relationships developed should provide for a degree of general application.

Sample predictions are made for several systems, and the results of some of these verification studies are included.

5.2.3 ARINC Research Corporation, Publication 152-2-274

Title: The Allocation of System Reliability

Publication Date: 30 November 1961

Description: This report, in two volumes, presents the final results of an ARINC Research Corporation study on methods for allocating weapon-system reliability requirements. The study was conducted under Air Force Contract AF 33(616)-7468 for the Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. Research started on July 1, 1960 and was completed November 30, 1961.

The development of the allocation model, procedural methods, and data inputs required for implementation of the methods are described in detail in Volume I. One section covers the various reliability-testing techniques for determining compliance to allocated requirements, and also presents guidelines for the selection of appropriate test plans.

Volume II outlines the step-by-step procedure for implementing the allocation models. Two of the more complicated steps are detailed in the appendixes of Volume II. The basic data inputs and the procedure for using them are described in Appendix A. Methods for determining the feasibility of the system requirements are described in Appendix B. Detailed examples of the complete allocation procedure for serial, modified serial, redundant, and bimodal systems are presented in Appendix C. Several sections of Volume I are duplicated or condensed in Volume II so that the latter may be self-contained and used independently of Volume I.

5.2.4 Boeing Space Center D2-22440 Publication

Title: Information Storage and Retrieval System -- Reliability, System Safety, and Product Assurance

Publication Date: June 1963

Description: This document is a guide for users of the information system maintained by Boeing Reliability, System Safety, and Product Assurance. The Data Center within this organization provides support to all Aerospace Group programs and also exchanges data with other Boeing divisions, other companies, and Government agencies. The principal file areas maintained by the Data Center are (1) Technical Reference File, (2) Historical Information and Failure Data File, and (3) Interservice Data Exchange Program (IDEP) File. The contents of these files, the indexing media, and the optimum search and retrieval methods are described in detail.

Frequent searches are made for historical data and technical information on specific topics that are required for reliability- and safety-assurance tasks. The time and effort involved in research have been greatly reduced by retaining the most frequently used reference materials within the immediate area. The Data Center has been assigned the responsibility of organizing and maintaining an information storage and retrieval system for use by the space center personnel and by personnel from other organizations. The system developed for filing, retrieving, and checking out these materials utilizes standard library methods wherever practical.

The Data Center furnishes the services of "information specialists" to provide information and assist the users in searching for material on specific subjects. The specialists, who are an integral part of the information system, are completely familiar with the subject categories and filing sequence of each of the major file areas. Therefore, they are able to suggest an effective search method for retrieving the desired information. In many cases, they are able to suggest additional sources.

5.2.5 Boeing Company D2-4819 Publication

Title: Aerospace Division - Supplier Reliability Guide

Publication Date: 15 September 1961

Description: This document was originally developed in response to MIL-R-26674 but is still applicable as reference material for contractor programs that must maintain surveillance over the reliability activities of suppliers. The contents provide guidelines of integrating subcontractor and supplier reliability programs into a master program for control purposes.

Provisions are included for maintaining a supplier selection system, based on reviews of the supplier's reliability program, quality control system, inspection of facilities, and past performance to assure that the suppliers selected are capable of maintaining the required level of performance. Records of each supplier's performance are maintained, from which an approved source list is established and periodically reviewed. This system assists the suppliers in problem solutions and provides feedback on corrective actions as necessary.

The basic program provides for the recognition, development, authorization and staffing of all disciplines required to optimize reliability. The degree to which a supplier implements reliability disciplines establishes his initial reliability rating. This rating is a principal factor in the selection of Boeing suppliers. How well the supplier applies basic disciplines to a particular project, based on the reliability requirements and cost definitions, determines the manner and degree of change made in his initial rating.

5.2.6 General Electric Missile and Space Division

Title: Vendor Reliability Specification SVS-4270

Publication Date: 21 September 1962

Description: This specification, developed in response to MIL-R-27542, provides criteria for complete supplier reliability programs that are integrated as contractual commitments. Assistance is provided to the supplier in the form of guidelines on establishing a reliability organization and program. Comprehensive Work Statements are required from suppliers to indicate that they understand the specifications and the degree to which they will meet the requirements.

After a supplier has become oriented to comply with the specification, he submits a program plan for review and approval, together with a proposal on the cost of implementing the program plan. The proposal is then evaluated and negotiated as a contractual document, and a program plan manual is published and distributed by the supplier.

The program plan manual provides details on how the supplier will meet the requirements, his organization to implement the plan, and periodic reports that will be submitted. For example, a reliability stress analysis is required for the hardware (Numerical Requirement - 3.2.2), a formal reliability organization is mandatory (3.2.3.2), design and process controls must be established (3.2.8), and test requirements must be developed and implemented (3.2.14) -- to list only a few of the basic requirements.

5.2.7 General Electric Missile and Space Division TRA-873-74 Publication

Title: Handbook of Reliability Analysis Data for Systems and Component Design Engineers

Publication Date: 1 July 1961

Description: Prepared to provide the design engineer with the tools and techniques to be utilized for achieving the highest possible reliability in his design responsibility, this handbook represents the results of consultations between reliability consultants and design engineers that have taken place since the original handbook was released in April 1960. The original and revision were developed and published by the Missile and Space Division of General Electric Company at Valley Forge, Pennsylvania. Principles, procedures, and techniques are included for all phases of reliability analysis, including computational methods, derivations of an exponential distribution, tables, and reporting forms.

5.2.8 Honeywell Ordnance and Aeronautical Division Publication

Title: Reliability Handbook

Publication Date: January 1963

Description: Originally developed in 1959 by the Honeywell Reliability Committee, in coordination with eight Military Product Groups, the handbook was expanded and revised prior to the most recent publication date.

The handbook was developed to explain reliability, and to serve as a reference to the engineer with responsibility for developing reliability in the product. It outlines some of the steps to be taken to achieve reliability in a given design and to evaluate and measure the design in terms of reliability. In some examples, the mathematical basis of reliability is shown. The appendixes provide bibliographies, definition of terms, and abstracts of appropriate specifications. They also cover quality control interfaces, sequential sample tests, and reliability through safety margins.

5.2.9 Hughes Aerospace Division Publication

Title: Component Application and Reliability Handbook for Aerospace Equipment

Publication Date: November 1964

Description: The primary purpose of this handbook is to achieve more reliable design by providing the designer with pertinent component application and failure rate data. This handbook replaces Designers Reliability Handbook R-67-2, dated 13 March 1962.

The assumption is made that the ultimate success and reliability of electronic equipment is controlled by individual components and how they are applied. The ability of an electronic system to meet its design objectives is described as a function of three types of component consideration:

(1) Selection for physical and electrical characteristics

(2) Design application to optimize functions for various combinations of electrical, mechanical, and environmental stress

(3) Failure rate, under conditions indicated above, consistent with the overall system requirements

This handbook is bound in volumes. Each volume comprises one or more chapters. Each chapter treats a unique component family, such as capacitors, resistors, etc. Chapters are presented in four sections:

Section 1 - Part Selection Guide
Section 2 - Comparative Information
Section 3 - Specific Information
Section 4 - Stress Analysis and Derating

The first section is said to enable the designer to categorize application of the component and select from a number of unique component types within the component family. The second section compares the various characteristics of the component types. This information is presented to give the designer a working knowledge of the characteristics and limitations of the selected type of component.

Additional details on the characteristics and limitations of component types are given in the third section. The bulk of the information in the third section is presented in the form of charts, graphs, and tables.

Stress analysis and derating data presented in the fourth section are intended to assist the designer in establishing a failure rate for the selected component. This section also provides data for determining the optimum derating factor for selected components in a specific environment and application.

5.2.10 Lear Siegler Astronics Division Publication

Title: Astronics Reliability Manual

Publication Date: 1966

Description: This manual was prepared by the Astronics Division as a guide for the Division's reliability activities. In addition to material on the mathematical treatment of reliability, it also contains discussions of failure-rate data and their application, reliability testing, formal reliability programs, and methods of collecting, recording, and analyzing reliability data.

Techniques and procedures for design reviews are covered, together with sample checklists. These checklists include the areas of general layout, electrical parts, environment, human factors, microcircuits, electromechanical and mechanical parts, installations, and a procedure on reliability follow-up.

The analytical-methods section gives definitions and concepts, life histories, random failures, failure rates, basic calculations, and redundancy treatments. Basic statistical methods are also covered in the last section.

5.2.11 Martin Orlando Report RR-001

Title: General Test Plan - Reliability Safety Margin Demonstration

Publication Date: January 1964

Description: This publication reports on a plan developed to present several methods for performing safety margin tests and to describe the advantages and disadvantages of each method. The plan was designed for safety margin testing on SPRINT NIKE-X equipment. This plan is intended to meet requirements for the formal demonstration of operating safety margins in subassemblies and assemblies and at the unit-module level.

The safety margins are demonstrated from the results of a test-to-failure program. The objective of the test-to-failure program is to demonstrate an operating safety margin of 5 with 70% confidence for each significant operating characteristic.

The equipment to be tested is divided into two categories:

(1) Devices that are capable of being operated repeatedly or continuously for long periods of time

(2) Devices that are capable of "one shot" performance only.

One-shot devices are subdivided into those devices for which small quantities are available for test and those devices for which large quantities are available for test.

Four methods for performing tests to failure are evaluated: a direct-measurement method, and the Langlie, Bruceton, and Probit sensitivity-test methods. A brief description of each method is given, and the advantages and disadvantages of each are discussed. A procedure is recommended for each category of equipment to be tested. For devices of the first category, it is recommended that direct measurements of failure stresses be recorded and that standard estimating and analysis techniques be used to evaluate the data. For the one-shot devices, it is recommended that sensitivity-testing technicians be used to establish the safety margin. Specifically, for those one-shot devices which will be available in small quantities, it is recommended that the Bruceton

sensitivity test method be used. The Probit sensitivity test method is recommended for the one-shot devices when large test quantities are available. A general test procedure and method of analysis is presented for each recommended test procedure.

5.2.12 Martin Orlando Publication OR-3583

Title: Maintainability Analysis and Evaluation

Publication Date: October 1963

Description: This publication was developed under Contract DA-01-009-ORD-634 to meet MIL-M-45765 for the U.S. Army. This specification established the quantitative maintainability requirements for weapon systems and equipment. It also covers qualitative requirements for active maintenance downtime at the operational level.

Quantitative requirements are integrated into a maintainability program and are based on the numerical computation of the expenditure of time, manpower, and other maintenance resources to maintain the specified operational and inherent availability. The quantitative maintainability program, covered in this plan, is divided into four sections as follows:

(1) Prediction Technique. The technique described in this plan was adopted from the method generally accepted by the three services. It was developed to provide an engineering tool for designing equipment to achieve maintainability goals. The prediction technique produces maintenance time budgets and mean and maximum corrective and preventive downtime to be used for design analysis. To ensure the highest degree of maintainability at the lowest cost, the technique is used at the earliest design phases as a continuing process, throughout R&D production, and tactical life of the equipment. If it is not implemented early in the program, the technique can be used to give the user an accurate accounting of the system capability, skill level requirements, support requirements, availability, etc.

(2) Design Analysis. The prediction technique is augmented by the use of design analysis methods. Design concepts are analyzed to assist in developing maintainable equipment for field use. This plan includes the quantitative treatment of these methods by analysis of the maintenance-downtime budget allocation. Trade-offs within and among physical design features, facilities, test equipment, and maintenance skills can be identified to assist designers in meeting downtime budgets.

(3) Maintainability Demonstration. The equipment is tested to determine compliance with maintainability requirements. An engineering prototype, or other late-model tactical equipment where no prototype is available, serves as a demonstration model. Evaluations are performed concurrently with other prescheduled tests on a non-interference basis. A separate detailed plan is prepared for any such operation.

(4) Test Evaluation and Reporting. Evaluation is provided for review and scoring of local and field tests. Maintenance-time budgets are assessed to provide actual accounting of the system capability and an evaluation of equipment design. Feedback and control of maintainability characteristics are accomplished. When actual performance during testing indicates that goals are not being met, recommendations for corrective action are made.

This plan includes quantitative estimates of all equipment replaceable at the operational level. Estimates are updated on actual downtime as testing progresses. Monthly reports are issued to summarize outstanding problem areas.

5.2.13 North American Aviation Autonetics Division Reliability Test Data

Title: Statistical Analysis of Electronic Parts Reliability Test Data

Publication Date: 8 June 1964

Description: To obtain the high degree of reliability required for the MINUTEMAN Guidance and Control Systems, Autonetics imposed reliability improvement programs on MINUTEMAN electronic suppliers. Each supplier was contractually obligated to obtain information on the characteristics of his particular part through prescribed testing. The large volume of data obtained from these tests were processed and analyzed. Rather than analyze the data with a collection of independent computer programs, an integrated system of analysis programs was developed and used to analyze the electronic parts parameter data. The statistical analysis methods, data processing, and graphic examples of the analysis outputs are described and presented in this report. The report states that the statistical methods, techniques, and computer programs discussed are applicable to the majority of engineering test data collected in the electronic industry today.

This report (PUB X4-880/3111) was presented at the Fort Monmouth Reliability Symposium in 1964. It represents the approaches taken for the complete analysis of electronic parts test data that were developed during the MINUTEMAN Reliability Improvement Program. Extensive reliability life tests were conducted on approximately 300,000 parts for periods of approximately 5000 to 10,000 hours. These tests, called matrix tests, were performed at many conditions of temperature,

power, and voltage. The purpose of the tests was to provide information to accomplish the following objectives:

(1) Improve reliability by obtaining failure-mode data and feedback for design and process improvement

(2) Completely characterize reliability of electronic parts

(3) Develop screening techniques

(4) Develop realistic acceptance procedures

To assure that the objectives of the Reliability Improvement Program had been met and to define clearly the reliability characteristics of the parts, an extensive analysis of the suppliers' data was developed. The basic approach of this analysis was to use graphic presentations of computer analysis to show trends in the characteristics of the parts with time and stress, and to define these trends in an analytical manner. The analysis used both failure data and electrical-parameter data. The parameter-data analysis was necessary because it was found economically unfeasible to conduct tests of sufficient duration or size over all desirable test conditions to generate enough failures for an extensive failure analysis.

Computer routines were developed to analyze the data and to present the output in a primarily graphical manner. The graphical output was presented on the Stromberg-Carlson 4020 CRT plotter, which accepts computer output and automatically plots the results. Data were submitted to Autonetics by suppliers on IBM cards, which amounted to approximately two-million cards. This volume of data required a new approach to the way in which the IBM 7094 computer was to be utilized in the analysis. This approach did not require an independent collection of analysis programs, but rather an integrated system of analysis programs. Two statistical analysis systems were developed to analyze any quantity of test data.

5.2.14 Reliability-Information Retrieval System

Technical Coverage: Reliability, maintainability, and value-engineering information and reports.

Mission and Description: The Reliability-Information Retrieval System (RIRS) is a commercial service for maintaining continuous cognizance of all areas that influence and affect the reliability, maintainability, and value-engineering fields. RIRS provides information tailored to the individual specialist.

Basically RIRS will provide subscribers each month with 40 to 50 coded summaries of selected articles pertinent to reliability, maintainability, and value engineering. Selected articles are summarized on 5 × 8-inch punched coded cards. It is reported that these cards require no special filing and are

retrievable whenever information in a specific area is required. The summaries are short, concise reviews summarizing the pertinent information and listing the title, author, date, and source of information.

Status: RIRS is reported to be used by Government agencies, prime system contractors, aerospace industries, and universities. Smaller companies are reported to have also used RIRS to support their reliability organizations.

Each summary is coded by the classification system shown on the file card. Tweleve major subject headings with more than 90 subdivisions are used, plus a section for special codes. The holes along the edge of each card are notched to correspond to the applicable subject.

This method of coding aids in classifying the subject and is used primarily for information retrieval. When information is desired in a specific area, a sorting needle is inserted through the hole of the desired classified subject. The cards are loosely held and the sorting needle lifted, and the cards containing the desired information -- those notched at the appropriate number -- will drop out for further study. This method of retrieval requires no time-consuming indexing or file searching, but simply the insertion of a needle into the desired classified hole.

All aspects of reliability, value, and maintainability engineering are covered. Journals, magazines, and symposium proceedings are searched for pertinent information. RIRS personnel attend applicable symposiums and meetings, interview authorities and search for information sources. The most desirable articles, presentations, or interview information are selected for inclusion in RIRS.

Summaries are prepared and shipped monthly, usually from 40 to 50 per shipment depending on currently available information. The majority of the summaries are mailed within three weeks after material becomes available.

Copies of the original articles are available at nominal cost.

A sorting needle and metal filing box are provided with the first shipment.

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5.2.15 ARINC Research Corporation Publication 203-1-344

Title: Prediction of Field Reliability for Airborne Electronic Systems

Publication Date: 31 December 1962

Description: Discusses a prediction procedure in general terms and details a step-by-step procedure for the prediction itself. The procedures and formula derivations are discussed in detail, and the observed part data are presented in the appendices under (1) Part Malfunction Rates, (2) Confidence Interval Prediction for System Malfunction Rate, and (3) Prediction of Operational Characteristics.

Also presents part reliability data for airborne electronic systems, including failures per hour and required adjustments per hour. The data are based on experience gained in 200-million part-operating hours that were accumulated in nine different types of airborne electronic systems used in the B-52 aircraft. These failure rates are sometimes referred to as the "ARINC failure rates."

5.2.16 ECRC Data Center

Technical Coverage: Reliability information on electronic parts -- summaries of test reports generated by users of the equipment and parts.

Mission and Description: The ECRC program was initiated at Battelle Memorial Institute, Columbus, Ohio, on 1 March 1959. The membership includes both Government and industrial organizations.

Organizations support ECRC through individual contracts with Battelle, which are renewable annually. Representatives of the member organizations meet at Battelle yearly, and Battelle personnel visit member installations each year to discuss the program.

The objective of the ECRC Data Center is to provide members with test information generated by users of electronic reports. Virtually all the data are obtained from reports submitted to the program by the individual member organizations. These reports are summarized by ECRC data analysts.

Status: The outputs of the ECRC Data Center are as follows:

- Technical Memorandums [illegible] provide state-of-the-art information, and data [illegible] from which manufacturer comparisons can be made, for high-use parts
- An Index of all reports summarized, arranged both by IDEP classification number and by alphabetical listing of manufacturers
- Data Summaries, which abstract data contained in test reports submitted by the members

- Copies of Test Reports, provided on request from the members
- A Special Services feature, which provides easy access to all Battelle's capabilities for quick-response projects

The cost of participation is $5000 a year, plus an additional $5000 the first year to cover the cost of issuing the necessary backlog of documents to the new member. (Cost to Government agencies is $4,600 a year, and no special services are provided).

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5.2.17 MINUTEMAN High-Reliability Component Parts

Title: Final Summary of Matrix Data - Report No. C4-83/319

Publication Date: 30 January 1964

Scope: Published by the Autonetics Division of North American Aviation under Contract AF 04(647)-923; presents a final summary of analyses of supplier data on MINUTEMAN high-reliability-electronic-component parts. The report contains descriptions of supplier tests and a sample of the analyses performed. The analysis included in this report consists of graphical presentations of both failure-rate and parameter-stability analyses and estimates of the failure rate and the acceleration factor. The data analyzed are primarily from the most recent matrix tests.

Description: At the inception of the MINUTEMAN contract, the reliability requirements for the guidance and control equipment were greater than could be achieved at the time. The MINUTEMAN system was required to be in a state of operational readiness in an underground silo with all equipment in a GO condition.

The report describes a Reliability Improvement Program Plan, which includes a series of tests that the parts supplier would implement to assure failure-mode detection and subsequent corrective action. The details of these tests are described in this report. One series of tests, the matrix tests, were life tests describing part-parameter behavior over a wide range of stress conditions.

The parts suppliers were required to submit analysis reports to assure that the failure-rate objectives were met. The data taken during the parts test contained information useful to all MINUTEMAN groups. Autonetics prepared a magnetic-tape history file or "data bank" based on the matrix tests.

The information from this data bank is currently being used to fulfill some of the requirements of the AFSC Parts Management Program. It is believed that these data will be useful in other programs to assure the growth and use of a family of known reliable parts.

This report presents a summary and a sample of the information available from the MINUTEMAN matrix tests.

5.2.18 Martin/Denver MI-60-54 and M-63-3 Publications

Titles: Reliability Application and Analysis Guide

Engineering Reliability Policy and Procedures Manual

Publication Dates: July 1961
October 1963

Description: The failure rates contained in MI-60-54 (Rev. 1) are sometimes referred to as "the Martin failure rates." A later version of this publication is the Engineering Reliability Policy and Procedures Manual, M-63-3 (Rev. 3), October 1963, Martin Company, Denver, Colorado.

The failure rates appearing in MI-60-54 (Rev. 1) first received wide circulation in a paper by D. R. Earles published in the Proceedings of the Seventh National Symposium on Reliability and Quality Control, January 1961, "Reliability Growth Prediction During the Initial Design Analysis."

A second paper by Earles, M. F. Eddins, and D. R. Jackson, "A Theory of Component Part Life Expectancies," appeared in the Proceedings of the Eighth National Symposium on Reliability and Quality Control, January 1962. This paper contains a tabulation of generic mean life expectancies for several hundred electronic, electrical, electromechanical, and mechanical parts. In it, life expectancy is defined as the point in time, or cycles, at which the failure rate increases above that due to random failures. A third paper, by Earles and Eddins, reporting on work performed with the AVCO Corporation, Wilmington, Mass., "Reliability Physics (The Physics of Failure)," appeared in the Proceedings of the Ninth National Symposium on Reliability and Quality Control, January 1963. This paper contains an updated tabulation of the generic failure rates and life expectancies presented at the two previous symposia. These values are sometimes referred to as "the AVCO failure rates."

6. DATA ELEMENT EVALUATION

Tables 3, 4, and 5 identify the data elements collected, and the collection forms used in 17 Government and 5 Contractor reliability and maintainability data-collection systems. Together, these tables provide a method of correlating the data element with each system data source so as to identify the type and number of data-element descriptors being collected by each of the 22 systems.

6.1 Table 3

Table 3 identifies the data elements collected for each of the 22 collection systems. These data elements are divided into the four main groups.

(1) Item Descriptors

(2) Reliability Descriptors

(3) Maintenance Descriptors

(4) Cost Accounting Descriptors

6.1.1 Item Descriptors

Item Descriptors are divided into two sections: (1) Item Identification, and (2) Hardware Location and Source Identification. The item-identification data elements identify the specific system down to the part level by name, part number, and serial number. The Hardware Location and Source Identification data elements locate the reporting organization and/or the activity using the equipment, the physical location of hardware in relationship to the particular system, the geographical location of the system, and identify the hardware manufacturer and contract number.

6.1.2 Reliability and Maintenance Descriptors

The Reliability and Maintenance Descriptors are also divided into two sections: (1) Time and Number Data Elements, and (2) Circumstantial Data Elements. The Time and Number Data Elements provide the quantitative information required to compute mean times/cycles between failures (MTBF/MCBF), failure rate, availability, and system effectiveness measures for the hardware. The Circumstantial Data Elements provide both the qualitative and quantitative information required for the following types of analyses:

(1) Confirm and isolate failures.

(2) Define the cause(s) of failures.

(3) Evaluate design performance and capability.

(4) Assess manpower and support requirements or deficiencies.

(5) Evaluate the supportability of the design in a military environment.

(6) Evaluate the operability of the design in a military environment.

6.1.3 Cost-Accounting Descriptors

The Cost-Accounting Descriptors are the data elements required to monitor the operational cost of the hardware. This information necessarily overlaps with certain of the other data-element descriptors. With the general exception of the Item Descriptor data elements, the most important data elements are repeated, where necessary, in the Cost-Accounting group to emphasize their dual application in Cost/System Effectiveness Analyses.

The other columns of Table 3 represent each of the data collection systems. The "X's" in each column mark the data-element descriptors collected by each system data source.

Each of the data-collection systems listed in Table 3 has been assigned an alphabetical system designator (A through V) for identification purposes. These alphabetical designators are also used in Tables 4 and 5 as a means of correlating the system data sources with the data-element descriptors collected and the data-collection forms used for each system.

6.2 Table 4

The first column in Table 4 lists the data-element descriptors and is identical to Table 3. The second clumn of Table 4 defines or explains the data-element descriptors. The third column itemizes the alphabetical designators of the systems that collect the particular data elements.

6.3 Table 5

Table 5 presents the data-collection forms used by each system. It is noted that certain of the data-collection systems use several data-collection forms. In such cases, an asterisk is inserted to indicate the form that was used to obtain the data in Tables 3 and 4.

The other data-collection forms are included to illustrate the various applications of reporting forms for management and equipment routing purposes. For the purposes of this Data-Source Guide, the forms selected to identify the various data elements collected are primarily used by organizational level maintenance activities, as opposed to intermediate or depot-level maintenance activities. Data elements collected at the latter maintenance levels seldom expand on the information collected during organizational maintenance activity. In a few cases, where some additional data is collected at the intermediate or depot-level, the additional data elements cannot be readily associated with the main body of information collected during the initial organizational-maintenance action.

6.4 Use of Tables 3, 4, and 5

Used together, Tables 3, 4, and 5 provide a conversion capability for the 22 data-collection systems. An example of how these tables may be used is given as follows:

If an MDCS participant requires data that are not collected under either MDCS (ships) or MDCS (air), reference can be made to Table 3 to determine under which systems the required data are collected. The participant can then refer to Table 4 to determine if the data elements of interest have the same definition in all systems. Then, by reference to Table 5, the data collection form which specifies the data's use can be found.

TABLE 3

IDENTIFICATION OF RELIABILITY AND MAINTAINABILITY DATA ELEMENTS COLLECTED BY EACH SYSTEM

(Item Descriptors, Reliability Descriptors, Maintenance Descriptors, and Cost-Accounting Descriptors)

Data Elements	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ITEM [illegible]																								
([illegible] Identification:																								
[illegible]			X		X							X		X				X	X		X	X		X
CID/APL/AN Number	X																	X						
[illegible] Name	X	X				X	X	X	X	X	X	X		X	X			X	X	X	X	X		X
[illegible] Identification Code	X	X		X				X	X	X	X			X		X		X	X	X	X	X		X
[illegible]	X	X		X		X	X	X	X	X						X			X	X	X			
[illegible]																			X	X	X			
[illegible]									X	X	X			X				X	X	X	X	X		X
[illegible] Identification [illegible]										X	X			X			X	X	X	X	X	X	X	X
[illegible]										X	X						X		X	X	X	X		
[illegible] Part N[illegible] or Identification Code	X	X			X	X			X	X								X		X	X	X		X
[illegible] Serial No.	X				X	X			X	X			X					X		X	X	X		
[illegible] Symbol/Designation					X	X														X	X	X		
[illegible] Part/Item Number	X	X			X					X		X	X	X		X	X	X		X	X	X	X	X
[illegible] Part/Item Name	X			X	X				X	X			X			X	X	X		X	X	X	X	X
[illegible] Part/Item Serial Number	X	X		X									X					X		X	X			
[illegible] Part/Item Symbol Designation or Code	X			X					X			X		X		X	X	X		X	X	X		
[illegible] N. (Removed Item)	X					X			X	X				X		X								
[illegible] (Installed Item)	X									X			X							X				
[illegible] Number (Installed Item)										X			X							X				
[illegible] Location and Course Identification:																								
[illegible] Type Station/ [illegible] /Site/Area No.	X	X		X	X	X	X	X	X	X			X	X		X	X	X		X		X	X	
[illegible] (Operational)								X	X				X				X							
[illegible] (Repairs)	X									X		X												
Installed In [illegible] Arresting Gear, Catapult, [illegible] Equipment										X														
Equipment Operator						X			X															
[illegible] Equipment Manufacturer																				X				X
Assembly Manufacturer										X	X						X	X						X
Subassembly Manufacturer					X					X								X						X
F[illegible] Part/Item Manufacturer	X					X			X	X		X			X	X	X	X		X		X		X
Manufacturer name or code (Company assembly replacements)										X	X													
Manufacturer name or code (Installed Item)										X									X					
Contract No.										X		X					X							
Production Status													X											
RELIABILITY DESCRIPTORS																								
(1) Time and Number Data Elements:																								
Date Form Submitted or Date of Report	X		X	X	X		X	X		X		X	X	X	X	X		X						X
Date of Failure				X	X	X	X		X	X							X		X	X				
Time of Failure				X		X			X				X				X				X			
Date of Last Failure					X																			
Total System/Equipment Operating Time								X		X			X	X			X	X						
Operating Hours on Failed Part				X	X						X		X		X	X	X	X						
Time Meter Readings (Log Book Time/Malfunctional Equipment)	X		X	X		X	X		X	X						X			X					
Operating Hours Since Last Component Failure			X	X	X						X													
Total Number of Launches, Starts or Landings Since New										X														
Miles																	X							
Rounds																	X							
Starts																	X							

[illegible] A through X [illegible] the systems' Designators.

(Contin[illegible])

TABLE 3 (continued)

Data Elements	Data Source Systems*																					
	MSC Ships	MMCS Aviation	ARMMS	CPEEVFOR	Boiler and Turbine Lab. (1)	Naval Propulsion Plant Basic (NPPB)	NAVAIENGRCTV	PMCARS (APL-Conn Operations)	FIR	(2)	MEARS	University of Pennsylvania (MEAL)	SIMS/PARADA	Air Force ARMMS	Air Force MAC	Army TAERS	Martin Marietta	General Electric	Honeywell	Bell Aerosp	[illegible]	[illegible]
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
RELIABILITY DESCRIPTORS (continued)																						
Time Since New (Vintage of Equipment/Year of Operating Status)										X			X	X				X				
Equipment Downtime									X	X						X						
Total Systems (Number)													X									
System Mean Time													X									
Total Number of Failures													X		X							
Number of Failures (Each Mode)											X		X		X						X	
Number of Failures (Each Part)											X		X								X	
Failed Material (Quantity)		X												X		X	X					
Estimated Percent of Total Failures Reported													X									
Failure Rate											X		X		X							
Part/Component Population												X	X				X					
Date and Duration of Test													X		X			X				
(ii) Non-Quantitative Data Elements:																						
Identification of Test or Activity in Progress															X		X	X			X	
Status of Equipment	X														X							
Intended Use													X									
Environment													X		X			X	X		X	X
Special Environmental Conditions													X		X						X	
Failure reporting system													X									
Type of Report						X				X						X			X			
Report Priority	X		X							X				X								
Equipment Status After Failure	X								X													
Type of Failure (Critical/Major/Minor)				X		X			X		X				X			X		X	X	
Primary or Secondary Failure			X			X					X				X							
Operational Condition						X			X		X											
Discovered (Code/Time/Situation)	X	X							X	X				X		X			X	X		
Complete Description of Failure and Discovery/Symptom Code)	X					X			X	X				X	X	X	X	X	X			
Malfunction Description		X									X			X	X		X	X	X			
Percent of Rating (Voltage/Power Etc.)													X		X						X	
Description/Remarks (Additional Information)	X		X	X	X	X		X		X	X	X	X			X	X		X	X		
Part Condition (Failed Part)	X									X						X						
Malfunction/Failure Cause	X		X	X	X	X			X	X							X		X	X	X	
Failure Code	X			X		X			X	X				X		X						
How Malfunctioned									X					X								
MAINTENANCE DESCRIPTORS																						
(i) Time and Number Data Elements:																						
Date Maintenance Began		X		X		X												X				
Time Maintenance Began			X	X		X																
Date Maintenance Completed	X	X		X		X				X				X		X	X	X				
Time Maintenance Completed			X	X		X								X		X	X	X				
Maintenance Time - Total Active Clock Hours	X	X	X	X						X	X											
Maintenance Time - Diagnosis (CH)	X		X	X					X													
Maintenance Time - Active Repair (CH)			X	X					X													
Maintenance Time - Technical Directives (CH)		X	X																			
Maintenance Time - Delay (CH)			X	X		X																
Date Inspected																X	X					
Scheduled Start Date	X													X								
Desired Completion Date	X																					
Estimated Active Repair Time (Man-Hours)	X			X										X								
Maintenance - Total Man-Hours	X	X			X						X			X		X	X	X				
Maintenance Time - Diagnosis (Man-Hours)									X	X	X						X					

*Letters A through V indicate the systems' designators.

(continued)

TABLE 3 (continued)

Data Elements	MDCS Ships	MDCS Aviation	AMMMS	OPTEC/FOR	Boiler and Turbine Lab. (1)	David Taylor Model Basin (DTMB)	NAVSECNOTE	FMSAEG (AFL-Conr. Hospitals)	FUR (2)	MEARS	University of Pennsylvania (MEAL)	IDEL, Inc.	Air Force ARMS	Air Force RACS	Army TAERS	Martin Marietta	General Electric	Honeywell	Borg Warner	NSA	AFSC, Eglin (VSAM)
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
MAINTENANCE DESCRIPTORS (continued)																					
Maintenance Time - Active Repair (Man-Hours)									X	X	X										
Maintenance Time - Active Repair Including Diagnosis (Man-Hours)											X					X	X				
Logistics and Administration Time (Man-Hours)																	X				
Units (No. on which Maintenance Performed)	X										X					X		X			
Required Material (Quantity)		X														X					
Quantity (No. of Items Received or Returned)	X									X						X	X	X			
Items Processed (Number)		X								X						X	X	X			
Number of Maintenance Checks Since Last Failure																					
Crew Size		X																			
(.) Circumstantial Data Elements:																					
Repair Activity/Work Center Maintenance Level/ Action Org/UIC	X	X	X	X					X	X	X	X		X		X	X	X			X	
Activity Work Center	X	X												X								
Maintenance Control No. Job Control No. Ship Account Number	X	X	X	X						X	X		X	X			X	X	X			
Work Unit Code		X	X											X								
Service Code	X															X						
Part Availability				X		X																
Type of Availability	X																					
Support Equipment Required		X	X	X							X											
Action Taken (Repair/Replace/Modify/Adjust/ Remove, etc.)									X	X	X								X			
Action Taken (Code)	X	X								X				X		X						
Status of Action											X			X								
Disposition of Action		X									X			X				X	X			
Failed Material (Action Code)		X													X							
Disposition of Removed Item						X										X	X	X		X		
Part Replacement Code				X		X			X								X		X			
Source Code	X															X		X				
Material of which Part is Made					X																	
Kit Required		X																				
Material/Kit Stock No.															X							
Code of Equipment After Maintenance									X							X						
Special (Note Frequent Trouble Item)										X												
Availability, Serviceability										X	X											
Reason For Delay (Code)			X												X							
Revision Number												X						X				
Alteration Identification	X															X		X				
Compliance (TD) Recorded		X														X						
Reference Documents (Specifications/Reports)	X		X	X									X				X					
Maintenance Required as a Result of Maintenance (Unscheduled Maintenance)		X		X							X		X			X						
Signature: Commanding Officer	X			X	X			X										X				
Supervisor	X	X	X							X				X	X			X	X			
Inspector		X									X			X	X		X	X	X			
Repairman and Specialty/Rate	X			X		X				X	X			X				X	X			
Person Reporting - Rate					X				X		X			X	X		X	X				

*(1) Cols. A through V indicate the systems' designators.

(continued)

TABLE 3 (continued)

Data Elements	Data Source System*																					
	MDCS Ships	MDCS Aviation	ARMMS	OPTEVFOR	Boiler and Turbine Lab.(1)	David Taylor Model Basin (DTMB)		NAVSECNORDIV	PMSAEJ (APL-John Hopkins)	FUR (2)	MEARS	University of Pennsylvania (Meal)	IDEP/FARADA	Air Force AFM66-1	Air Force RADC	Army TAERS	Martin Marietta	General Electric	Honeywell	Borg Warner	RCA	APIC/PRINCE (NASA)
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
COST ACCOUNTING DESCRIPTORS:																						
Contract Number										X		X					X					
Total Systems (Number)													X									
Total Number of Failures													X		X							
Number of Failures (Each Mode)											X		X		X						X	
Number of Failures (Each Part)											X		X								X	
Failed Material (Quantity)		X									X			X		X	X					
Unit Cost	X										X				X	X						
Estimated Percent of Total Failures Reported													X									
Failure Rate											X		X		X							
Part/Component Population												X	X									
Maintenance - Total Man-Hours	X	X				X					X			X		X	X	X				
Maintenance Time (Diagnosis Man-Hours)									X	X	X						X					
Maintenance Time - Active Repair Including Diagnosis (Man-Hours)											X					X	X					
Logistics and Administrative Time (Man-Hours)																	X					
Required Material (Quantity)		X														X						
Quantity (Number of Items Received or Returned)	X									X	X					X	X	X				
Items Processed (Number)		X															X	X				
Maintenance Control No./Job Control No./Report Control Serial No./Ship Account No.	X	X	X	X						X	X		X	X		X	X	X	X			
Disposition of Removed Item						X										X	X	X		X		
Repairman and Specialty/Rate	X			X		X				X	X			X				X	X			
Person Reporting - Rate						X			X		X			X	X		X	X				

*Letters A through V indicate the systems' designators.

(1) Philadelphia Naval Shipyard Report Form.
(2) Failure and Unsatisfactory Report, Naval Aviation Form (obsolete)

TABLE 4

DATA ELEMENT DEFINITIONS AND IDENTIFICATION OF SYSTEM SOURCES OF DATA APPLICABLE TO EACH DATA-ELEMENT DESCRIPTOR

Data Elements	Definition or Explanation	System Identification
ITEM DESCRIPTORS		
(1) Item Identification:		
FSN/Bureau Plan and Piece Number, Drawing Number	Federal stock number, bureau piece number, or drawing number of system equipment	C-E-K-L-O-P-R-S-V
CID/APL/AN Number	Component identification number, Allowance-Parts-List number, Army-Navy number of equipment in which replacement part was used	A-O
System/Equipment Name	Noun name identification of system/equipment at the highest assembly level	A-B-F-G-H-I-J-K-L-M-O-P-Q-R-S-V
System/Equipment Part Number or Identification Code	Seven-digit letter/number sequence code (EIC) or federal stock number (FSN) at the highest assembly level	A-D-H-I-J-K-L-M-O-P-Q-R-S-V
System/Equipment Serial Number	Manufacturer's serial number assigned to the system/equipment	A-B-D-F-G-H-I-J-M-P-Q-R
Vehicle Serial Number	Serial number of missile, aircraft or other vehicle in which failed part was located	Q-R
Assembly Name	Noun name identification of the assembly in which the failed part is located	I-J-K-L-O-P-Q-R-S-V
Assembly Part Number or Identification Code	Equipment identification code number (EIC) or federal stock number (FSN) of the assembly	J-K-L-M-O-P-Q-R-S-T-V
Assembly Serial Number	Manufacturer's serial number of the assembly containing failed part	I-J-M-Q-R-S-T
Subassembly Name	Noun name identification of the subassembly where the failed part is located	E-F-I-J-O-P-Q-R-S-V
Subassembly Part Number or Identification Code	Equipment identification code number (EIC) or federal stock number (FSN) of the subassembly containing failed part	A-E-I-J-M-O-P-Q-R-S-V
Subassembly Serial Number	Manufacturer's serial number of the subassembly containing the failed part	A-E-F-I-J-M-Q-R-S
Subassembly Symbol/Designation	Manufacturer's drawing reference, circuit, symbol, or other identification of the subassembly containing failed part	E-F-Q-R-S
Failed Part/Item Number	Equipment identification code number (EIC) or federal stock number (FSN) of the failed part	A-B-E-J-L-M-N-O-P-Q-R-S-T-U-V
Failed Part/Item Name	Noun name identification of the failed part	A-D-E-I-J-M-O-P-Q-R-S-T-U-V
Failed Part/Item Serial Number	Manufacturer's serial number of the failed part or item	A-B-D-N-Q-R-S
Failed Part/Item Symbol Designation or Code	Manufacturer's drawing reference, circuit, symbol or other identification of failed part or item	A-D-I-L-N-O-P-Q-R-S-T
Federal Stock Number (Removed Item)	Federal stock number (FSN) of failed parts of items removed from equipment	A-F-I-J-O-P
Part Number (Installed Item)	Part number or federal stock number of replacement part or item	A-J-M-R
Serial Number (Installed Item)	Manufacturer's serial number of replacement part or item	S-M-R
(2) Hardware Location and Source Identification:		
Ship Name/Hull Number/Activity Type Station/Originator/Administrative Org/UIC/Bureau Number	Location of the equipment that is the source of the data	A-D-E-F-G-H-I-J-M-N-O-P-Q-R-T-U

(continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	System Designator
Location (Geographic)	Geographic location of equipment when part failed, such as: North Atlantic, Western Pacific, Central Mediterranean, etc.	H-I-M-P
Location (Physical)	Location of failed part in the equipment, such as port, starboard, inboard, outboard, or name of assembly if more than one of the same part is used	A-J-L
Installed in A/C Arrestment Gear, Catapult, or Support Equipment	Model description and bureau number or serial number of equipment in the categories where failed part was located	J
Equipment Contractor	Name of contractor or manufacturer of equipment	F-I
System/Equipment Manufacturer	Noun name identification of prime manufacturer	J-V
Assembly Manufacturer	Noun name identification of manufacturer of assembly containing failed part	J-K-P-Q-V
Subassembly Manufacturer	Noun name identification of manufacturer of subassembly containing failed part	E-J-P-J-V
Failed Part/Item Manufacturer	Noun name identification of manufacturer of the failed part or item	A-F-I-J-L-O-P-[illegible]-T-V
Manufacturer Name or Code (Component Assembly Replacements)	Noun name identification of manufacturer of replacement assembly	J-K
Manufacturer Name or Code (Installed Item)	Noun name identification of manufacturer of replacement part of item	J-R
Contract Number	Number identification of contract under which the system/equipment containing failed part was procured	J-L-[illegible]
Production Status	Development, preproduction, or operational at the time failure occurred	M
RELIABILITY DESCRIPTORS		
(1) Time and Number Data Elements:		
Date Form Submitted or Date of Report	Calendar date form is submitted or calendar date report is completed	C-D-E-G-H-J-L-M-N-O-P-R-U-V
Date of Failure	Calendar date failure occurred or malfunction first observed	D-E-F-G-I-J-Q-S-T
Time of Failure	Clock time failure occurred or was first observed	D-F-I-M-Q-U
Date of Last Failure	Calendar date of last failure of any kind on the equipment	E
Total System/Equipment Operating Time	Total clock hours of operating time logged on the equipment when the failure occurred	H-J-M-N-Q-R
Operating Hours on Failed Part	Total clock hours of operating time accumulated on the failed part	D-E-K-M-O-Q-R
Time Meter Readings (Log Book Time/Malfunctional Equipment)	Clock hours of operating time on the equipment -- from meters or log book -- when failure occurred	A-C-D-F-G-I-J-P-S
Operating Hours Since Last Component Failure	Total operating hours on failed equipment since the last part failure of any kind	C-D-E-K
Total Number of Launches, Starts, or Landings Since New	Total accumulated number of launches, starts, or landings since the failed equipment was originally installed.	J
Miles	Mileage from odometers mounted on the equipment where failed part is located	P
Rounds	Total number of rounds fired	P
Starts	Total number of hot starts for jets or turbine engines	P

(Continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	Center Designation
Time Since New (Vintage) of Equipment (Year of Operating Status)	Calendar years and months since the equipment was installed in a new condition for operational use	H-M-N-
Equipment Downtime	The total time during which the equipment is not in acceptable operating condition	I-J-O
Total Systems (Number)	Total numbers of equipments in operation at the reporting activity	M
System Mean Time	Total measured operating time divided by the total number of failures	M
Total Number of Failures	The sum of all failures involved in an equipment malfunction	M-O
Number of Failures (Each Mode)	Total number of failures in each failure mode for each equipment malfunction	K-M-O-U
Number of Failures (Each Part)	Total number of parts as related to total number consumed in making the repairs	K-M-O-U
Failed Material (Quantity)	Total number of parts replaced during each equipment malfunction	B-N-O
Estimated Percent of Total Failures Reported	Estimated percent of all failures reported during a given report period	M
Failure Rate	At any point in the life of material, the incremental change in the number failures (change in the measure of life)	K-M-O
Part/Component Population	Total number of parts or components in a given universe under study	L-M-O
Date and Duration of Test	Calendar date of test where failure occurred and duration in hours to the time of failure	M-O-R
(b) Circumstantial Data Elements:		
Identification of Test or Activity in Progress	Conditions of test, type of test, test data, and duration	O-Q-R-U
Status of Equipment	Circle an arrow to indicate status of equipment prior to incorporating specified technical directives	B-O
Intended Use	Intended end use environment by installation environment	M
Environment	Environment when failure occurred	K-M-O-R-S-U-V
Special Environmental Conditions	Special environmental conditions when failure occurred	M-O-U
Failure Reporting System	Controlled or uncontrolled system, method of reporting, personnel reporting, definition of failure, and estimated percent of total failures reported	M
Type of Report	Check-off list of six classes of reports; approximate block is checked to indicate type of report	F-J-P-S
Report Priority	The assignment of priority classifications such as "Urgent" and "Flight Safety" to the report	A-C-J-N-P
Equipment Status After Failure	Equipment performance after failure occurred	A-I
Type of Failure (Critical/Major/Minor)	The one code, out of three, best describing the type of failure	D-F-I-K-O-R-T-U
Primary or Secondary Failure	To indicate a prime failure or a failure caused by the failure of another part	D-F-K-O
Operational Condition	One of three classifications describing effect of failure on equipment operation	F-I-K
Discovered (Code/Time/Situation)	A single-letter code which identifies when malfunction of the equipment or component was discovered	A-B-I-J-N-P-S-T

(continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	System Designator
Symptoms (Description of Failure and Discovery Symptom Code)	Description of any obvious reason for failure or abnormal manifestations in operation at the time of malfunction	A-D-F-I-J-O-P-[illegible]-S-T
Malfunction Description	Describes the trouble in the system, component identified in the work unit code block	F-K-M-N-[illegible]-P-[illegible]
Percent of Rating (Voltage Power, etc.)	Percent of rated load for the part application under operating-stress conditions	M-O-U
Description/Remarks (Additional Information)	Any additional descriptions, remarks, or suggestions related to the malfunction	A-C-D-E-F-H-J-K-L-M-[illegible]-[illegible]-S-T
Part Condition (Failed Part)	A three-digit number code describing residual condition of failed part by code system	A-J
Malfunction/Failure Cause	Cause of malfunction or failure	A-C-D-E-F-I-[illegible]-[illegible]-S-T-U
Failure Code	Enter code from "part condition" which best describes residual condition; may be physically observed or apparent during test or operation	A-D-F-I-J-N-P
[illegible]	A three-digit number used to provide a description of the trouble on or in the equipment or the component listed in the EIC block	I-N
MAINTENANCE DESCRIPTORS		
(1) Time and Number Data Elements:		
Date Maintenance Began	Calendar date maintenance action was started to correct the malfunction	B-D-F-I
Time Maintenance Began	Clock time maintenance action was started to correct the malfunction	C-D-F
Date Maintenance Completed	Calendar date maintenance was completed	A-B-D-F-J-N-P-[illegible]-R
Time Maintenance Completed	Clock time maintenance was completed	C-D-F
Maintenance Time - Total Active Clock Hours	Total clock hours during which one or more technicians are working on the item to effect a repair	A-B-C-D-J-K
Maintenance Time - Diagnosis	Total clock hours required to identify cause of malfunction and determine corrective action	A-C-D-I
Maintenance Time - Active Repair	Total clock hours during which one or more technicians are working on the item to effect a repair	C-D-I
Maintenance Time - Technical Directives	Total clock hours during which one or more technicians are reading technical manuals or instructions on making repairs	B-C
Maintenance Time - Delay	Total clock hours during which no action is taken to diagnose or repair the equipment, such as crew at mess and equipment inspection	C-D-F
Date Inspected	Calendar date equipment is inspected after repairs have been completed	P-Q
Scheduled Start Date	Calendar date the repair activity estimates work will commence on the requested maintenance	A-N
Desired Completion Date	Calendar date the repair must be completed for the requesting activity to meet its operational commitments	A
Estimated Active Repair Time (Man-Hours)	Estimated time during which one or more technicians are working on the item to effect a repair	A-N
Maintenance - Total Man-hours	Total man-hours required during a maintenance action	A-B-D-F-K-N-P-Q-R
Maintenance Time - Diagnosis	Total number of man-hours required to identify cause of malfunction and determine corrective action	I-J-K-Q

(continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	System Designation
Maintenance Time - Active Repair	Total number of man-hours during which one or more technicians are working on the item to effect a repair	I-J-K
Maintenance Time - Active Repair Including Diagnosis	The sum of total maintenance man-hours to diagnose failure and total maintenance man-hours for active repair	[illegible]
Logistics and Administration Time	Total number of man-hours repair is delayed solely in waiting for a replacement part and that portion of downtime not included under active repair time	Q
Units (Number on which maintenance performed)	A maximum of two numbers indicating number of identical items (In the EIC block) on which maintenance was attempted or performed	A-K-R
Required Material (Quantity)	The number of units of parts or material used to accomplish a specific maintenance action	P-K
Quantity (Number of Items Received or Returned)	The number of units of parts or material used to accomplish a specific maintenance action	A-J-P-Q-R
Items Processed (Number)	The number of times collective action was taken against the item described in the work-unit code block	P-Q-R
Number of Maintenance Checks Since Last Failure	Total number of maintenance checks completed on the equipment since the last failure occurred	E
[illegible]	Total number of personnel required to complete a given maintenance action	B
( ) Circumstantial Data Elements:		
Repair Activity/Work Center Maintenance Level/Action Org/UIC	The department or group performing maintenance actions on the failed equipment. UIC is the activity for which maintenance is performed.	A-B-C-D-I-J-K-L-N-P-Q-R-U
Assisting Work Center	Name of work center providing maintenance assistance when work center is not under the maintenance-data collection system	A-B-N
Maintenance Control Number/Job Control Number/Report Serial Number/Ship Account Number	Four-digit number assigned by the maintenance data control center	A-B-C-D-J-K-M-N-P-Q-R-U
Work Unit Code	Work-unit code number for part or component being replaced (from code manual)	B-C-N
Service Code	A single-letter code that identifies the type of assistance the requesting ship will furnish the repair activity in completing the maintenance	A
Part Availability	Yes or no on availability of replacement part from local sources	D-F-P
Type of Availability	To indicate outside repair assistance required, representing type needed to complete the maintenance action	A
Support Equipment Required	Support equipment required to complete a maintenance action	B-C-D-K
Action Taken (Repair/Replace Modify/Adjust/Remove, etc.)	Statement on what action was taken to correct malfunction	I-J-K-S
Action Taken (Code)	A series of letter codes used to designate what action was taken to effect a repair	A-B-J-N-P
Status of Action	The appropriate status code (block G) that describes the action taken by the reporting work center	K-N
Disposition of Action	A letter code indicating "Disposition or corrective action" for each part or item used in the maintenance action	B-K-N-R-S

(continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	System Data Entry [illegible]
[illegible]	A three-digit code, malfunction-description code, [illegible] code, and part numbers of failed material	[illegible]
[illegible] of Removed Item	[illegible] codes [illegible] to indicate disposition of removed item	[illegible]
[illegible] Replacement Code	Yes, if replacement available on demand from normal supplies; no, if part was not available on demand from local supplies	[illegible]
[illegible] Code	A letter number code which identifies source of parts or material used in a maintenance action	A-P-R
Material of Which Part Is Made	Name of material in part involving failure remarks	E
Kit Required	To indicate if a kit is required; if required, write in kit number	B-K
Material/Kit Proc. Number	Material required or kit stock number of the item(s) required to incorporate a technical directive	N
Code of Equipment After Maintenance	Three-code check-off to indicate condition of the equipment after maintenance has been performed	I
[illegible] (Note Frequent Trouble Item)	Two-[illegible] check-off to indicate if the failed part is a frequent trouble item or if it [illegible] installed wrong	I-J
(Accessibility [illegible])	Two-block check-off to indicate satisfactory or unsatisfactory accessibility	J-K-P
Reason for Delay (Code)	Series of codes to account for any delay during a maintenance action	C-P
Revision Number	The revision number of technical documents used as reference during a maintenance action	L-R
Alteration Identification	Alteration numbers to indicate modification in design of equipment	A-R
Compliance (TD) Recorded	To indicate by check that an entry is required, and has been made in the specified equipment records or logs	B
[illegible] Documents (Specifications Reported)	List of specifications, drawing numbers, or technical reports used as reference in effecting a repair	[illegible]
[illegible] Maintenance Required as a Result	Reason for maintenance action in check-off form to preventive [illegible]	J
Type of Maintenance	The type maintenance code that describes the type of maintenance [illegible] performed	B-D-K-M
Signature: Commanding Officer	Signature of the commanding officer at the reporting activity	A-D-E-H-R
Supervisor	Signature of the supervisor or person in charge of the maintenance action	A-B-C-J-N-O-P-R-S
Inspector	Signature of inspector or person verifying failures and repairs	B-K-N-O-P-[illegible]-R-S
Repairman and Specialty/Rate	Name of personnel making repairs or adjustments to failed equipment and his title or technical rating	A-B-D-F-J-K-N-P-R-S
Person Reporting - Rate	Name signature or personnel recording data on report	P-I-K-N-O-[illegible]-R

(continued)

TABLE 4 (Continued)

Data Elements	Definition or Explanation	System Designator
COST ACCOUNTING DESCRIPTORS:		
Contract Number	Number identification of contract under which the system/equipment containing failed part was procured	J-L-Q
Total Systems (Number)	Total numbers of equipments in operation at the reporting activity	M
Total Number of Failures	The sum of all failures involved in an equipment malfunction	M-O
Number of Failures (Each Mode)	Total number of failures in each failure mode for each equipment malfunction	K-M-O-U
Number of Failures (Each Part)	Total number of parts as related to total number consumed in making the repairs	K-M-O-U
Failed Material (Quantity)	Total number of parts replaced during each equipment malfunction	B-K-N-Q
Unit Cost	Unit price of parts or material used in the maintenance action, except pre-expensed bin material	A-K-O-P
Estimated Percent of Total Failures Reported	Estimated percent of all failures reported during a given report period	M
Failure Rate	At any point in the life of material, the incremental change in the number of failures (change in the measure of life)	K-M-O
Part/Component Population	Total number of parts or components in a given universe under study	L-M-O
Maintenance - Total Man-Hours	Total man-hours required during a maintenance action	A-B-D-F-K-N-P-Q-R
Maintenance Time - Diagnosis	Total number of man-hours required to identify cause of malfunction and determine corrective action	I-J-K-Q
Maintenance Time - Active	The sum of total maintenance man-hours to diagnose failure and total maintenance man-hours for active repair	K-Q
Logistics and Administration Time	Total number of man-hours repair is delayed solely in waiting for a replacement part and that portion of downtime not included under active repair time	Q
Required Material (Quantity)	The number of units of parts or material used to accomplish a specific maintenance action	B
Quantity (Number of Items Received or Returned)	The number of units of parts or material used to accomplish a specific maintenance action	A-J-K-P-Q-R
Items Processed (Number)	The number of times collective action was taken against the item described in the work unit code block	B-Q-R
Maintenance Control Number/Job Control Number/Report Serial Number/Ship Account Number	Four-digit number assigned by the maintenance-data-control center	A-B-C-D-J-K-M-N-P-Q-R-U
Disposition of Removed Item	One of 8 codes checked to indicate disposition of removed item	F-I-Q-R-T
Repairman and Specialty/Rate	Name of personnel making repairs or adjustments to failed equipment and title or technical rating	A-B-D-F-J-K-N-P-R-S
Person Reporting - Rate	Name signature of personnel recording data on report	F-I-K-N-O-Q-R

TABLE 5
DATA COLLECTION FORMS USED BY DATA BANKS

System Name	System Designator	Data Collection Forms
MDCS (Ships)	A	OPNAV 4700-2B* - Shipboard Maintenance Action OPNAV 4700-2D - Deferred Action OPNAV 4700-2C - Work Request - Intermediate Maintenance OPNAV 4700-2E - Man-Hour Exception Time Accounting OPNAV 4700-2F - Daily Work Supplement-Intermediate Maintenance OPNAV 4700-2J* - Shipboard Maintenance Action (The 2J series, currently being evaluated, includes additional R&M data elements not required by the 2B form.) DD - 1348 - Material Issue for Mechanized (ADP) Ships NAVSANDA 1250 - Material Issue for Nonmechanized Ships
MDCS (Aviation)	B	MMMPC Form No. 1 - Man-Hour Accounting Card MMMPC Form No. 4*- Maintenance Action Form MMMPC Form No. 5*- Maintenance Action Form MMMPC Form No. 6 - Organizational Maintenance Control Register MMMPC Form No. 7 - Organizational Work Center Register MMMPC Form No. 9 - Intermediate Maintenance Register MMMPC Form No. 10- Support Action Form MMMPC Form No. 11- Technical Directive Compliance Form MMMPC Form No. 12- Configuration Control Form
ARMMS	C	Individual Record of Corrective Action (IRCA)
OPTEVFOR	D	Materiel Maintenance Record (No Form Number) (COMOPTEVFOR Instruction P3930-I D Volume II)
Boiler and Turbine Lab.**	E	9120-1 (NAVSHIPS 3621)
David Taylor Model Basin (DTMB)	F	[illegible]-1 (NAVSHIPS DD-78[illegible])
	G	[illegible]-14 (NAVSHIPS [illegible])
[illegible]	H	9670-1 (NAVSHIPS 3878)
FMSAEG (API/JHH)	I	8000-13 SAM FLEET Weapons Systems Component and Failure Report. 8000-23 SAM FLEET Operating Time Report
[illegible]	J	BUWEPS 13070-3
MEARS	K	Exhibits IB-XIII (WR-30)
MEAL	L	No Form Number
IDEP/FARADA	M	77ND-FMSAEG-8800-9 77ND-MFSAEG-8800-10
APM66-1	N	AFTO Form 210 - Maintenance Discrepancy/Production Credit Record (Processing Repairable Item not involved) AFTO Form 211 - MD/PCR (Processing Repairable Item is involved) AFTO Form 212 - Time Compliance Technical Order Work Record
RADC	O	No Form Number
TAERS	P	DA Form 2407 - Maintenance Request DA Form 2408-1 Equipment Daily or Monthly Log DA Form 2408-3 Equipment Maintenance Record (Organizational) DA Form 2408-4 Weapon Record Data DA Form 2408-11 Accumulative Repair Cost Record
Martin Marietta	Q	MM - 1021A - Martin Automatic Reporting System Balt.- 066414- Trouble Report and Withholding Tag DEN - 066124- Quality Reliability Consumption Report DEN - 066069- Equipment Time Record
General Electric	R	DCS/NCR Form RS-1168 Nonconformance Report COTA Form RS-1575 Component Operation Time Accumulation
Honeywell Aeronautical	S	R-ED 25078 Failure Report
Borg Warner	T	Failure Report
RCA	U	Failure Report
APIC/PRINCE	V	No Form Number

* Maintenance Reporting Forms used to identify the data elements listed in Tables 1 and 2.

** Philadelphia Naval Shipyard

APPENDIX A

DESCRIPTION OF THE METHOD OF APPROACH USED IN THE SURVEY OF DATA SOURCES

APPENDIX A

DESCRIPTION OF THE METHOD OF APPROACH USED IN THE SURVEY OF DATA SOURCES

1. Survey of Government Data Sources

Letters of inquiry were sent to 68 military and industrial data banks listed in the Naval System Effectiveness Control Manual. Fifty-three responses were received. Information resumes (Form DD-1498) also were received from Headquarters Naval Materiel Command, NAVMAT 0325D, describing over 60 systems that are in operation or are shortly to become operational at various U.S. Naval activities. The information obtained from these sources is described in Sections 2 and 3.

Exhibit 1 is a typical letter of inquiry that was sent to activities known to have data banks in operation. Exhibit 2 is a list of the activities that responded to the letters of inquiry, including the name and address of the person to be contacted on matters concerning the data bank.

2. Survey of Contractor Data Sources

Exhibits 3 and 4 are copies of the letter of transmittal and questionnaires, respectively, that were sent to 300 contractors during the data-source survey. The names and addresses of the 126 respondents participating in this data-source survey are listed in Exhibit 5.

Exhibit 6 presents a tabulation of the answers received from the data-source questionnaires. The total number of answers to individual questions does not equal the total number of replies to the questionnaire. Many contractors answered several parts of a single question, while others provided comments under the broad heading of "Other" without answering specific questions. For example, under Question 7: of the 69 contractors who used in-house data for studies of reliability and maintainability, the majority also use MIL handbooks and specifications. Also, almost every contractor checked more than one answer to Question 12.

3. Observations from the Data-Source Survey

An evaluation of the responses to Question No. 7, regarding the source used for failure rates and procedures, revealed that practically all contractors use a combination of data sources to obtain information for reliability and maintainability predictions. In only a few cases did a contractor use only a single

document for this purpose. The extent of such document use is noted as follows:

Referenced Document Used	Number of Contractors
MIL-HDBK-217A	72
In-House Data Bank	69
MIL-STD-756A	41
All Other Data Sources	37
NAVSHIPS 93820	24
Other MIL Documents	22
FARADA Data	20
MIL-M-23313A	20
IDEP Data	6

3.1 Currency of Data

The currency of data used for predictions can be established by the publication date of each document. For example, NAVSHIPS 93820 was published in April of 1961; MIL-HDBK-217A in December of 1965; FARADA is updated periodically; and in general, contractor in-house data are updated approximately once each year. However, before specific contractor data are used as reference material, it is recommended that the contractor be contacted to verify the currency of his data.

3.2 Contractor Methods of Collecting Data

The following observations of contractor data-collection methods were made during the data survey:

- Of the companies responding to the survey questionnaire, 80 percent maintain some form of data collection, and most of the contractors use a mandatory form supplemented by information obtained from their engineering reports. The mandatory form was one of several methods used by 48 percent of the contractors; a review of data obtained from engineering reports was the method used by 46 percent. Combinations of these two methods are also used. Evaluation of the survey responses indicated that a typical data-bank profile would consist of the following elements:
  - Data collected by mandatory form
  - Data used primarily by reliability, management, and quality-control personnel
  - Predictions made from MIL-HDBK-217A and in-house data; stress analysis and k-factors usually used for predictions
  - Parts normally derated for environmental conditions
  - Data classified by type

- Limited field data from operational equipments; most of the data from aircraft and ground equipment
- Data from environmental and reliability demonstration testing (The main source of data)
- AGREE test data (minimal)

- Reliability and engineering personnel are the major users of such data, 96 percent and 88 percent, respectively.
- For the prediction of reliability, MIL-HDBK-217A is the primary data source (77 percent), followed by in-house data (74 percent).
- Stress analyses are provided in 80 percent of predictions. Application factors (k-factors) are used in 79 percent of the studies, and parts are derated for environmental conditions in 88 percent of the studies.
- Sixty-five percent of the bank data are classified by equipment type, such as electrical, electronic, etc.
- The three applications from which data are most widely derived are aircraft (50 percent), ground equipment (49 percent), and missiles (35 percent).
- Thirty-four percent of the data banks collect nonoperating failure data.
- Of the contractors answering the survey who do collect data, 15 percent collect test data but not operational data. Therefore, these data would tend to be optimistic. Five percent of the companies collect all operational and no test data. These data, therefore, would tend to be conservative.
- The major sources of test data for the contractor data banks are environmental testing (68 percent) and reliability demonstration testing (68 percent).
- Seventy-eight percent of the contractors collect both test and operational data.
- Eighty-eight percent of the respondents collect field data from operational equipment.
- AGREE test results are used to some extent by 20 percent of the contractors. The AGREE results were lower then predictions in 32 percent of the cases, and AGREE results were lower than operational failure rates in 47 percent of the cases.

EXHIBIT 1

LETTER OF INQUIRY

ARINC
RESEARCH CORPORATION

September 2, 1966
MSP-66-123
Work Order 527-10

Applied Physics Laboratory
Johns Hopkins University
8621 Georgia Avenue
Silver Spring, Maryland

Gentlemen:

Under Contract N00140-66-C-0151 with the U. S. Naval Applied Science Laboratory, ARINC Research will perform a survey to determine the status of the data sources in Appendix B-2 of the Naval System Effectiveness Manual, Book 2, published in July of 1965. In addition, the company will determine if any additional significant sources exist, and acquire the information to update and expand the description and classification of the sources in Appendix B-2.

The FMSAEG Data Bank is one of the listed sources to be surveyed in the Task Statement. A description of FMSAEG appears below; it was taken directly from Appendix B-2.

FMSAEG -- Fleet Missile System Analysis and Evaluation Group

FMSAEG is a BuWeps organization that has an integrated program for the collection, processing, and analysis of reliability, operability, and component part-failure data for surface-missile systems. While the major portion of the data-collection function will be replaced by the MDC system, the FMSAEG processing and analysis will continue. During the transition period, both FMSAEG and MDC systems will be used.

FMSAEG has the following three principal areas of analysis:

(1) Surface-missile flight analysis, including firing reports, telemetry records, and flight-test scoring.

(2) Surface-missile test equipment and missile checkout experience, including failure rate tabulations of missile modules and check-out equipment.

(3) Analysis and summarization of certain fleet equipment data to yield measures of average up-time in various operating states. This type of analysis produces a gross measure of readiness.

Information not available from the MDC system, but required by FMSAEG for its analyses, includes the following:

(1) Periodic, identified time-meter readings of all time meters on the "selected" equipments, as now provided in Form 8000/23. These data yield comparative-usage time comparisons in the various operating modes, and allow the single meter reading, taken at the time of maintenance in the MDC system, to be far more useful.

(2) Daily System Operability Test (DSOT) scoring and results, formerly provided in NAVWEPS Form 8821/9. (The recent revision, Instruction 8821.3A, eliminates Form 8821/9 and, instead, provides for the collection of DSOT scoring and result information from status reports.)

(3) Continuity detail, showing the sequence, time of day, and interaction of maintenance jobs. These data are invaluable during a detailed engineering review of selected portions of the data base.

(4) Operational challenge and administrative pre-emptive information, so useful in analysis of the relationship of ship operations to readiness, or to obtain fault detectability measurements.

(5) Hourly status categorization, as now provided in Form 8821/5. This type of reporting makes possible the Status Indices.

The required information will be obtained through the use of an additional reporting form, probably Form 8821/5B, which is a simplified version of the present status report and two other reports currently in use; namely, the "Commanding Officer's Narrative Report" and Form 8821/8, "The Surface Missile System Firing Report". There will be a minimum of data overlap between these three reports and the MDC report.

For Part I of this survey, will you please up-date this description and return this document, or provide the necessary changes so that updating may be performed by ARINC Research.

For Part II of this survey, please provide correct information on the following:

1. **Official name of your data bank.**
2. **Location - Street and City, or mailing address.**
3. **Name and Title of person to contact.**

4. Description of data-processing facilities and estimated capacity

5. Kind of outputs provided, such as failure rates, repair times, MTBF calculations, summaries, etc.

6. Equipment specialization, such as RADAR, SONAR, general communications equipment, etc.

7. Specialized area of data interest, such as reliability, maintainability, etc.

Your cooperation in responding to this request is appreciated; it will contribute to the quality of data-source information available to Government Agencies.

Very truly yours,

J. H. Robinson, Jr.
Project Engineer, MSP

JHR:zm

EXHIBIT 2

ACTIVITIES RESPONDING TO LETTERS OF INQUIRY ON THE STATUS OF EXISTING DATA BANKS

Commander, Naval Air Systems Command
Department of the Navy
Washington, D. C. 20360

ATTN: Mr. R. J. Foxter

U. S. Naval Fleet Missile Systems
Analysis and Evaluation Group
IDEP Data Bank
Corona, California 91720

ATTN: Mr. S. I. Pollock

U. S. Naval Fleet Missile Systems
Analysis and Evaluation Group
FARADA Data Bank
Corona, California 91720

ATTN: Mr. R. R. Moore

Department of the Navy
Headquarters Naval Material Command
Washington, D. C. 20360

ATTN: Mr. D. W. Monson

The Johns Hopkins University
Applied Physics Laboratory
8621 Georgia Avenue
Silver Spring, Maryland

ATTN: Mr. B. H. Buckingham
Assistant to the Director

Maintenance Engineering Analysis Branch
Service Test Division
Naval Air Test Center
Patuxent River, Maryland

ATTN: Mr. D. P. Manahan
Assistant Head

Commanding Officer
Naval Supply Depot
5801 Tabor Avenue
Philadelphia 20, Pennsylvania

ATTN: LCDR SC F. H. Keefer, USN
Director, Data Processing Department

National Oceanographic Data Center
Department of the Navy
Washington, D. C. 20390

University of Pennsylvania
Project Monidan
3634 Walnut Street
Philadelphia, Pennsylvania 19104

ATTN: Mr. William A. Miller
Research Specialist

Department of the Navy
Naval Ship Engineering Center
Philadelphia Division
Philadelphia, Pennsylvania 19112

ATTN: Mr. C. T. G. Murphy, Head
Dependability Engineering Branch
Assurance Engineering Department

Fleet Work Study Group, Atlantic
U. S. Naval Station
Norfolk, Virginia

ATTN: LCDR H. W. Hughes, USN

Department of the Navy
Bureau of Naval Weapons
Fleet Readiness Representative
Atlantic
U. S. Naval Air Station
Norfolk, Virginia 23511

ATTN: Mr. A. H. Schmieder

Department of the Navy
Operational Test and Evaluation Force
Norfolk, Virginia 23511

ATTN: LCDR J. R. Spero, USN

Department of the Air Force
Headquarters Rome Air Development Center (AFSC)
Griffiss Air Force Base
New York 13440

ATTN: EMERC (M. Haus/330-4102)

(continued)

EXHIBIT 2 (continued)

Department of the Air Force
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base
Ohio 45433

ATTN: MAAM (Mr. Klinger)

Purdue University
Thermophysical Properties Research Center
Purdue University Research Park
2595 Yeager Road
West Lafayette, Indiana 47906

ATTN: Mr. Y. S. Touloukian
Director

Mechanical Properties Data Center
13919 West Bay Shore Drive
Traverse City, Michigan 49684

ATTN: Mr. M. J. Konold
Administrative Assistant

Department of the Air Force
Air Force Materials Laboratory (AFSC)
Wright-Patterson Air Force Base
Ohio 45433

ATTN: MAAM (Mr. Emrich)

Department of the Air Force
Headquarters Rome Air Development Center (AFSC)
Griffiss Air Force Base
New York 13440

ATTN: EMERR/L. Gubbins/330-4064

Department of the Air Force
Headquarters United States Air Force
Washington, D. C.

ATTN: AFSMEBB

Department of the Army
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Rock Island, Illinois 61201

ATTN: Mr. K. A. Herbst, Chief
Stdzn & Tech Serv Office
R&D Directorate

Director
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Aberdeen Proving Grounds
Maryland

Plastics Technical Evaluation Center
Picatinny Arsenal
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ATTN: Mr. Harry E. Pebly, Jr.
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ATTN: Mr. Dale H. Sieling
Scientific Director

U. S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

ATTN: Colonel Dimitri A. Kellogg
Director

Department of the Army
United States Army Tank-Automotive Center
Warren Michigan 48090

ATTN: Mr. Raymond K. Braman
Acting Director
Maintenance Directorate (NMP)

Department of the Army
Headquarters, U. S. Army Test and Evaluation Command
Aberdeen Proving Ground
Maryland 21005

ATTN: Mr. G. A. Gustafson
Acting Chief
Test Analysis and Operations Office

U. S. Army Nuclear Defense Laboratory
Edgewood Arsenal, Maryland 21010

ATTN: Mr. Luther M. Hardin
Chief, Evaluations Division

(continued)

EXHIBIT 2 (continued)

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ATTN: AMCRD

Department of the Army
Office of the Chief of Research
and Development
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ATTN: Colonel Dale L. Vincent
Chief, Scientific and
Technical Information
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U. S. Army Ballistic Research
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ATTN: Mr. John G. Schmidt
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Director

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ATTN: Mr. Jack P. Wilson
Manager, Defense Logistics
Studies Information Exchange

Commanding General
U. S. Army Electronics Command
Fort Monmouth, New Jersey 07703

Department of the Army
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Materiel Command
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ATTN: Mr. Willie N. Calcote
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ATTN: Mr. Robert S. Kohn
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EXHIBIT 2 (continued)

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Cameron Station
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National Aeronautics and Space
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Scientific and Technical
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Marshall Space Flight Center
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ATTN: Mr. S. J. Courtney
R-ASTR-TR

Radiation Effects Information Center
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ATTN: Mr. E. N.Wyler, Director

Shock and Vibration Information
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U. S. Naval Research Laboratory
Code 7020
Washington, D. C.

ATTN: Mr. W. W. Mutch, Director

EXHIBIT 3

FORM LETTER USED FOR CONTRACTOR DATA-SOURCE SURVEY

ARINC
RESEARCH CORPORATION

Under Contract No. N00140 66 C 0151 with the U.S. Naval Applied Science Laboratory, ARINC Research Corporation has been assigned a task to develop and publish a Reliability and Maintainability Data-Source Guide.

The guide will describe existing data sources and provide a cross-reference to data collected by each source on the basis of data-element definitions. The guide will also classify the data as to (1) usefulness during the phases of the system acquisition life cycle, (2) conservative or optimistic failure rates, (3) applicability to a common source for multi-contractor systems, and (4) degree of obsolescence of the data.

In connection with this task, a survey has been authorized to obtain the necessary information to meet the assigned objectives. We hope to obtain this information by means of the attached Reliability and Maintainability Data Questionnaire. Will you kindly complete the questionnaire and return it to the writer at your earliest convenience.

You will note from Question No. 16 that by participating in this survey you will have an opportunity to receive a copy of the tabulated results. This information may be of assistance to your organization. Your cooperation in responding to this request will be greatly appreciated. It will contribute to the knowledge of Government agencies on the existing status of available data.

Very truly yours,

J. H. Robinson, Jr.
Project Engineer
Marine Systems Program

Exhibit 4

RELIABILITY AND MAINTAINABILITY DATA QUESTIONNAIRE

1. Do you maintain a "data bank" or data center of reliability and maintainability information collected from programs in which you are engaged?

   Yes ☐ No ☐

2. How is the data collected for this "data bank"?

   Mandatory form ☐ Questionnaire ☐

   Review of engineering reports ☐

   Other ☐ _____

   _____

3. Please identify the source of your data.

   Production testing ☐ Life testing ☐

   Environmental testing ☐ Incoming testing ☐

   AGREE testing ☐

   Reliability demonstration testing ☐

   Maintainability demonstration testing ☐

   Other ☐ _____

   _____

4. In what categories are the collected data classified?

   Electrical, Electronic, Mechanical, Hydraulic, etc. ☐

   Function: Power Supply, Amplification Modulation, etc. ☐

   Application: Radar, Sonar, Communications, etc. ☐

   Please describe: _____

   _____

   _____

(continued)

Exhibit 4 (continued)

5. Do you have non-operating failure data from equipment in storage or during shipment?

   Yes ☐ No ☐

6. Do you collect reliability or maintainability data on:

   Servo mechanisms ☐ Hydraulic parts ☐

   Mechanical parts ☐

   Other ☐ _____

   _____

   _____

7. In making reliability and maintainability predictions, what data source is used for failure rates and procedures?

   MIL-HDBK-217A ☐ NAVSHIPS 93820 ☐ MIL-STD-756A ☐

   MIL-M-23313A ☐ In-house data ☐

   Other ☐ _____

   _____

8. Depth of predictions:

   (a) Are stress analyses provided?

   Yes ☐ No ☐

   (b) Are application (K) factors used?

   Yes ☐ No ☐

   (c) Are parts derated for environmental conditions?

   Yes ☐ No ☐

   Please explain: _____

   _____

   _____

   _____

(continued)

Exhibit 4 (continued)

9. Is field data collected from operational equipments?

Yes ☐ No ☐

If yes, how do the operational failure and repair rates compare with predictions?

Operational MTBF was within 25% ☐ greater ☐ lower ☐ than prediction.

Operational MTTR was within 25% ☐ greater ☐ lower ☐ than prediction.

What data source was used in making predictions? _____

_____

10. From what applications is the data derived?

Aircraft ☐ Missiles ☐ Shipboard ☐

Ground equipment ☐ Satellites ☐ Underseas ☐

Laboratory ☐

Other ☐ _____

_____

11. What method do you use to convert existing failure rate data from one application to another (example: missile to shipboard)? Please describe.

_____

_____

_____

_____

_____

_____

_____

(continued)

Exhibit 4 (continued)

12. Who are normal users of this data?

Management ☐ Engineering ☐ Purchasing ☐

Reliability ☐ Quality Control ☐

Other ☐ _____

_____

13. Have you used AGREE test results to any extent?

Yes ☐ No ☐

Comment: _____

_____

_____

(a) How do they compare with predictions?

_____

_____

(b) How do they compare with operational failure rates?

_____

_____

14. Do you know of others who have made similar surveys or studies on reliability and maintainability data collection?

Yes ☐ No ☐

If yes, please give name and address:

_____

_____

_____

_____

(continued)

Exhibit 4 (continued)

15. Is the information in your data bank available to qualified Government agencies and commerical concerns? If so, who should be contacted to obtain information, and in what form is it available?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

16. Would you be interested in receiving a copy of the tabulated results from this survey?

Yes ☐ No ☐

If yes, please give name and address:

_____

_____

_____

When completed, return this form to:

ARINC Research Corporation

2551 Riva Road, Room 223-B

Annapolis, Maryland 21401

ATTN: J. H. Robinson, Jr. -- MSP

EXHIBIT 5

CONTRACTOR AND GOVERNMENT SOURCES PARTICIPATING IN THE DATA-COLLECTION SURVEY QUESTIONNAIRE

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ATTN: Mr. A. H. Cronshagen
Head Reliability Department

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Corporate Reliability and
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or
Mr. R. L. Harris

Aerojet-General Corporation
Technical Program Control
Apollo Program
Department 8500, Building 2015B
Nimbus, California

ATTN: Mr. J. H. Madden, Manager

Aerospace Industries Association
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ATTN: Mr. P. E. Everett
Executive Secretary
Reliability Committee

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14250 Plymouth Road
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ATTN: Mr. A. J. Junker
Chief Quality Engineer

American Society for Testing
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ATTN: Mr. J. W. Caum
Technical Secretary

Airborne Accessories Corporation
Reliability and Quality Control
1414 Chestnut Avenue
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ATTN: Mr. R. P. Iachetta
Manager

AFLC (MCFA)
Space Systems Division
Air Force Unit Post Office
Los Angeles Air Force Station
Los Angeles, California 90045

ATTN: Mr. Alison I. Kurth

AFCS (CSSMEM)
Scott Air Force Base
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OAR (RRYB)
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Arlington, Virginia 22209

SSD (SSSIR)
Los Angeles Air Force Station
Air Force Unit Post Office
Los Angeles, California 90045

American Bosch Arma Corporation
Arma Division
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Garden City, New York 11532

ATTN: Mr. Victor J. Bonardi

Astrodata Incorporated
Reliability Engineering
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ATTN: Mr. Chong M. Fong

Avco Corporation
Missile Systems Division
Reliability Department
201 Lowell Street
Wilmington, Massachusetts

ATTN: Mr. Stafford B. Beach, Jr.
Manager

(continued)

EXHIBIT 5 (continued)

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ATTN: Mr. David R. Bair

Picatinny Arsenal
Dover, New Jersey 07801

ATTN: Mr. Anthony J. Ricciardi
QAD, NRD, M&S Branch
SMUPA-NR2
or
Mr. Augustus Stanfield
QAD, ARD, M&S Branch
SMUPA-ND6

Commanding General
U. S. Army Missile Command
Redstone Arsenal, Alabama 35809

ATTN: AMSMI-QSL (Mr. R. E. Akin)

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Friez Instrument Division
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ATTN: Mr. Donald B. Keidan,
Reliability and
Maintainability Supervisor

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Bendix Radio Division
Department 473
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ATTN: Mr. J. B. Jorster

The Bendix Corporation
Red Bank Division
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Eatontown, New Jersey 07724

ATTN: Mr. C. S. Townsend

The Boeing Company
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Kent, Washington

ATTN: Mr. G. R. Herrold

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Bell Aerosystems Company
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ATTN: Mr. R. A. Nowacki
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or
Dr. A. Bonis
Mail Zone A-40
or
Mr. E. O. Allen
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The Bendix Corporation
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Clevit Corporation
Brush Instruments Division
Reliability & Quality Assurance
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ATTN: Earl W. Hummer, Manager

Collins Radio Company
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Reliability:
ATTN: Mr. R. L. Vander Hamm

Maintainability:
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Mail Station 401-055

(continued)

EXHIBIT 5 (continued)

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Wichita Kansas

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Reliability-Maintainability
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EXHIBIT 5 (continued)

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U.S. Naval Air Development Center
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EXHIBIT 5 (continued)

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ATTN: Mr. R. O. Wilson, Manager
Surveillance & Engineering
QRA Department

TRW, Incorporated
23555 Euclid Avenue
Cleveland, Ohio 44117

ATTN: Mr. Philip F. Carey
Reliability Engineering
Manager
Room 2728

(continued)

EXHIBIT 5 (continued)

United Aircraft Corporation
Norden Division
Helen Street
Norwalk, Connecticut

ATTN: Mr. Allan Lieberman

United Control Corporation
Overlake Industrial Park
Redmond, Washington 98052

ATTN: Mr. W. Buckingham
Reliability Supervisor

United States Testing Company, Incorporated
1415 Park Avenue
Hoboken, New Jersey 07030

ATTN: Mr. A. F. Maxfield
Manager

Unidynamics/St. Louis
472 Paul Avenue
St. Louis, Missouri 63135

ATTN: Mr. M. G. Zornada
Staff Engineer

U. S. Department of Commerce
Office of Standard Reference Data
National Bureau of Standards
Washington, D. C. 20234

ATTN: Dr. Edward L. Brady, Chief

Varian Associated
Eimac Division
301 Industrial Way
San Carlos, California

ATTN: Mr. John Quackenbush

Varian Associates
Tube Division
611 Hansen Way
Palo Alto, California 94303

ATTN: Mr. Frank Jean
Manager of Reliability

Weston Instruments, Incorporated
614 Frelinghuysen Avenue
Newark, New Jersey 07114

ATTN: Mr. Max Friedman

Walter Kidde & Company, Incorporated
675 Main Street
Belleville, New Jersey

ATTN: Mr. Harold P. Marino
Director of Quality
Control and Reliability

Westinghouse Electric Corporation
D & S Center, M. S. 480
P. O. Box 746
Baltimore, Maryland 21203

ATTN: Mr. W. C. Bullock, Manager
Reliability & Maintainability

Westinghouse Electric Corporation
Marine Division
Hendy Avenue
Sunnyvale, California 94088

ATTN: Mr. L. D. Connell,
Manager, Reliability

Westinghouse Electric Corporation
Surface Division, M. S. 849
P. O. Box 1897
Baltimore, Maryland 21203

ATTN: Mr. T. K. Brown
Supervisor, Engineering

Westinghouse Electric Corporation
R & D Center
Pittsburgh, Pennsylvania 15235

ATTN: Mr. T. A. Daly
Director of Reliability

Westinghouse Electric Corporation
Underseas Division
P. O. Box 1797
Baltimore, Maryland 21203

ATTN: Mr. S. D. Haas

Worthington Corporation
Harrison
New Jersey

EXHIBIT 6

TABULATED RESULTS OF
THE RELIABILITY AND MAINTAINABILITY DATA QUESTIONNAIRE

1. Existence of "data bank" or data center of reliability and maintainability information?

Yes	79
No	23
Partial	15
Replied but did not answer questionnaire	9
Total Replies	126

2. Method of data collection?

Mandatory Form	45
Questionnaire	1
Review of Engineering Reports	43

Other:

IDEP Reports	1	Farada Reports	1
Warranty Reports	1	Maintenance Reports	2
Lab Reports	11	Preproduction Testing	1
Military Contracts	1	Production Testing	1
Field Reports	12	Test Data	14
Failure Reports	4	Evaluation Programs	1
IBM Cards	1	TFR	1
FUR	1	3M	2
AFM 66-1	4	Data Logger	1
UCR	1	Engineering Data	3
Survey	3	Prime Contractor Data	1
Customer Reports	3	Filed in Office of Originator	1
Mandatory	1		

3. Source of data?

Production Testing	57
Environmental Testing	64
AGREE Testing	11
Reliability Demonstration Testing	63
Maintainability Demonstration Testing	25

(continued)

Exhibit 6 (continued)

Life Testing. 52

Incoming Testing. 24

Other:

Field Data.	31	Flight Operations	8
Customer.	4	System Integration Testing. . .	1
Acceptance Tests.	1	MTBF Predictions.	1
AFM 66-1.	2	AFM 65-110.	1
Qualification Test.	6	Airline Service Reports	1
Vendor Test Data.	2	Literature Search	2
System C. O.	1	Burn-in Test Data	2
Life Tests	1	Engineering Analysis and Prediction	1
R & D Production Tests. . .	2	Engineering Reports	1
Development Testing	2	Storage Testing	1
Air Force Records	1	Maintenance Records	1
FARADA.	1	IDEP.	1

4. Categories in which collected data are classified?

Electrical, Electronic, Mechanical, Hydraulic, etc. . . . 61

Function: Power Supply, Amplification Modulation, etc. . . 35

Application: Radar, Sonar, Communications, etc. 26

Other:

Launching and Handling Equipment	1	By System	8
Near, Deterioration.	1	Drift Measurements in Parts/Million	1
Application.	8	Major Component	2
Piece Part	2	Equipment Failure/ Replacement Reports	1
Part Number and Name	13	Work Unit Code.	2
Machine Type and Size.	4	None.	2
As Applicable to Product . . .	3	Performance Data.	3
FSC Codes.	1	As required for Logistic. . .	1
Box and Module	1	Planning.	1
By Supplier, Subsystem Use Environment.	1	Developmental, Test, and Operational Use Data. . . .	1
Federal Stock Number	1	By Test Level	1
By Subassemblies	9	Tube Type	2
Part Type.	5	By Product Line	1
		By Cause.	1

(continued)

Exhibit 6 (continued)

5. Existence of non-operating failure data from equipment in storage or during shipments?

Yes . . . 32

No . . . 73

6. Reliability or maintainability data collected on the listed items?

Servo Mechanisms . . . 36

Mechanical Parts . . . 57

Hydraulic Parts. . . . 29

Others:

Special Components.	1
Appearance Items.	1
Missile Subsystems.	2
Complete Machines	1
Electronic Equipment.	1
Electronic Parts.	13
Electro-Mechanical Parts. . .	5
Digital Computers	1
Electrical Indicating Meters.	1
As Defined by 3M WVC.	1
Wirewound Resistors and Inductors	1
Electrical Parts.	11
Pneumatic Parts	2
Ordnance Parts.	2
Missile Systems	1
Electronic Measuring Equipment.	1
Components	1
No	2
Semiconductors	2
Wheels and Brakes.	1
Aircraft	1
Systems.	3
Missile Assemblies	1
Electron Tubes	1
Transmitters	1
Power Supplies	1
Microwave Tubes.	1
Rocket Engine Parts.	1
Aeronautical Material. . . .	1
Miniature Motors	1
Thermoelectric Couples . . .	1

7. Data source used for failure rates and procedures in making reliability and maintainability predictions?

MIL-HDBK-217A . . . 72

MIL-M-23313A. . . . 20

NAVSHIPS 93820. . . 24

In-house Data . . . 69

MIL-STD-756A. . . . 41

Others:

Weibull Predictions.	1
Cumulative Experience Curves	1
NAVWEPS 00-65-502.	1
NAVSHIPS 94501	1

(continued)

Exhibit 6 (continued)

O.E.M.	1
FARADA	20
Minuteman Standard Part Handbook	4
IDEP	6
Prince	1
Reliability Symposium Papers	3
Manufacturer's Data	10
MIL-STD-690	2
MIL-R-39005	1
MIL-R-38101	1
Special Procedures	1
Calculate from Field Data	2
MIL-C-39014	1
Reliability Analysis Program Handbook	1
Customer Supplied Data	1
Component Failure Physics Analysis Handbook	1
MIL-S-19500	1
MIL-STD-750	1
Not Applicable	1
Earles	4
MIL-STD-470	2
MIL-STD-471	1
Testimonials	1
AFM 66-1	1
MIL-HDBK-217	1
Estimate	2
Commercial Handbook	1
MIL-S-23603	1
MIL-M-26512A	1
Government Agencies	1
RADC-TR-66-348	2
RCA	1
ARINC Research	2
Boeing Document D6-5762-1	1
Martin	1
Hughes	1

8. Depth of predictions?

- Stress analyses provided?

  Yes . . . 75

  No. . . . 20

- Application (k) factors used?

  Yes . . . 74

  No. . . . 19

- Parts derated for environmental conditions?

  Yes . . . 83

  No. . . . 11

Explanations:

Prediction depth depends on contractual requirements	11
Failure rates are selected and modified by MIL-HDBK-217A	15
Stresses are calculated and a standard derating procedure is used for temperature and environment	30
No prediction made	1

(continued)

Exhibit 6 (continued)

In-depth analysis made on certain components but not entire systems. 1

Predictions are primarily at system level. 3

Tests are conducted as per MIL-R-39008 1

Data are taken at maximum rated stress conditions without modifying for use conditions. 1

Tests are conducted at all anticipated requirements and conditions. . . 1

All assemblies having problems are stress analyzed. 1

Depth of prediction increases as design is finalized. 1

Experience and engineering knowledge are used to improve predictions based on experimental data. 1

Some analyses are done on the level of failure mode, failure effect, and failure criticality. 3

9. Field data collected from operational equipments?

Yes. . . 83

No . . . 19

9a. Operational MTBF within 25% of prediction?

Yes, greater . . . 34

Yes, lower 17

9b. Operational MTTR within 25% of prediction?

Yes, greater . . . 16

Yes, lower 4

9c. Data source used in making predictions?

Warranty and Fleet Experience Data . . . 1

In-house Data. 15

Past Experience. 2

MIL-HDBK-217A. 24

NAVWEPS 00-65-502. . . . 1

NAVSHIPS 94501 1

Historical Data. 3

Service Reports. 2

Customer Reports 2

Field Use Data 1

PB161894 1

NAVSHIPS 93820 3

Vendor Supplied Rates. 4

Components Failure Physics Analysis Handbook. 1

No Predictions Made. 4

MIL-STD-470. 2

MIL-STD-471. 1

FARADA 3

Qualification Tests. 1

MIL-STD-23603. 1

MIL-M-26512A 1

Reliability Demonstration Program. 1

DA - Form 240D 1

(continued)

Exhibit 6 (continued)

AVCO Failure Rates	4	Test Logs	1
MIL-M-23313A	3	U. S. Army TAERS Report	1
MIL-STD-756A	2	RCA/RADC Methods	2
Available Published Literature	4	Survey	1
		Martin	1
IDEP	1	Generic Data	1

10. Applications from which data were derived:

Aircraft	47
Ground Equipment	46
Laboratory	32
Missiles	33
Satellites	20
Shipboard	28
Underseas	11

Others:

Missile Launchers and Associated Equipment	1	All Product Lines	1
Automobiles	1	Drones	1
Commercial Installations	1	Rocket Engine Firings	1
Reliability and Quality Control Symposium	1	Mobile Equipment	1
Air Conditioning, Refrigeration, and Ice Making	1	Missiles	1
Flight Simulators	1	Shipboard	1
Drone Helicopter	1	Underseas	2
Test	1	Laboratory	1
Wheels and Brakes	1	Space	1
Torpedo	1	Generators	1
All Types Electronics Usage	1	Training Devices	1
		In-house Testing	1

11. Method used to convert existing failure rate data from one application to another?

None	26	Component Reliability	1
K Factors	22	Compare to Similar Parts	6
MIL-HDBK-217A	20	MIL-STD-256A	1
Experience	1	Engineering Judgment	3
NAVWEPS OD29304	1	Field Data	1
MIL-STD-756A	18	Derating Curves	1
FARADA	1	FARADA Stress Level Multipliers	1

(continued)

Exhibit 6 (continued)

12. Normal users of data:

Management 50

Reliability. 90

Engineering. 83

Quality Control. . . 49

Purchasing 19

Other:

Manufacturing Departments. . . 1

Project Offices. 1

Design 2

Repair 1

Field Service. 4

Sales. 4

Marketing. 5

Production 3

All Functions Requiring Knowledge of System Reliability. 1

DoD 1

Operations Research and System Effectiveness Analysis. 1

Customer. 13

IDEP. 1

Reliability and Quality Groups. 1

Logistics Planners. 3

Contracting Agency. 1

Technical Documents 1

Spares Provisioning 3

Navy. 1

Quality Assurance 1

13. AGREE test results used :

Yes . . . 19

No . . . 87

Comments:

Improved product as result of AGREE testing. 1

Have test similar to AGREE in process. 1

When they are up-to-date 1

Not applicable 3

MIL-R-26667A is usually used 1

Major reliability effort directed to mechanical products . . . 1

Limited to avionics equipments 1

Good results 1

No AGREE tests have been performed to date 1

(continued)

Exhibit 6 (continued)

Comparison of AGREE test results with predictions (comments):

Depends upon prediction accuracy. 1

AGREE results lower 6

As predictions involved 1

Depending on equipment, as closely as 1:1 . . . 1

Not applicable. 3

Inconsistent. 2

No conclusions. 1

No data available 1

Completely random 1

Comparison of AGREE test results with operational failure rates (comments):

Not enough usable data to compare 2

AGREE results lower 9

Operational failure rates are lower 1

Not applicable. 2

No conclusions. 1

About the same. 1

14. Respondent's knowledge of others who have made similar surveys or studies on reliability and maintainability data collection:

Yes . . . 29

No . . . 73

15. Availability of information in respondent's data bank to qualified Government agencies and commercial concerns:

Yes 61

No 15

Commercial. 52

To Government Agencies Only . . . 9

APPENDIX B

RELIABILITY AND MAINTAINABILITY DEFINITIONS

APPENDIX B
RELIABILITY AND MAINTAINABILITY DEFINITIONS

Accessibility. A qualitative equipment design feature that describes the ease of admission to an area within an equipment for the performance of maintenance.

Achieved Reliability. The reliability demonstrated at a given point in calendar time under specified conditions of use and environment.

Active Repair Time. That portion of downtime during which one or more technicians are working on the system to effect a repair.

Adjustment. The act of bringing any out-of-tolerance condition into tolerance by manipulating equipment adjustable features.

Administrative Time. That portion of downtime not included under active repair time and logistic time.

Availability. The probability that the system is operating at any point in time when used under stated conditions, where the total time considered includes operating time, active repair time, administrative time, and logistic time.

Capability. A measure of the ability of a system to achieve mission objectives given the system conditions during the mission.

Catastrophic Failure. A sudden change in the operating characteristics of material, resulting in a complete lack of useful performance.

Component. A combination of parts that cannot be disassembled in the field without invalidating functional integrity. Examples: valves, relays, actuators, gyros.

Confidence Interval. A range of values that is calculated from the data so that it has a given probability (confidence level) of containing the true value of the universe characteristics.

Confidence Level. The percentage figure that expresses the confidence in a given statement that the true population value lies between two limits (the confidence interval).

Confidence Limits. The extremes of a confidence interval within which the true population value has a designated chance (confidence level) of being included.

Corrective Maintenance. Maintenance performed to restore an item to a satisfactory condition by providing correction of a malfunction that has caused degradation of the item below the specified performance.

Correlation. A relationship between two or more variables such that a change in one is accompanied by a corresponding change in the other.

Correlation Coefficient. A number that indicates the magnitude of the relationship between two or more variables.

Cost Effectiveness. A measure of the value received (effectiveness) for the resources expended (cost).

Debugging. A process of shakedown on each finished equipment or unit that is performed prior to placing it in use in order to exclude early failures. During debugging, weak elements are expected to fail and to be replaced by elements of normal quality that are not subject to early failure.

Density Function. A mathematical function $f(x)$ that for discrete random variables represents the probability that the value of the variable is x. For continuous random variables, $f(x)dx$ represents the probability that the value of the random variable is between x and x dx.

Dependability. A measure of the condition of the system during an operational mission as reflected by reliability and maintainability performance.

Derating. The application of parts or components at stress levels below rated values.

Design Review. A progressive review, starting after the design study and continuing through the prototype stage, that provides an assessment of reliability, maintainability, and performance by the use of applicable tests and prediction techniques.

Documentation. Information that is generated to record data required for the control of design, production, procurement, maintenance, and supply of material--such as drawings, specifications, handbooks, and manuals.

Downtime. The total time during which the equipment is not in acceptable operating condition. Downtime can, in turn, be subdivided into a number of categories such as active repair time, logistic time, and administrative time.

Endurance Testing. The process of subjecting material to stress levels within design limits until failure occurs or until the desired life has been demonstrated. Accelerated endurance testing is accomplished by subjecting material to stress levels beyond design limits to induce failures.

Environment. The external conditions that directly or indirectly affect the operation of equipment.

Exponential Distribution. A one-parameter distribution used to characterize failures that occur randomly in time according to the density function $f(t) = \lambda \exp(-\lambda t)$.

Failure. The inability of an item to perform one or more of its specified functions.

Failure Analysis. The study of a specific failure to determine the circumstances that caused the failure.

Failure Mode. The manner in which an item of hardware may fail as a function of the physical properties of the item.

Failure Mode and Effects Analysis (FMEA). An analysis of possible modes of failure and their cause, effects, expected frequency of occurrence, and means of elimination.

Failure Rate. The average number of failures occurring per unit of time in a specified time interval.

Failure Reporting and Corrective Action. A systematic and comprehensive method of reporting all failures, and a plan for implementing corrective action required by these failures.

Free Time. Time during which operational use of the system is not required. This time may or may not be downtime, depending on whether or not the system is in operable condition.

Gaussian Normal Distribution. A density function of a population that is bell-shaped and symmetrical and is completely defined by two independent parameters, the mean and the standard deviation.

Hazard Rate. Instantaneous failure rate.

Human Factors. A discipline that deals with the understanding, prediction, and control of man's role and performance with equipment.

Intrinsic Availability. The probability that the system is operating satisfactorily at any point in time, where the time considered is operating time and active repair time.

Logistic Requirements. Material requirements, such as tools, test equipment, spare parts, equipment, transportation, construction, and the operation of facilities, that are established as necessary to maintain or restore a system to an operational status, and the administrative procedures necessary to assure the stocking and delivery of these materials at the time of need.

Logistic Time. That portion of downtime during which repair is delayed solely because of the necessity for waiting for a replacement part.

Maintainability. The probability that when maintenance action is initiated under stated conditions, a failed equipment will be restored to operable condition within a specified total downtime.

Maintainability Parameters. A group of factors and/or environmental, human, and design features that affects the performance of maintenance on an equipment.

Maintenance. All actions necessary for the retaining of equipment in, or restoring it to, a serviceable condition. Maintenance includes servicing, repair, modification, moderization, overhaul, inspection, condition determination, and initial provisioning of support items.

Maintenance Procedures. Established methods for periodic checking and servicing of equipment to prevent failures, or to effect a repair.

Malfunction. An occurrence, either catastropic or as gradual deterioration, that causes the performance of an equipment to deviate from limits in the equipment specification. It is a condition that requires the services of maintenance personnel to return the equipment to satisfactory condition.

Mean. The sum of a set of values divided by the total number comprising the set.

Mean Time Between Failures (MTBF). The mean value of the operating periods between all failures occurring in a particular equipment during a given time interval.

Mean Time To Repair (MTTR). Effective maintenance man-hours during a given period of time divided by the total number of maintenance actions during the same time interval.

Module. An organized group of parts complete in itself and capable of being handled as an entity. It is a preassembled element of the equipment to which it belongs and is installed or taken out of that equipment as an entity.

Monitoring. The continual checking of an equipment program to insure that all phases of the program are satisfactorily impelemented and are continued throughout duration of the program.

Operational Readiness. The probability that at any point in time the system is either operating satisfactorily or ready to be placed in operation on demand when used under stated conditions. Total calendar time is the basis for computation of operational readiness.

Operating Time. The time during which the system is operating in a manner acceptable to the operator.

Part. The smallest subdivision of an equipment that would not normally be subject to further subdivision in field maintenance. For example: tubes, transformers, resistors, bearings, bolts.

Preventive Maintenance. The maintenance performed to retain an equipment in satisfactory operational condition by providing systematic inspection, detection, and prevention of incipient failures.

Prediction Techniques. Methods for estimating future behavior of material on the basis of knowledge of its parts, functions, operating environments, and their interrelationships.

Probability of Survival P(s). The probability that an equipment will perform for a period t provided it is operating at the start. For the exponential distribution it is given by:

$$P(s) = e^{-\lambda t}, \text{ where } \lambda = 1/MTBF$$

Prototype. The first complete and working member of a class or series of equipment intended to serve as the pattern or guide for subsequently produced members of the same class; a preproduction model suitable for complete evaluation of form, design, and performance.

Quality Assurance Program. A planned and systematic pattern of all actions necessary to provide adequate confidence that the end items will perform satisfactorily in actual operations.

Random Failure. Any failure whose occurrence is unpredictable.

Redundancy. Characteristics of design that make available to a function alternate paths or equipment, either as permanent elements or by means of automatic or manual control, for purposes of improving reliability.

Regression Equation. A formula for computing the most probable value of one variable from the known value of one or more other independent variables based on their correlation.

Reliability. The probability that the system will perform satisfactorily for a given period of time when used under stated conditions.

Reliability Apportionment. The assignment of reliability goals to systems, subsystems, and components within a system. Attainment of the assigned goals will result in fulfillment of the overall contractual reliability requirement for the equipment.

Reliability Assessment. An analytical determination of numerical reliability of a system or portion thereof. Such an assessment usually employs mathematical modeling, directly applicable results of tests on system hardware, and some estimated reliability requirement figures.

Reliability Control. The coordination and direction of technical reliability activities through scientific planning from a system point of view. Reliability control is the broad look at reliability. Reliability control and quality control are parallel control operations considered to extend from early concept and engineering through field use, each in its own respective domain.

Reliability Demonstration. Statistically designed testing, with specified confidence level, to demonstrate that an item meets the established reliability requirement.

Reliability Element. That portion of a reliability program that pertains to a single phase of the program.

Reliability Engineering. That applied science which is concerned with utilizing matter, the properties of matter, and the physical forces involved, to achieve material having known reliability characteristics.

Reliability Goal. A preset reliability objective determined by program management from consideration of such factors as operational needs, state-of-the-art capability, cost, and time. The goal can be a minimum acceptable level, an expected program accomplishment, or an idealistic target.

Reliability Model. A mathematical relationship in formula or graphic form that expresses the interrelationship between a system failure pattern and the failure patterns of system subdivisions.

Reliability/Maintainability Prediction. An analytical determination of the numerical reliability/maintainability of a system or portion thereof; similar to a reliability/maintainability assessment except that the prediction is normally made in the earlier design stages, where very few directly applicable test data are available.

Reliability/Maintainability Program. A program established to ensure that reliability/maintainability requirements established by the procuring activity and incorporated in the contract are achieved in the system.

Reliability/Maintainability Program Plan. A document that details the approach and procedural steps by which a contractor shows his intent of compliance with the reliability/maintainability provisions of the contract.

Reliability/Maintainability Specification. A statement of reliability/maintainability levels that must be achieved. Such specifications can occur in contracts, in project plans, or in both.

Reliability/Maintainability Test. Testing a sample of material under specified conditions for predetermined periods or until a predetermined number of failures or maintenance actions occur.

Repair. Restoration of an equipment to satisfactory operating condition after the source of malfunction, damage, or deterioration has been determined.

Repairability. The probability that a failed system will be restored to operable condition within a specified active-repair time.

Serviceability. The degree of ease or difficulty with which an equipment can be repaired.

Standard Deviation. A measure of the variability of a group in terms of the dispersion of individual scores around the average or mean score.

Standard Error. A measure of an estimate of the sampling errors affecting a statistic; a measure of the amount the statistic may be expected to differ by chance from the true value of the statistic; the standard deviation of the obtained values of the statistic on successive samples.

Storage Time. The time during which the equipment is presumed to be in operable condition but is being held for use at a later date, such as a spare.

Subassembly. Two or more parts that form a portion of an assembly or a unit, replaceable as a whole, and having a part or parts that are individually replaceable.

Subsystem. A combination of equipments or groups that perform an operational function within a system. A subsystem is a major subdivision of a system.

Supply. A composite of related facilities, equipment, material, services, and personnel required for the operation and maintenance of equipment, so that it can be considered as a self-sufficient unit in its intended operational environment.

System Effectiveness. The probability that the system can successfully meet an operational demand within a given time when operated under specified conditions.

Trouble-Shooting. Locating and diagnosing malfunctions or breakdowns in equipment by means of systematic checking or analysis.

Wearout Failure. A failure that occurs as a result of deterioration processes or mechanical wear and whose probability of occurrence increases with time.

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13. ABSTRACT

This Reliability and Maintainability Data-Source Guide was prepared by ARINC Research Corporation for the U.S. Naval Applied Science Laboratory, Brooklyn, New York, under Contract N00140-66C-0151. Under this contract, ARINC Research also was assigned the task of updating and augmenting the data sources referenced in the Navy Systems Effectiveness Control Manual (Review Copy) published in 1965.

This data-source guide identifies twenty-three Government reliability and maintainability data sources and over ninety-five sources of technical and scientific information for related engineering data. The technical coverage, mission, status, and the address of contacts associated with each data source are summarized in the guide.

The guide tabulates responses received from 118 contractors in reply to a questionnaire prepared by ARINC Research. A matrix shows that ninety-four of the 118 had established reliability and maintainability data collection activities. Also presented is a review of the collected data, as to its utility, optimism, currency, and applicability to multicontractor use.

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