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Sandia Laboratories Technical Capabilities

Quality Assurance

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SANDIA LABORATORIES TECHNICAL CAPABILITIES

QUALITY ASSURANCE

ABSTRACT

This report characterizes the quality assurance capabilities at Sandia Laboratories. Selected applications of these capabilities are presented to illustrate the extent to which they can be applied in research and development programs.

FOREWORD

Sandia Laboratories, a multiprogram laboratory of the Department of Energy, is located in Albuquerque, New Mexico, and Livermore, California, with a remote testing facility at Tonopah, Nevada. In fulfilling its responsibilities in the fields of national security and energy, and in other programs, Sandia has acquired extensive capabilities in research, development, testing, and evaluation, and has made numerous contributions in scientific and engineering fields. These capabilities—the basic tools used in research and development—are the subjects of this series of reports. Each of these capabilities is described in a separate report, as listed below. In each report supporting information is provided to show applications of the capabilities.

All the capabilities are in current use. It is intended that their descriptions will allow planners to directly associate them with the technical requirements of studies being considered, and that they will also be sources of technical information for other laboratories, federal agencies, universities, and the Sandia staff.

For those interested in the overall capabilities of the Laboratories, all the reports are compiled in a single publication bearing its own number.

C. Donald Lundergan, Technical Editor
P. L. Mead, Publication Editor

TECHNICAL CAPABILITIES OF SANDIA LABORATORIES

Summary (SAND77-0651)

Aerosciences	SAND74-0075	Instrumentation and Data Systems	SAND74-0083
Applied Mathematics	SAND74-0079	Materials and Processes	SAND77-0002
Biosciences	SAND74-0076	Measurement Standards	SAND74-0077
Computation Systems	SAND77-0767	Physical Sciences	SAND74-0074
Design Definition and Fabrication	SAND76-0413	Quality Assurance	SAND77-0652
Earth Sciences	SAND74-0085	Safety and Reliability Assurance	SAND74-0090
Electronics	SAND74-0086	Systems Analysis	SAND74-0089
Engineering Analysis	SAND74-0087	Testing	SAND74-0088
Explosives, Electrochemistry, and Electromechanisms	SAND74-0081	Auxiliary Capabilities	SAND74-0082
		Environmental Health	
		Information Sciences	

Compilation of
Sandia Laboratories Technical Capabilities
(SAND74-0092)

QUALITY ASSURANCE*

The quality assurance function consists of technical and management activities which provide a continuous and comprehensive evaluation of how effectively system design agencies and production contractors control the manufacturing system, how precisely procedures are followed, and how nearly a product conforms to specifications for performance, life use, maintainability, and safety.

Assurance of quality for a nuclear weapon involves all the functions described above, plus continuing product evaluations. Acceptable quality of weapons as manufactured is assured by audits of the practices and equipment used by a manufacturer and by quality-verification inspections of the product itself. A weapon is evaluated from its early development phases, through its stockpile life, and into retirement. This is done by extensive data collection and analyses, and formulation of decisions based upon those actions. Data are generated by tests and inspection of piece parts, components, and higher assemblies. Surveys of production and control operations supplement the test program. These evaluations provide assurance that every weapon delivered to stockpile meets and retains the required quality standards; discovery of a failure at any time in the life of a weapon or its components results in remedial action.

Technical and management techniques developed through 30 years of application to nuclear weapon programs have also been applied to a number of nonweapon programs for Sandia organizations and, by request, for other agencies. In contrast to the weapon situation, however, quality assurance activities for these other products typically end when the product is accepted because subsequent use of the product makes performance evaluations possible.

To guarantee third-party objectivity, quality assurance evaluations are carried out by a Sandia organization which is independent of the project groups that were concerned with development, and which acts under the auspices of ERDA's Albuquerque Operations Office.

Quality Assurance Professional Staff and Investment in Equipment

	Professional Staff	Investment in Equipment (in \$1000)
Quality Engineering	33	-
Test Program Development	27	310
Product Acceptance and Production Control	30	2900
New and Field Material Surveillance	52	19000
Data-Base Management	19	300

*Compiled March 1977.

PROGRAM IMPLEMENTATION

The quality assurance organization develops and administers engineering, test, and evaluation activities necessary to assure that components, subsystems, and systems are developed, produced, and maintained with desired attributes as expressed and implied by product requirements. Analysis, inspection, and testing of materials, components, subassemblies, and systems provide information for the systematic evaluation of products with respect to ranges of credible environments and anticipated use. Quality assurance is also closely tied to reliability prediction and modeling, and quality assurance results are used to confirm the adequacy and accuracy of failure model assumptions.

Quality Engineering

The purpose of quality engineering is to prevent potential problems and risks. This is done by reviews, surveys, evaluations, qualifications, and audits of products and processes throughout design, development, procurement, fabrication, processing, assembly, inspection, testing, packaging, storage, and shipping. (Item 1)

Activities

- Product Design Review
 - Design requirements
 - Evolution of design
 - Development testing
 - Design, material, and process specifications
 - Product acceptance requirements
 - Adequacy of definitions
- Test Equipment Design Review
- Supplier Precontractual Survey
 - Past performance
 - Facilities
 - Quality program
 - Fabrication techniques
- Supplier Development and Liaison
- Manufacturing Evaluation
 - Equipment and tooling
 - Methods and processes
 - Rate capability
- Tool-made-sample conformance to:
 - Product specifications
 - Design intent
 - Required quality
- Evaluation of Deficiencies
- Instigation of Corrective Actions

Test Program Development

An effort is made to coordinate and provide for the information needs of all organizations involved in product assurance. Tests are interrelated over time and hardware configurations to maximize information use in

an overall program individually developed for each product. As another part of its charter from ERDA, Sandia's QA organization is charged with continuing program review and revision to avoid technical obsolescence.

Activities

- Statistical Modeling and Analysis
 - Design of experiment
 - Sampling plans
- Technical Interchanges
- Determination of Requirements and Specifications
 - Information needs
 - Types of tests
 - Test configurations
 - Environmental exposures
 - Instrumentation and procedures
 - Data acquisition and processing
- Support Organization Direction
- Design and Fabrication of Testers and Instrumentation
- Qualification of Test Equipment and Facilities
 - Test proposals
 - Operating procedures
 - Calibration
 - Equipment function
 - Tester/product compatibility
 - Accuracy and precision
 - Long-term maintenance
 - Provision for spares

Product Acceptance and Production Control

Technical direction, including criteria and procedures, is provided for determining product acceptability by the customer. Vendor production controls are supplemented by Sandia-developed specifications. Acceptance and control procedures are applied throughout the production cycle. (Item 2, 3)

QUALITY ASSURANCE

Activities

- Development of Acceptance Test and Inspection
 - Procedures
 - Configuration of material
 - Critical characteristics
 - Testers and gauges
 - Parameters and limits
 - Test records and certification
 - Defect classification guidance
 - Acceptance criteria
- Laboratory Component Evaluation
 - Early production material
 - Environmental tests
 - Detailed evaluation
 - Comparison to design requirements
- Qualification Evaluation Release
 - Product and processes
 - Acceptance equipment
- Acceptance Tests and Certification
- Periodic Production Process Surveys
- Quality Ratings
 - Hardware
 - Vendor
 - Corrective actions

New and Field Material Surveillance

This surveillance includes all inspections, tests, and investigations performed on material samples that are randomly selected continually throughout production and product life. New material programs emphasize early detection of any significant design, production, and assembly defects. Field material programs further seek to detect and evaluate any degradation that might affect the safety, reliability, or life of a product population. Many complementary inspection and test activities are performed. (Items 4, 5)

Activities

- System Disassembly and Inspection
 - Proper mechanical assembly
 - Internal atmosphere analysis
 - Electrical and mechanical measurements
 - Physical condition
- Accelerated-Aging Tests
 - Elevated temperature environment
 - Temperature cycling
 - Material compatibility
- Safety Tests
 - Accident environments
 - Response characteristics
 - Fail-safe

PROGRAM IMPLEMENTATION

- Vulnerability Tests
 - Enemy countermeasures
 - Inadvertent interferences
 - Denial to unauthorized users
- Joint Interface Tests
 - Interagency hardware compatibility
 - Automated test beds
 - Analog and digital data recording
- Joint Flight or Firing Tests
 - System configuration
 - On-board instrumentation and telemetry
 - Actual use conditions
 - Visual, radar tracking, and electrical signal data
- Laboratory System Tests
 - System configurations
 - Automated test beds
 - Simulated environments and inputs
 - Analog and digital data recording
- Laboratory Component Tests
 - Environment extremes
 - Controlled inputs and loads
 - Overtest and design margin evaluation
- Postmortems
 - Nondestructive
 - Dissection
 - Destructive

Data-Base Management

Data-base management is used to provide accurate, complete, and timely information needed by all organizations and agencies involved. The data system is flexible to accommodate arrays of multi-source data for a variety of products. Data operations for a particular program include common data communication language format provisions for both attributes and variables types of primary data, as well as supplementary data such as assembly records, data codes, and test identifiers. Computers are extensively used. (Item 6)

Activities

- Determination and Specification
- Recording
- Processing
- Transmission
- Editing
- Storage
- Retrieval
- Analysis
- Purge and Destruction

PROGRAM IMPLEMENTATION

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HIGHLIGHTS

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Item 1. Design Review

Design review, applied at the component level, is a systematic, documented study of product definitions for designs, materials, and manufacturing processes. The study is performed by specialists not directly associated with product development and who have had experience with similar products. The purpose is to provide early discovery of potential quality problems or risks.

Item 2. Product Acceptance

A critical component of an electronic assembly, such as the hybrid microcircuit shown in Fig. 1, is typical of accepted product. Acceptance inspection verifies conformance to requirements for assembly, visual and mechanical characteristics, and critical electrical parameters. Surveys are conducted to assure acceptability of critical processes such as sputtering, evaporation, cleaning, substrate sizing, resistor stabilization, and thermo-compression bonding. The product acceptance function is intended to assure operability, interchangeability, and fitness for next-assembly use.

Figure 1. Hybrid microcircuit

Item 3. Monthly Quality Index

A numerical quality index is computed for each supplier as a way of administratively monitoring and centrally coordinating product acceptance activities. Defects in a product are categorized, quantified, and measured against quality criteria, and quality ratings of the product and of the supplier are determined.

Item 4. Laboratory System Testing

System function and safety features are evaluated under controlled conditions. Acquisition of extensive, accurate data allows diagnostic evaluation and detection of degradation trends. Figure 2 illustrates the fixture and centrifuge setup for simulation of launch and reentry environments for a missile warhead; the system under test is operated and monitored during flight simulation.

Figure 2. Centrifuge for simulation of launch and reentry accelerations

Item 5. *Flight Test Program and Instrumentation*

The objective of flight tests conducted jointly with the military services is to verify and diagnose weapon system function in the actual operating environment and to confirm compatibility of systems and procedures designed by ERDA, Army, Navy, and Air Force. Instrumentation components must have the same high-quality characteristics as the systems being monitored; therefore the components undergo comparable quality engineering and product acceptance procedures. Figure 3 shows the launch of a missile and Fig. 4 depicts an instrumentation and telemetry

Item 6. *Data Acquisition and Processing System*

A data acquisition and processing system (Fig. 5) acquires up to 100 channels of real-time analog data from any of several laboratory system testers, processes and records the data, and performs comprehensive analyses. Matching between the tester and recording equipment is provided by amplifiers within the system. Test information is continuously digitized and recorded on magnetic tape at a rate of 15,000 to 120,000 nine-bit samples per second; an analog recorder is provided for backup. At the end of the test, the PCM tape is relayed into a computer-controlled processing subsystem where the data are decoded, compressed, and analyzed. Results are printed in full English statements, and the final data tape is available for transmittal, further analysis, and data-bank storage.

Figure 4. Instrumentation and telemetry package

Figure 3. Sergeant missile launch

Figure 5. Computer room of data acquisition and processing system

PROGRAM IMPLEMENTATION

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