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SANDIA REPORT

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Quality-Assurance Program For Isotopic Power Systems

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Robert L. Hannigan, Robert R. Harnar

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Quality-Assurance Program For Isotopic Power Systems

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Abstract

This report summarizes the Sandia National Laboratories Quality Assurance Program that applies to non-weapon (reimbursable) Radioisotopic Thermoelectric Generators. The program has been implemented over the past 16 years on power supplies used in various space and terrestrial systems. The quality assurance (QA) activity of the program is in support of the Department of Energy, Office of Space Nuclear Projects. Basic elements of the program are described in the report and examples of program documentation are presented.

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Quality Assurance Program For Isotopic Power Systems

1. Introduction

The Department of Energy, Office of Space Nuclear Projects (DOE/OSNP) has assigned the responsibility for a Quality Assurance Program on Isotopic Power Systems (IPS) (designed and produced by non-weapon production contractors) to Quality Assurance Sandia Laboratories (QASL). Appendix A of this report is a copy of the letter authorizing this responsibility. Basically, QASL is charged with verifying that contractors on isotopic power system programs administered by DOE/OSNP comply with applicable (i.e., contractually imposed) sections of OSNP-2, Quality Assurance Program Requirements for Space and Terrestrial Nuclear Power Systems, and produce a product that meets specifications.

2. Scope

A contractor is required to develop a Quality Program plan in accordance with OSNP-2. QASL will normally assist DOE/OSNP in the review and approval of this program; but more than that, it is our responsibility to provide assurance to DOE that both the plan as implemented and the quality of products meet requirements. The techniques necessary to provide this assurance are outlined in this report. Appendix B of this report is a copy of a letter suggesting activities that support OSNP-2 requirements. The letter, dated August 15, 1980, is from DOE/OSNP (formerly the Space and Terrestrial Systems Division) and considers the scope of the QASL mission. An attachment to Appendix B (Task 1) can be used as a guide in preparing work package authorization.

3. Basic QA Program

The QASL IPS Program consists basically of three parts: (a) evaluation of contractor quality operations, (b) evaluation of product, and (c) review of the reliability program.

3.1 Evaluation of Quality Operations

Two techniques, review and formal audit, are used for evaluating operations.

3.1.1 Review

The review is an analysis of paperwork including the documents that describe the contractor quality control operations. The entire range of classical quality control operations is of interest; it includes (a) organization (personnel and management methods), (b) data collecting and analysis techniques, (c) inspection and test requirements, (d) acceptance criteria, (e) process capability determinations, and (f) test and inspection records.

In addition, the review covers quality control-related functions, such as (a) drawing and specification maintenance and change control; (b) techniques of qualifying, evaluating, and selecting subcontractors and vendors; (c) purchase order control; (d) receiving inspection and testing of subcontractor or purchased material; (e) raw material certification or test; (f) in-plant control, identification, handling, and storage of raw and fabricated material; (g) handling of nonconforming material; (h) manufacturing process control and inspection; (i) sampling inspection; (j) standards and calibration programs on instruments, gages, and testers; and (k) adequacy of engineering test planning.

Implementation of the review requires contractors to make available all documents that describe the various facets of planned quality control and related functions as described above. Where documentation is lacking, it may be requested. In addition to original documentation, changes must be made available.

3.1.2 Formal Audit

An audit agenda is formulated from the reviews. Though the agenda serves as a guide for the audit, changes to it can be recommended by any of the concerned parties. After the agenda is prepared, the contractor is notified of the intent to audit. The

contractor is asked to recommend a convenient time; he is also asked to provide a quality control representative to assist the team. The average time spent at the supplier's (or subcontractor's) facility is 3½ days.

The formal audit attempts to establish that the contractor's quality control requirements are adequate and that they are being implemented. Based on the agenda, the audit team, consisting of Sandia National Laboratories' Quality representatives and, usually a representative from DOE/OSNP, reviews the contractor controls and operations. The extent and complexity of contractor operations normally preclude making a detailed audit of all areas; however, major areas are reviewed. In addition, an in-depth study may be made of selected areas. For example, an in-depth study may be made of the procedures and operations for calibrating a particular tester, or a quality check-point operation may be studied in detail to determine how tests are made and how the resulting data will be used.

A postaudit conference is held with the contractor to review the findings, which are later reported to DOE. Experience shows that a carefully performed formal audit of contractor quality planning can prevent many potential problems and result in improved communication between the contractor and DOE. Continuing informal contacts are made between the contractor and QASL/DOE. This open communication leads to a good working relationship.

3.2 Evaluation of Product

Three techniques are used in product evaluation: (a) process survey, (b) verification inspection, and (c) monitoring of engineering tests.

3.2.1 Process Survey

The process survey, like the formal audit, will involve a visit to a contractor's plant. The intent of the visit, however, is considerably different. The process survey is hardware oriented and this tends to involve more specific areas of interest; usually, the areas are those that are especially critical to use function. For example, the team may observe the operation in which emissivity coating is applied to a generator case and fins, and the subsequent check of thickness, emissivity, and adhesion. The process survey applies to areas where the end product will not or cannot be tested or inspected to assure the effectiveness of the process.

The process survey team is made up of Sandia National Laboratories' quality engineers and specialists. Findings of the process survey are reviewed with the contractor and reported to the DOE Program

Manager. Less formal process surveys may be performed by resident Sandia Quality Assurance Representatives (SQAR).

3.2.2 Verification Inspections

To provide quality information, independent verification inspections are performed on piece parts and at lower assembly levels. The inspections are also made at the final level of assembly as part of the "DOE-acceptance of product" process. Procedures for inspections are prepared by Sandia National Laboratories' quality engineers and performed by SQAR. The inspection procedures require nondestructive tests and inspections of hardware and processes at levels of assembly where the required information can most feasibly be obtained without interfering with the normal production process. Results are reported by the quality engineer to appropriate levels in the DOE and Sandia National Laboratories. In the verification inspection the SQAR uses contractor equipment unless the equipment is judged to be inadequate. Where special test or gaging equipment is required to support verification inspection, such equipment is provided by DOE. Sandia National Laboratories' facilities will also be used, if necessary, to support this function.

3.2.3 Engineering Developmental Tests

Engineering developmental tests are considered a necessary part of evaluating a product. These tests should be conducted (a) on products in their natural environments and (b) on a design capability overtest. Engineering personnel normally conduct a postmortem analysis. QASL will review contractor planning for these tests and, when adequate testing appears to be lacking, QASL will inform the Program Manager.

3.3 Review of the Reliability Program

Responsibility for the reliability assessment program lies with the contractor. Since the duties and responsibilities of reliability and quality control often overlap, QASL will be cognizant of the contractor's reliability effort and will use data from that program, when possible, to provide information for the DOE judgment of acceptability. When specifications are not compatible with reliability requirements, the deficiencies will be documented and forwarded to the DOE Program Manager for correction.

4. Isotopic Power System QA Program Documentation

The Quality Assurance Operating Procedures used by QASL to accomplish verification inspection of IPS material in behalf of DOE are defined and illustrated in the Sandia National Laboratories IPS-1 Handbook: *IPS-1, Quality Assurance Procedures for Isotopic Power Systems*. It should be noted that QASL acceptance is the only government acceptance of IPS material produced by nonweapon contractors. The acceptance function for production that is the responsibility of DOE captive contractors is normally performed by the associated DOE office.

When comparable functions are performed, acceptance routines and paper work generally follow those routines established by the Weapons program. However, functions may not be comparable where there are few IPS units or where QASL weapons activities (i.e., New Material Laboratory Testing, Stockpile Laboratory Testing, Quality Engineering Project) do not lend themselves to the IPS Program. The weapons Tool-Made Sample Program is somewhat analogous to the IPS qualification unit activity in which a flight-type IPS is subjected to qualification level environments to confirm that design meets specification requirements.

Documentation used by (or of prime significance to) QASL in performing the IPS acceptance function is described in subparagraphs 4.1 to 4.8.

4.1 Quality Assurance Inspection Notifications (QAINs)

The QAINs are planning documents issued by QASL. These documents notify the contractor regarding current quality assurance requirements for particular items and pertain to certain conditions or stages of the contractor's production process. Data or certification requirements will be given on a QAIN (Figure C1).* When a QAIN requires certification, test and inspection data, or calls for special tools and gages to perform an inspection, these shall be provided by the contractor. Common, open setup items are not normally specified. The SQAR may specify verification activity that is not identified on a QAIN. The representative will do this when, in his judgment, such

activity is needed to determine conformance to drawings and specifications.

For each IPS, QASL publishes an official list of the current QAINs and related verification instructions. This is called the Master QAIN/QAVI List; a sample is given as Figure C2.* The contractor is expected to provide adequate schedule information and to coordinate detailed requirements of verification with the SQAR as necessary. The SQAR then makes local arrangements for further information and for obtaining the equipment specified in the QAIN.

4.2 Quality Assurance Verification Instructions (QAVIs)

The QAVIs are issued by QASL, and are item- or process-oriented instructions that specify the verification actions to be performed by the SQAR. The words "Verification Instructions" appear in the titles of two different types of instructions. The first is the QA Verification Instruction (QAVI) given here as Figure C3.* The second is the Sequential QA Verification Instruction (SQAVI) given as Figure C4.* QAVIs are QASL directives to the SQAR regarding the performance of a verification activity at a given time or point in the manufacturing sequence. SQAVIs are QASL directives to the SQAR regarding the performance of specific *sequential* series of verification activities. These activities are performed at successive points or stages in the manufacturing sequence.

The SQAR performs any or all of the following activities, as necessary, to determine the degree of conformance to applicable drawings and specifications: inspections, inspection and/or test data examinations; participation in surveys; and observation of contractor operation. Usually these activities are performed as specified in QAINs, SQAVIs, and QAVIs. However, the SQAR may request non-QAIN submission documents, or may perform non-SQAVI verification operations. He will do this when it is his judgment that such action is necessary to determine the degree of conformance to drawings and specifications.

Normally, acceptance will be based on one or more of the following:

- Verification inspections of material by the SQAR,
- Quality evidence and/or certifications provided by the responsible prime contractor,
- QASL evaluation of the prime contractor's manufacturing and quality control operations.

*Figures C1 through C8 are included in Appendix C.

The SQAR determines that all contractor equipment he uses, in accordance with the QAIN, has been calibrated and properly certified by the contractor. Generally, verification activities are performed at the prime contractor's facilities, but may extend to subcontractor locations.

4.3 Certificate of Inspection (CI)

The CI documents the performance of key quality assurance acceptance activities. At the points in the production process identified by the QAIN or otherwise identified by the SQAR, the contractor provides the formal CI and specified supplemental information regarding the material. The SQAR records entries regarding the acceptance function in a space provided on this document. Manufacturing contractors use a CI (Figure C5) to submit material for QASL (DOE) acceptance. The SQAR performs liaison as necessary to insure that the contents and format of the submitted documents meet QASL requirements. The SQAR indicates the appropriate material disposition category on each CI. Four lot-disposition categories can be assigned during verification activities.

- **Accept** — This category applies to (a) materials where no defects were observed and (b) materials that contain defects but nonetheless are approved by appropriate Material Review Board action.
- **Conditional Acceptance** — This category applies to materials for which a partial acceptance has been given. Additional verification is required for final acceptance. Shipment of conditionally accepted material may be made to other installations provided there is agreement between the shipping and receiving facilities concerning the responsibility for final acceptance requirements.
- **Qualified Acceptance** — This category is reserved for special application as defined by QASL. Detailed instructions will be issued when the category is used in this way. The category may also be used in the normal sense to qualify acceptance. Used in this way, the term indicates that material so accepted does not meet all the specifications or requirements deemed important to the end use of the material. The category designation does not necessarily indicate the material cannot be used; however, it does identify material that does not merit unqualified acceptance.
- **Reject** — This category applies to materials with unapproved deviations.

Numbered stamp sets and unnumbered lead-seal dies are issued to individual representatives who have

acceptance authority. Stamps are normally used to signify in-process acceptance on non-CI documentation, while the lead seal is normally reserved for shipments.

In certain cases where mutual benefits exist, QASL may authorize the use of existing contractor records for in-process activities in lieu of the CI. Such records must contain minimum acceptable information about the product including:

- The item being processed
- Applicable drawing by issue and any applicable engineering changes
- Traceability information (by purchase order, subordinate contractor record, etc) on subordinate parts and materials
- Reports of nonconformances that were generated in support of contractor processing
- Unique contractor record identification number.

Contractor travelers are an example of this type of record. The SQAR accepts the traveler by marking the record with an applicable ink stamp. The representative rejects the item by filling out a Report of Nonacceptance (Figure C6), which he addresses to the contractor.

4.4 Material Inspection and Receiving Report (DD-250)

A Material Inspection and Receiving Report is prepared by the contractor after he receives authority to ship from the contracting officer (DOE). When product acceptance authority has been delegated to QASL by DOE, the SQAR examines the contents of the document in relation to records of verification activities on the particular unit or units and indicates his acceptance by signing the appropriate block of Form DD-250 (Figure C7). His signature certifies that the listed items conform to contract specifications and acknowledges his responsibility in accounting for the material.

4.5 Requisition and Invoice/Shipping Document (Form DD-1149)

A Requisition and Invoice/Shipping Document is used for shipping material and/or transferring accountability of property not identified in a contract as a deliverable end item. The contractor originates the DD-1149 and ordinarily the SQAR will *not* sign the document.

4.6 Acceptance Cancellation Form

An Acceptance Cancellation Form is used by the contractor to inform the SQAR of acceptance cancellation on material the QASL previously accepted (Figure C8). Such a situation might arise if, in the judgment of the prime contractor, rework and reverification may be required, or if a unit may be unusable or unsuitable. Dropout or recycled units typically represent conditions not known to the SQAR without a report from the contractor.

4.7 Data Package

A data package must accompany delivered end items that are subject to QASL acceptance in behalf of the DOE. Prior to end item acceptance (Form DD-250), the SQAR inspects the data package for accuracy and proper completion of various documents. The data package is considered a deliverable end item and, as such, is subject to acceptance by QASL.

A typical data package includes the following items, preferably in bound form:

- Title page
- Form DD-250
- Operating Log
- Product Definition
- Replacement Records
- Weight and Balance
- Qualification and Acceptance Test Data
- Certificates of Inspection
- Nonconformance Reports
- Drawings and Specifications
- Operations/Maintenance Manuals

4.8 Delegation of Authority

The Delegation of Authority for specific programs comes from DOE/OSNP, as stated in Section 1. Normally, a letter from the Contracting Officer (Appendix A) is used to notify the contractor of this delegation of authority. Redelegation matters are conducted as stated in the letter.

5. Responsibilities / Activities of Quality Engineer and Sandia Quality Assurance Representative

5.1 Quality Engineer (QE)

5.1.1 Basic Program Responsibilities

Section 3.1 outlines the two techniques for evaluating operations. The quality engineer is responsible for these evaluations; he oversees the review process and heads the formal audit. He is also charged with product evaluation per Section 3.2, which includes planning, conducting and reporting on process surveys, and preparing both inspection notifications and verification instructions. In addition, the QE will be aware of reliability implications that affect product acceptance per Section 3.3.

5.1.2 Visits to Site

The QE will make periodic visits to the DOE contractor's work site to observe the progress and determine the quality of the work; i.e., verify that the work meets general contract requirements. Exhaustive or continuous on-site physical measurement-type inspections by the engineer are not required. Furthermore, a resident project representative (SQAR) will act as assistant to the QE. The principal responsibility lies in evaluating the project and in determining whether or not the completed project will conform to contract requirements. On the basis of on-site observation, the QE will inform DOE on the progress of the project and will endeavor to guard DOE against defects and deficiencies in the work of the contractor and/or subcontractors.

5.1.3 Correction/Clarification to Specifications

When, in the opinion of the QE, technical documentation is judged to require clarification, correction, augmentation, or any other change, such changes will usually be requested in writing as follows:

- When the change or clarification is clearly to bring the specification or other document into compliance with contractual requirements, or when it is necessary to clarify, correct, or improve existing contractual requirements, the change can be requested through the contractor Quality Manager.
- When the change or clarification is deemed necessary but is *not* clearly within contract scope, the change will be requested of the DOE/OSNP Quality Manager for appropriate DOE action. Information copies of the change or clarification may be forwarded to the DOE/OSNP Program Manager and Contractor Quality Manager.

5.1.4 Rejecting Defective Work

The QE has the authority to disapprove or reject work that is damaged or defective. The term defective is used to describe work that (1) is unsatisfactory or faulty, (2) clearly does not conform to contract design requirements, (3) does not meet the requirements of inspection or testing, and (4) is not approved by Material Review Board Action.

5.1.5 Limitations on QE's Responsibility

Neither the QE's authority to act under the provisions of the contract nor any decision made by him in good faith shall influence the progress of the work under the contract.

The QE is not responsible for the contractor's means, methods, techniques, sequences or procedures of fabrication, or the safety precautions and programs employed. He is not responsible for the contractor's failure to perform work in accordance with contract documents. Furthermore, the QE is not responsible for acts or omissions by the contractor or any subcontractor.

5.1.6 Support to DOE

The QE will support DOE to the extent necessary to accomplish the Tasks outlined in Appendix B.

5.2 Sandia Quality Assurance Representative (SQAR)

Generally, a resident SQAR will assist the QE in carrying out responsibilities at the contractor's site. The duties and limitations in authority of the appointed SQAR are given below.

The SQAR will have access to contractor facilities in accordance with contractual provisions and will examine work prepared under those contracts. All items built, tested, and/or delivered under articles of the contracts are subject to on-site examination by the SQAR. In addition, the representative will observe critical process features and in-process tests and inspections performed by the contractor. These checks will be made on a monitor/verification-type basis so that the activity will not usually interfere with normal manufacturing routines. Use of contractor data for judging the quality of certain product features in lieu of actual examination will be necessary in some instances. Request for this type data, as required, will be made at the discretion of the SQAR and is considered within the scope of the contract.

To implement the Sandia Quality Evaluation Program at the contractor facility, the SQAR shall do the following:

- Participate, as required, in system design reviews and in periodic program meetings.
- Conduct necessary checks to assure that processing methods and controls are adequate, and sufficient in-process control and inspection is performed to show conformance to detailed process specifications.
- Review inspection records and in-process testing and material certifications for any deviations from specifications.
- Conduct inspection operations, as required, to assure that method and controls do not vary from those previously judged as adequate.
- Verify that all test equipment furnished or used under contract is operational and ready for conducting all required tests, and that calibration and operational checkout procedures are adequate for testing the product.
- Conduct quality evaluations of all test components, converters, auxiliary hardware, and ground support equipment, using procedures given by QAVIs and SQAVIs.
- Provide on-site technical assistance to the QE, as required

- Report major design and manufacturing problems or discrepancies encountered during surveillance operations to the Contractor Program Manager for resolution. All problems relating to product quality shall be reported to the Sandia QE for further action, as required.
- With the prior knowledge of the QE, reject defective work within the constraints of Section 5.1.4.
- Support DOE in accomplishment of the tasks outlined in Appendix B to the extent directed by the QE.

6. QASL QA Procedures

Working guidelines for the SQAR to accomplish verification inspections and other related functions on IPS program material, in behalf of DOE/OSNP, are published by QASL as IPS-1. Since some of these procedures affect the QASL-Contractor interface, information copies of IPS-1 shall be supplied to prime contractors.

7. Summary

The QASL QA Program has evolved over a period of 16 years, and is a logical outgrowth of the long-standing Sandia weapons quality program. Included in the QASL QA program are sections from the weapons quality program that were considered applicable to the quality program for the IPS. Funding restraints plus differences between weapons and IPS programs, however, dictated a specially tailored program of the scope indicated in this report.

Since only a few flight systems are delivered in each IPS program, heavy reliance is placed on assessing completeness and effectiveness of the contractors' quality operations and on the evaluation of the product. The assessment concentrates heavily on traditional product quality control techniques while the evaluation of product concentrates on product/process control and conformance to specifications.

The program outlined in this report has proven to be a good balance between quality costs and the need to verify quality on low-production, high-cost systems with high reliability requirements.

APPENDIX A

Quality Assurance Activities in Support of OSNP



Department of Energy
Washington, D.C. 20545

June 8, 1979

Mr. W. P. Thomas
Organization 1412
Sandia Laboratories
Post Office Box 5800
Albuquerque, New Mexico 87115

Dear Mr. Thomas:

QUALITY ASSURANCE ACTIVITIES IN SUPPORT OF ANSP

You are hereby delegated, with power of further redelegation, the authority to perform quality assurance functions in support of ANSP programs including product acceptance for the DOE for ANSP programs effective upon receipt of this letter. Any redelegation of this authority is to be in writing to your designated representative(s) with copies to the contractor, myself, the ANSP Power Systems Section (2), and the ANSP Safety and Isotope Fuels Section.

The enclosed letters will be sent to each of the ANSP contractors officially notifying them of this delegation. As set forth in the enclosed, you will be designated the official point of contact for quality assurance matters pertaining to ANSP contracts. Correspondence related to such matters as audits and surveys of the contractor's quality control program and operations will be transmitted to the contractors over your signature or the signature of your designated representative acting for you in your behalf.

Acceptance of product and services for the DOE shall be based on assurance that contract requirements have been met and that acceptance is performed in accordance with applicable portions of the DOE approved Quality Assurance Program Plan, Federal and DOE Procurement Regulations.

A copy of DD Form 250 and Sandia Laboratories Certificate of Inspection (CI) showing final acceptance of end-items to be delivered to ANSP and/or its User Agency, shall be sent to the undersigned and to the ANSP Power Systems Section.

Further distribution of these and other quality related documents to ANSP shall be made in accordance with agreements reached between your staff and appropriate personnel.

Sincerely,

William G. Blumenauer
W. A. Blumenauer
Contracting Officer
Office of Procurement Operations

Enclosure:
Letter from Blumenauer to
GE & Teledyne Energy Systems

cc: B. Rock, ET-772
J. Lombardo, ET-772
F. Dieringer, ET-772
T. Dobry, ET-772
R. Brouns, ET-772
R. Morrow, ET-772
D. Kenney, ET-772
W. Slivka, GE
R. Harnar, Sandia

APPENDIX B

Sandia Technical Support and Operations Analysis Program Guidance for FY 1981-1982, Sandia National Laboratories

Aug 15 1980

NE-543

Sandia Technical Support and Operations Analysis Program Guidance for FY 1981-1982, Sandia Laboratories

H. E. Roser, Manager
Albuquerque Operations Office

The following are Sandia Laboratories Technical Support and Operations Analysis assumptions to be used for planning purposes for FY 1981 and for FY 1982.

Funding is in support of project activities of the OANSP Space and Terrestrial Systems Division, B&R Coded AE-15-25-20 (Task 1, Technical Support - Reliability and Quality Assurance) and AE-15-30-00 (Task 2, Operations Analysis).

Fiscal Year Funding Levels that can be used for planning purposes:

Task	FY 1981		FY 1982	
	BA	BO	BA	BO
1	600	600	600	600
2	50	50	60	60

Major task categories listed in the attachment reflect activities required to support the requirements, and should serve as guidance in preparation of the work package authorization.

B. J. Rock, Acting Director
Space and Terrestrial Systems Division
Office of Nuclear Energy

Attachment

Major Task Categories / Activities

Task 1 AE-15-25-20 Technical Support - R&QA

Objectives

- Assure Department of Energy that the Contractor conducts his Quality and Reliability activities in accordance with Department-approved plans.
- Assure Department that processes, material, components, and systems are designed, developed, fabricated, and tested in compliance with established engineering criteria.

Major Task Activities

1. Provide support to Department in preparation of Quality and Reliability Policy Standards documents.
2. Provide Quality and Reliability support in proposal, contract, and plan evaluations.
3. Provide Quality and Reliability inputs and representation to design reviews.
4. Provide onsite representatives, as required, for programs under the cognizance of the Department.
5. Critique contractor's specifications, drawings, and procedures; submit comments to the Department.
6. Develop QA verification instructions for acceptance of product, processes, assembly, and tests.
7. Verify conformance to specifications of hardware fabrication, processing, assembly, and test.
8. Support the Department on Material Review Board Activities.
9. Conduct periodic formal quality audits.
10. Provide support for special quality audits.
11. Provide support for special investigations.
12. Provide vendor surveillance for critical items.
13. Recommend more cost-effective or reliable nondestructive test methods.
14. Conduct/develop experimental nondestructive test programs as requested/approved by the Department.
15. Provide planning and support for periodic Quality and Reliability management meetings with contractor's Quality and Reliability managers.

16. Stimulate integration of Reliability into analytical design and test activities.
17. Provide Quality and Reliability support, as necessary, on problems, failures, and quality trends; provide analytical support and/or recommendations for corrective action, as appropriate.
18. Recommend statistical programs relating to process control, product acceptance, etc.
19. Review ongoing failure event trends for indications of systematic reliability impact, i.e., common modes of failure, quality trend effects, etc.
20. Accept product.
21. Provide biweekly QE "Nuclear Power Supply Program" Reports and monthly Contract Management Summary Reports.

Task 2 AE-15-30-00 Operations Analysis

Objectives

- Analyze operations involving the nuclear heat source from fuel form fabrication to deployment of the completed nuclear system, with emphasis on safety and safeguards of the nuclear material.
- Formulate and implement an operations analysis system.

Major Task Activities

1. Conduct operations analysis system.
2. Draft notification to the Department and contractor participants of meetings, visits, and surveys for OA purpose.
3. Participate in all OA activities and conduct visit and reviews as requested.
4. Prepare minutes of all meetings, visits, surveys, etc, and maintain log of recommendation and action items and status.
5. Prepare and issue an Operational Analysis Report on each program. The OA report should be cumulative of each phase of OA such that the final OA report will be a complete record of the OA findings, recommendations, and resolutions for a particular program.

The contractor should maintain continuity of personnel and expertise for performing OAs through FY 81-82 and later as required and funded. Current programs as candidated for OA application are NASA's Project Galileo and Solar Polar Mission.

APPENDIX C

Illustrations

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QUALITY ASSURANCE INSPECTION NOTIFICATION

QAIN NO: GP 304 B

Design Specification Reference:
47D305338 thru 5343; 47D305345 thru
5347; and 47B305613

Date: 9 Mar 1981

Material Description:
Straps (Electrical)

GENERAL

The purpose of this document is to notify the contractor of DOE verification inspection and survey requirements. Where applicable, the documentation and test equipment required by Quality Assurance Sandia Laboratories (QASL) to perform these functions are listed on sheet 2 of this QAIN.

The contractor is required to complete, sign, and provide a modified AL Form 834, Certificate of Inspection (CI), with each submittal of material. The point of submittal of the CI is specified in the "Special Instructions" below.

The contractor will notify the QASL representative of the time and place of the survey points listed on sheet 2 of this QAIN.

SPECIAL INSTRUCTIONS

1. DOE verification inspection will be performed at GE unless the QASL is notified of an alternate location.
2. The Certificate of Inspection will accompany material presented for DOE verification inspection.

APPROVED:


Sandia Labs, 1012

DISTRIBUTION: . . .

GE - E. Urbanik (3 cys.)
ANSP - F. M. Dieringer
1411-1 - SQAR
1412 - File

Reason for Change: AN3 to dwgs 5338, 5339, 5340,
5342, 5343, 5347 and 5613.
AN4 to dwgs 5341, 5345 and 5346.

Figure C1. Sample of a Quality Assurance Inspection Notification

QUALITY ASSURANCE INSPECTION NOTIFICATION

Figure C1. (Cont)

DATE 16 Feb 81

GENERAL PURPOSE HEAT SOURCE RTG

MASTER QAIN/QAVI LIST

QAIN ISSUE	NUMBER	QAVI ISSUE	DRAWING NUMBER	CONFIGURATION DESCRIPTION	NOTE
A	SP301	B	47A303948	UNICOUPLER FABRICATION	1
A	SP302	A	47E303917	18 COUPLE MODULE ASSY	1, 4
A	GP303	A	47J305231	THERMOPILE FOIL INS ASSY	4
A	GP304	A	47D305338	STRAP CIRC, END, LONG	4
A	GP304	A	47D305339	STRAP AX, FEED AND RETURN	4
A	GP304	A	47D305340	STRAP CIRC, END U-TY	4
A	GP304	A	47D305341	STRAP CIRC, CENTER, STRAIGHT	4
A	GP304	A	47D305342	STRAP CIRC, CENTER, U-TY	4
A	GP304	A	47D305343	STRAP CIRC, END, SHORT	4
A	GP304	A	47D305345	CONNECTING STRAP RETURN	4
A	GP304	A	47C305346	CONNECTING STRAP FEED	4
A	GP304	A	47B305347	CONNECTING STRAP, UNIC	4
A	GP304	A	47B305613	STRAP PARALLEL CONN	4
A	GP305	A	47D305659	CONN STRAP AX, BRAZING	4
A	GP306	A	47J305194	INNER FRAME ASSY	4
A	GP307	A	47J305000	ELECTRIC HEAT SOURCE ASSY	4
A	GP308	A	47D303435	SENSOR, TEMP (RTD)	4
	GP309		47E305020	RTD AND CABLE ASSY	4
A	GP310		47J305920	OUTER SHELL ASSY	4
A	GP311	A	47J305034	SHELL AND FIN ASSY	4
A	GP312	A	47J305935	PRD VENT CHAMBER ASSY	4
X A	GP313	X B	47D305900	MASS MODEL (DELIVERABLE)	5
X	GP314		Later	THERMAL MODEL (DELIVERABLE)	5
X	GP315		Later	CET CONVERTER ASSY (DELIV.)	5
X A	GP316	X A	47E305499	SHIPPING CONTAINER ASSY, GPHS	3
X A	GP317	X A	NAS 577	NUT, SELF-LOCKING, BARREL	5
D	MH111	F	47C301616	P1/3 T/C SEAL ATT SCREW	4
D	MH114	F	47C301631	P2 NUT PLATE	4
D	MH141	E	47B302562	P1/3 SCREW-PRESSURE DOME	4
K	MH148	L	47C302638	P1/12 "C" SEAL	4, 3
A	MH713	B	N/A	GENERAL PURPOSE	4
A	MH722	A	47E305248	14 COUPLE MODULE ASSY	1, 4

NOTES: 1 - SiGe Reestablishment Program

x 2 - Deleted

3 - GSE

x 4 - GPHS Qualification & Flight Units

5 - GPHS Deliverable Items

X - Change or addition from previous issue

Note that carry over MHW QAIN/QAVIs (MHXXX), modified as necessary for GPHS application, are included in the above list.

Distribution:

GE E. J. Urbanik, (3 cys.)

GE SQAR, (1 cy.)

DOE F. M. Dieringer, (1 cy.)

1412 File (1 cy.)

Figure C2. Sample of a Master QAIN/QAVI List

QUALITY ASSURANCE VERIFICATION INSTRUCTIONS

QAVI NO: GP 304 BDATE: 9 Mar 1981MATERIAL DESIGNATION:

Straps (Electrical)
 47D305338 thru 5343; 47D305345 thru 5347; and 47B305613

APPLICATION:

New Production

EFFECTIVE DATE:

Upon Receipt

GENERAL INSTRUCTIONS:

After first article inspection by the SQAR, Inspection Items identified with the # symbol may be waived, provided:

1. Review of GE QC planning by QASL confirms the items listed are being checked by GE,
2. The SQAR is satisfied that GE inspection techniques are adequate, and
3. Review of GE or supplier inspection records shows conformance with requirements.

SAMPLING PLAN:

<u>Lot Size</u>	<u>Sample Size</u>	<u>Accept. No.</u>	<u>Reject No.</u>
2-15	2	0	1
16-25	3	0	1
26-90	5	0	1
91-150	8	0	1
151-280	13	0	1
281-500	20	0	1

NOTE: Handle parts with white gloves or finger cots at all times.

APPROVED: Robert L. Hannigan
 Sandia Labs, K-12

Distribution:

ANSP F. M. Dieringer
 1411-1 SQAR (2 cys.)
 1412 File

Reason for Change: AN3 to dwgs 5338, 5339, 5340,
5342, 5343, 5347 and 5613.
AN4 to dwgs 5341, 5345 and 5346.

Figure C3. Sample of a Quality Assurance Verification Instruction

Sheet 2 of 2

QAVI NO: GP 304 B

Date: 9 Mar 1981

CI No. _____

QUALITY ASSURANCE VERIFICATION INSTRUCTION

Inspection Item No.	Design Specification	Instructions	Date Item Completed
1.0		<u>RECORD EXAMINATION</u>	
1.1	47D305338 thru 5343; 47D305345 thru 5347; and 47B305613 QQ-N-290A	Review evidence for conformance to the following: a. Previous QASL acceptance for the copper starting material (SP 301). b. Nickel plate thickness (0.0001 to 0.0003) and post plating bakeout per note on applicable drawing. c. Nickel plate adhesion test results (sample) per QQ-N-290A, para. 3.3.2.	
2.0		<u>COMPONENT INSPECTION</u>	
2.1	47D305338 thru 5343; 47D305345 thru 5347; and 47B305613	Check that identification markings are present, correct, legible and in conformance with specification per <u>Note 2</u> .	
2.2	ditto	Check that parts appear to be complete, undamaged and in conformance with drawing. Check for scratches, dents, etc. Check that parts are free of foreign material.	
2.3	ditto 47A305296 NS0060-02-107 QQ-N-290A	Observe or otherwise verify that the following requirements meet specifications: 1. That parts are free of loose or potentially loose conductive contamination per 47A305296 and NS0060-02-107. 2. That nickel plating meets the visual inspection requirements as detailed in para. 3.4.2 of QQ-N-290A. # 3. Part thickness per drawing material callout.	Date QAVI Completed _____

SEQUENTIAL QUALITY ASSURANCE VERIFICATION INSTRUCTION

SQAVI NO.: GP 307 B

DATE: 9 Mar 1981

DESIGNATED OPERATION: Electrical Heat Source Assembly
47J305000

APPLICATION: GPHS Qualification and later units

GENERAL INSTRUCTIONS:

1. Prior to SQAVI activities the GE Planning should be reviewed for familiarity. Necessary MIPs should be identified.
2. During inspection activities, parts must be handled carefully since they are fragile and can be easily damaged.
3. During inspection activities, observe cleanliness requirements stated in notes 6 and 7 of 47J305000.
4. After first article inspection by the SQAR, Inspection Items identified with the # symbol may be waived, provided:
 - a. Review of GE QC planning by QASL confirms the items listed are being checked by GE,
 - b. The SQAR is satisfied that GE inspection techniques are adequate, and
 - c. Review of GE or supplier inspection records shows conformance with requirements.

DISTRIBUTION:

F. M. Dieringer, DOE/ANSP
1411-1 SQAR (GE)
1412, File

APPROVED:

Robert L. Hannigan
Sandia Labs - 1406

Reason for Change: AN 47J305000-5

Figure C4. Sample of a Sequential Quality Assurance Verification Instruction

SQAVI NO: GP 307 B

Sheet 2 of 4

SEQUENTIAL QUALITY ASSURANCE VERIFICATION INSTRUCTION

Date 9 Mar 1981

Audit Item No.	Reference Specification	Instructions	Date Item Completed
10.0	<u>COMPONENT PROCESSING AUDIT</u>		
10.1	47J305000 47E305030 47A305296 CP47A14641 NS0060-02-117	<p>As a minimum, this stage of the assembly and test operations should be audited on a regular basis. Audit activities should include:</p> <p>a. Parts configuration inspection prior to assembly. Verify that parts have been previously accepted by GE including all necessary cleanliness inspections in support of 47A305296.</p> <p>b. Parts cleaning per notes 7 of 47J305000.</p> <p>c. Basic assembly and assembly inspection operations per 47J305000. During these operations, pay particular attention to:</p> <ol style="list-style-type: none">1. Parts handling per notes 6 and 7 of 47J305000.2. Torquing requirements.3. Instrumentation per 47E305030.4. Electrical characteristics per note 5 of 47J305000. <p>d. Weight and CG measurements per para 4.3.1.1, 4.3.1.2, 3.2.2.2 and 3.2.2.3 of CP47A14641.</p>	_____

Figure C4. (Cont)

SQAVI NO: GP 307 B

Sheet 3 of 4

SEQUENTIAL QUALITY ASSURANCE VERIFICATION INSTRUCTION

Date 9 Mar 1981

Audit Item No.	Reference Specification	Instructions	Date Item Completed
20.0		<u>RECORD EXAMINATION</u>	
20.1	47B301557 47A302310 47D305001 47C305002 47D305003 47C305004 47D305005 47C305011	In conjunction with component processing (Inspection item No. 10.0) review evidence for conformance to the following requirements: <ul style="list-style-type: none"> a. Material and material bakeout per material block and note 4 of 47D305001. b. Material and material bakeout per material block and note 4 of 47C305002. c. Material and material bakeout per notes 4 and 5 of 47D305003. d. Material per material block of 47C305004. e. Material (P1 and P2) per material block of 47B301557. f. Material per note 3 of 47C305011. 	
30.0		<u>COMPONENT INSPECTION</u>	
30.1	47E305030	Check that identification markings are present, correct, legible and in conformance with note 2 and note in zone 9D.	
30.2	47J305000 47E305030	Check that the assembly appears to be complete, undamaged and in conformance with drawings. Check for cracks, gouges, scratches, etc.	
30.3	47J305000 47E305030 47A305296 CP47A14641 NS0060-02-107	Observe or otherwise verify that the following requirements meet specification. <ul style="list-style-type: none"> # a. Envelope dimensions per 3.2.2.1 of CP47A14641 and 47J305000. # b. Power lead extension per para 3.2.3 of CP47A14641. c. That the assembly is free of loose or potentially loose conductive contamination per 47A305296 (Cat B) and NS0060-02-107. 	

Figure C4. (Cont)

Sheet 4 of 4

QAVI NO: GP 307 B

Date: 9 Mar 1981

QUALITY ASSURANCE VERIFICATION INSTRUCTION

CI No. _____

Inspection Item No.	Design Specification	Instructions	Date Item Completed
---------------------	----------------------	--------------	---------------------

**ADDENDUM TO QAVI GP 307
EHS CERTIFICATION PROGRAM**

One EHS will undergo the Certification program provided for in CP47A14641 para 4.2.2 and Table I. Successful completion of these requirements are a prerequisite to the unconditional buyoff of the EHS.

100.0

MONITOR REQUIREMENTS

100.1

CP47A14641
NS0020-05-04

Monitor the Dynamic Test per CP47A14641 Table 1 and para 4.2.2.3.1.
Acceptance Criteria: Para 3.2.1.6 of CP47A14641.

200.0

RECORD EXAMINATION

200.1

CP47A14641
NS0020-05-04

Review evidence for conformance to the following requirements of CP47A14641 Table I:

1. Storage Life - Acceptance Criteria: Para 3.2.1.2.
2. Humidity - Acceptance Criteria: Para 3.2.5 (3.1.3 of NS0020-05-04).
3. Corrosion... - Acceptance Criteria: Para 3.3.1.2.
4. Safety - Acceptance Criteria: Para 3.3.8.
5. Transportability - Acceptance Criteria: Para 4.2.2.2.
6. Interface Requirement - Acceptance Criteria: Para 4.2.2.2.
7. Operating Life - Acceptance Criteria: Para 3.2.1.1.
8. Dynamic Test - Acceptance Criteria: Para 3.2.1.6.

Figure C4. (Cont)

Modified
AL Form-334 (2-80)

DEPARTMENT OF ENERGY

RTG PROGRAM

CERTIFICATE OF INSPECTION - PART I
LOT SUBMISSIONS

QASL
Lot
No.

Item Identification		QAIN No.
Part Number	Use	Submission <input type="checkbox"/> O (Original Sub.) <input type="checkbox"/> R (Resubmission)
Product Definition		Mfg. Lot No.
Serial numbers of items in lot, if serially numbered. Use additional forms, if necessary, and attach.		
Serial or Control Number		Serial or Control Number
1		11
2		12
3		13
4		14
5		15
6		16
7		17
8		18
9		19
10		20
Nonconformance Reports:		
Remarks:		
The listed material meets the applicable specifications and the quality requirements of the contract.		
Date	Signature, Head, Production Inspection Agency	
Lot Disposition: A (Accept) C (Conditional Acceptance) Q (Qualified Acceptance) R (Reject)		Remarks:
Date	(S)QAVI No.	Accepted by _____ Sandia QA Representative

Page ____ of ____

Figure C5. Sample of a Certificate of Inspection

REPORT OF NONACCEPTANCE

Traveler No. 7.79 Lot PR36

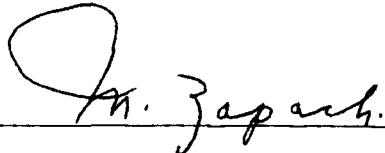
Date 2/17/81

1. Item Identification Wrapped Unicouple Assy.

2. Reason(s) for Nonacceptance

LDT PR36 S/N 1763 sharp edges not broken per 3058 Note 2 and RG17D1 para.

3.3.9 (in notched area). S/N 1632 traveler shows "D" stamp with Dog bone overlay, however, No "NC" has been written.

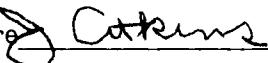
3. SQAR Signature 

Reply

4. Date 2/23/81

5. Reply Statement

S/N 1632 Traveler - Inspector mistakenly used "D" stamp - No "NC" was needed. "D" stamp was voided after he was informed of his mistake.

6. GE Signature 

Page 1 of 1

Figure C6. Sample of a Report of Nonacceptance

MATERIAL INSPECTION AND RECEIVING REPORT		1. PROC. INSTRUMENT IDENT/CONTRACT DE-AC01-79ET32043		2. ORDER NO.	3. INVOICE	4. PAGE 1 OF 1
2. SHIPMENT NO.	3. DATE SHIPPED	4. B/L TCN	5. DISCOUNT TERMS U.S. AIR LINES, PHL #4792- 4505	6. DISCOUNT TERMS		7. ACCEPTANCE POINT N/A
9. PRIME CONTRACTOR GENERAL ELECTRIC COMPANY ADVANCED ENERGY PROGRAMS DEPARTMENT KING OF PRUSSIA, PA 19406		10. ADMINISTERED BY DEPARTMENT OF ENERGY OFFICE OF PROCUREMENT OPERATION		CODE		
11. SHIPPED FROM (If other than 9) CODE GENERAL ELECTRIC CO ADVANCED ENERGY PROGRAMS DEPARTMENT KING OF PRUSSIA, PA 19406		12. PAYMENT WILL BE MADE BY DEPARTMENT OF ENERGY OFFICE OF THE CONTROLLER COMMERCIAL PAYMENTS P.O. BOX 500 GERMANTOWN, MD 20767		CODE		
13. SHIPPED TO MONSANTO RESEARCH CORPORATION MOUND FACILITY BLDG 50, DOCK 134 MIAMISBURG, OHIO 45342		14. MARKED FOR MARK FOR ATTENTION OF DR. G. D. MILLER		CODE		
15. ITEM NO.	16. STOCK/PART NO (Indicate number of shipping containers, type of container, container number)	DESCRIPTION	17. QUANTITY SHIP REC'D.	18. UNIT	19. UNIT PRICE	20. AMOUNT
PENDIX A-3 TACHMENT V	ITEM 5 RTG MASS MODEL REV-A, AN-1 47D305900G1 S/N # 6420201 JOB # RZ=863, RZ=864, RZ=904, & RZ=863 WEIGHT DISKS REV-0, AN-0 JOB #RZ=863 47C305982P5 DATA PACKAGE CONSISTING OF: C of I # GP-GE-0140A (1 Copy) NR #48958 (1 Copy) DWG #47D305900G1 & 47E305956G1 (1 Copy)		1	EA	N/A	N/A
21.	PROCUREMENT QUALITY ASSURANCE		22.	RECEIVER'S USE		
<input type="checkbox"/> PQA <input type="checkbox"/> ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents		<input type="checkbox"/> PQA <input type="checkbox"/> ACCEPTANCE of listed items has been made by me or under my supervision and they conform to contract, except as noted herein or on supporting documents		Quantities shown in column 17 are for one receipt good and in excess of one		
/s/ 2/25/81 H. G. Neues				DATE RECEIVED: SIGNATURE: AUTHORITY: <input type="checkbox"/> TYPED NAME AND OFFICE: <input type="checkbox"/>		
DATE	SIGNATURE OF AUTH GOVT REP	DATE	SIGNATURE OF AUTH GOVT REP	If signature is checked by the government, it is the signature of the official to whom the contract is assigned. If checked, it is the signature of the government		
TYPED NAME AND OFFICE		TYPED NAME AND TITLE				

SN 35538 SJ 9590

S/0 7155-8A-3820-00

DD FORM 1 NOV 68 250

REPLACES EDITION OF 1 AUG 67 WHICH MAY BE USED.

Figure C7. Sample of a Material Inspection and Receiving Report

ACF Sequence No. 42

ACCEPTANCE CANCELLATION FORM

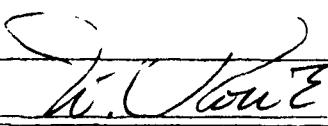
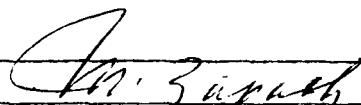
ITEM IDENTIFICATION Cover Assembly, RTG			
PART NUMBER HPGB3000003-009		QASL LOT NO.	HP-TE-2455 A
SERIAL OR CONTROL NO. Serial No. 407	SERIAL OR CONTROL NO.	SERIAL OR CONTROL NO.	
REASON FOR CANCELLATION			
Cover, damaged requires repair. (Reference see Reporting System Tag No. 14452)			
(Ref. : HPG-025 B QAIN)			
DATE 3-7-80	SIGNATURE, HEAD, PROD. INSP. AGENCY 		
SQAR CANCELLATION STATEMENT			
Acceptance cancellation request is approved and previous acceptance status is voided.			
DATE 3-13-80	SIGNATURE  Sandia Quality Assurance Representative		

Figure C8. Sample of an Acceptance Cancellation Form

DO NOT MICROFILM

DISTRIBUTION:

7400 L. J. Heilman
7410 W. C. Kraft
7417 F. W. Muller
7417 R. R. Harnar (20)
9234 B. J. Tolman
9700 E. H. Beckner
8214 M. A. Pound
3141 L. J. Erickson (5)
3151 W. L. Garner (3)
3154-3 C. H. Dalin (25)
For DOE/TIC (Unlimited Release)