**Westinghouse
Astronuclear
Laboratory**

**WANL-TME-1966
July 1970**

DATA ITEM P-017

**PRODUCT ASSURANCE
PROGRAM PLAN**

MASTER

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Westinghouse Astronuclear Laboratory

Subcontract NP-1

CODE IDENT NO. 14683

WANL-TME-1966

July 1970

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DATA ITEM P-017

PRODUCT ASSURANCE

PROGRAM PLAN

Approved

F. W. Henning, Manager
Product Assurance

A. C. Sanderson, Manager
Program Management
NERVA Nuclear Subsystem

INFORMATION CATEGORY

J. M. Hingley 1/28/70
AUTHORIZED CLASSIFIER DATE

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1.0	INTRODUCTION	1-1
1.1	OBJECTIVE	1-1
1.2	APPLICABILITY	1-2
1.3	RELATIONSHIP TO DETAIL REQUIREMENTS	1-2
1.4	RELATIONSHIP TO RELIABILITY AND SAFETY REQUIREMENTS	1-3
1.5	GOVERNMENT QUALITY ASSURANCE ACTIONS	1-3
1.5.1	General	1-3
1.5.2	Assignment of Government Quality Representatives	1-3
1.5.3	WANL Support to Government Quality Representatives	1-3
1.6	REVISIONS	1-4
2.0	BASIC REQUIREMENTS	2-1
2.1	GENERAL	2-1
2.2	PROGRAM DOCUMENTATION	2-1
2.2.1	Documentation Description	2-1
2.2.2	Document Submittal Terms	2-3
2.3	CHANGE CONTROL	2-4
3.0	MANAGEMENT	3-1
3.1	PLANNING	3-1
3.1.1	Program Plan Submission	3-2
3.2	ORGANIZATION	3-2
4.0	DESIGN AND DEVELOPMENT CONTROL	4-1
4.1	GENERAL	4-1
4.1.1	Quality Rating of Designs	4-1

TABLE OF CONTENTS (CONTINUED)

<u>Section</u>		<u>Page</u>
4.2	DRAWING AND SPECIFICATION REVIEW	4-2
4.2.1	General	4-2
4.2.2	Qualified and Preferred Parts	4-3
4.2.3	Design and Program Document Review	4-4
4.2.4	Planning	4-4
4.3	QUALIFICATION TESTS	4-5
4.3.1	General	4-5
4.3.2	Materials, Parts and Processes	4-6
4.3.3	CEI's and ECC's	4-6
4.3.4	Requalification Tests	4-6
4.3.5	Qualification Status	4-6
4.4	IDENTIFICATION	4-7
5.0	CONTROL OF CONTRACTOR-PROCURED MATERIAL	5-1
5.1	GENERAL	5-1
5.2	SELECTION OF PROCUREMENT SOURCES	5-1
5.2.1	General	5-1
5.2.2	Records	5-2
5.3	PROCUREMENT DOCUMENTS	5-2
5.3.1	Contents	5-2
5.3.2	Review	5-4
5.4	GOVERNMENT SOURCE INSPECTION	5-4
5.5	CONTRACTOR SOURCE INSPECTION	5-4
5.6	RECEIVING INSPECTION	5-5
5.6.1	Planning and Inspection	5-5
5.6.2	Documentation of Inspection Results	5-6
5.6.3	Control of Nonconforming Items	5-6
5.7	IDENTIFICATION	5-6

TABLE OF CONTENTS (CONTINUED)

<u>Section</u>		<u>Page</u>
5.8	FAILURE AND DEFICIENCY FEEDBACK	5-7
5.9	SUPPLIER RATING AND PREFERRED SOURCE LISTS	5-7
5.10	COORDINATION OF CONTRACTOR SUPPLIED MEASURING AND TEST EQUIPMENT AND STANDARDS	5-7
5.11	ANSC-FURNISHED MATERIAL	5-7
6.0	CONTROL OF GOVERNMENT-FURNISHED PROPERTY	6-1
6.1	DEFINITION OF GOVERNMENT-FURNISHED PROPERTY	6-1
6.2	INSPECTION OF GOVERNMENT-FURNISHED PROPERTY	6-1
6.3	DEFECTIVE GOVERNMENT-FURNISHED PROPERTY	6-1
7.0	CONTROL OF CONTRACTOR-FABRICATED ARTICLES	7-1
7.1	GENERAL	7-1
7.2	CONFORMANCE CRITERIA	7-1
7.3	INSPECTION AND TEST PLANNING	7-2
	7.3.1 Inspection and Test Procedures	7-2
	7.3.2 Establishment of Values to be Observed in Support of the Trend Data Program	7-4
	7.3.3 Workmanship Standards	7-4
7.4	INSPECTION AND TEST PERFORMANCE	7-4
	7.4.1 In-Process Inspection and Test	7-4
	7.4.2 Test and Final Inspection	7-5
7.5	FABRICATION CONTROLS	7-6
	7.5.1 Production Tooling and Fabrication Equipment	7-6
	7.5.2 Material Control	7-7
	7.5.3 Control of Cleanliness of Fabrication and Test Areas	7-7
	7.5.4 Process Control	7-7

TABLE OF CONTENTS (CONTINUED)

<u>Section</u>		<u>Page</u>
8.0	NONCONFORMING MATERIAL	8-1
8.1	MATERIAL REVIEW	8-1
8.1.1	Material Review by Suppliers	8-1
8.2	APPROVAL OF CONTRACTING OFFICER	8-1
8.3	CONTROL OF NONCONFORMING MATERIAL	8-2
8.3.1	Engineering Review Board (ERB)	8-2
8.3.2	Material Review Board (MRB)	8-2
8.3.3	Preliminary Review Action (PRA)	8-3
8.3.4	Standard Repair Authority	8-3
8.4	REWORK WITHOUT REVIEW BOARD ACTION	8-3
9.0	INSPECTION, MEASURING AND TEST EQUIPMENT	9-1
9.1	GENERAL	9-1
9.2	CALIBRATION	9-1
9.3	CALIBRATION FACILITIES AND STANDARDS	9-2
9.4	EVALUATION	9-2
9.4.1	Commercial Equipment	9-2
9.4.2	Special Equipment	9-2
9.5	MAINTENANCE AND CONTROL	9-3
9.6	WRITTEN PROCEDURES	9-3
9.7	RECORDS	9-3
10.0	INSPECTION STAMPS	10-1
11.0	PRESERVATION, PACKAGING, HANDLING, STORAGE AND SHIPPING	11-1
11.1	GENERAL	11-1
11.2	PRESERVATION	11-1
11.3	PACKAGING	11-1

TABLE OF CONTENTS (CONTINUED)

<u>Section</u>	<u>Page</u>
11.4 HANDLING	11-2
11.5 STORAGE	11-2
11.6 SHIPPING	11-3
12.0 STATISTICAL PLANNING, ANALYSIS AND QUALITY CONTROL	12-1
12.1 GENERAL	12-1
12.2 STATISTICAL ANALYSIS AND TEST PLANNING	12-1
12.3 SAMPLING PLANS	12-1
12.4 STATISTICAL QUALITY CONTROL CHARTS	12-2
13.0 TRAINING AND CERTIFICATION OF PERSONNEL	13-1
13.1 TRAINING	13-1
13.2 CERTIFICATION OF FABRICATION AND INSPECTION PERSONNEL	13-1
13.2.1 WANL Personnel	13-1
13.2.2 Certification of Suppliers' Procedures and Personnel	13-1
14.0 DATA REPORTING AND CORRECTIVE ACTION	14-1
14.1 GENERAL	14-1
14.2 DATA REPORTING	14-1
14.2.1 Quality Status Reports	14-1
14.2.2 Laboratory and Experimental Data	14-1
14.2.3 Quality Data	14-2
14.2.4 Completed Item Report	14-3
14.2.5 Operational Data	14-4
14.2.6 Trend Data Program	14-4
14.3 FAILURE REPORTING AND CORRECTIVE ACTION	14-4
14.3.1 Policy	14-4
14.3.2 Problem Failure Reports	14-5
14.3.3 Deficiency Reporting and Corrective Action	14-6

TABLE OF CONTENTS (CONTINUED)

<u>Section</u>		<u>Page</u>
15.0	AUDIT PROGRAM	15-1
	15.1 PERFORMANCE OF AUDITS	15-1
	15.2 AUDIT REPORTS	15-2
16.0	FLIGHT READINESS	16-1
APPENDIX B	LIST OF REFERENCED DOCUMENTS	B-1

1.0 INTRODUCTION

1.1 OBJECTIVE

This Product Assurance Program Plan, which is prepared in accordance with NERVA Data Item Description P017, describes the Product Assurance policies and procedures governing all subcontract NP-1 activities in the Nuclear Subsystem (NSS) design, development, qualification and delivery program. The program plan is intended to supplement and be consistent with the overall Data Item P017 prepared by Aerojet Nuclear Systems Company (ANSC). In regard to responsibilities, the program plan is consistent with the WANL supplement to the NERVA Management Plan, Data Item M-001.

The Product Assurance Program Plan is based on the requirements of NASA Quality Publication NPC 200-2, and the NERVA Program Requirements Document (NPRD). The Program Plan follows the general outline of Data Item Description P017, Rev. B, modified as necessary to describe the NSS Product Assurance Program.

The guiding philosophy of the Product Assurance Program Plan is to provide a planned and systematic pattern of all actions necessary to provide adequate confidence that end items will meet specified requirements. The program plan recognizes the special requirements for man rating and it fully supports and is guided by the following requirements from Section III, B, 8(a) of the NPRD:

"The NERVA Engine shall be man rated. Equipment is man rated when its utilization in manned space vehicles provides for and protects the crew's well being and utilizes man's ability to control and repair. It follows that man rated equipment, and especially propulsion, must be highly reliable. Man rating is not attained solely by compliance with some particular specification or rule. Rather it results from that fastidious approach to the total effort from concept to final disposition in flight which takes every reasonable step to assure the safety of the astronauts the launch crew and the general public. Special steps are required to assure the elimination of errors and, in particular, errors caused by the use of "engineering judgment" by individuals during design, test or fabrication. To give visibility to the use of judgment special procedures and approaches will be devised to assure that the judgments do not stand unreviewed."

1.2 APPLICABILITY

This program plan defines the management policy applicable to all activities affecting the quality of NERVA Articles. The term NERVA Articles is defined to include all development, prequalification, qualification, and end item hardware, facilities, test support equipment and ground support equipment. The description of hardware falling into the development, prequalification, and qualification categories is defined in Data Item T101. Hardware for engineering feasibility studies is included in the development category.

The program plan applies to all phases of the NSS design, development, qualification, delivery, and launch readiness program. Applicability of the plan to specific contract years will be shown by an appendix to the P017 Product Assurance Program Plan.

1.3 RELATIONSHIP TO DETAIL REQUIREMENTS

This Program Plan is based on, and supports, the detailed requirements of Subcontract NP-1 and the referenced NPRD. The requirements of the subcontract are assumed to take precedence over the requirements of NPC 200-2.

The overall management of the NERVA Nuclear Subsystem program is described in the WANL supplement to the NERVA Management Plan, Data Item M-001. The Product Assurance Program Plan is consistent with the requirements of M-001. Plans supporting M-001 are reviewed by a management team including Product Assurance to assure consistency among the plans. The Product Assurance review of M-001 and supporting plans assures that the provisions of P017 and other directives on quality assurance are correctly reflected in the plans. It also assures that all actions affecting quality are specified and that the characteristics, criteria and methodology for their management and control are specified.

Plans supporting M-001, and relating to this plan include:

C-018	NERVA Configuration Management Plan
C-100	NERVA Data and Document Management Plan
P-013	Product Plan
R-101	NERVA Reliability Program Plan
R-102	NERVA Maintainability Program Plan
R-106	Reliability Test and Evaluation Plan

S-019	NERVA Safety Plan
S-021	Contamination and Corrosion Control Plan
T-101	System Test Plan

In addition, Product Assurance contributes to establishing and implementing of the Trend Data Program.

1.4 RELATIONSHIP TO RELIABILITY AND SAFETY REQUIREMENTS

This program plan supports the achievement of the NERVA Program reliability and safety requirements primarily by providing the actions necessary to evaluate and control risk in the hardware, processes, test operations, and other hardware handling activities. The reliability and safety requirements are the prime factors in establishing the basic requirements of this program plan as shown in Section 2.1.

1.5 GOVERNMENT QUALITY ASSURANCE ACTIONS

1.5.1 General

It is recognized that the work of WANL and its subcontractors and suppliers is subject to evaluation, review, audit, and inspection by SNPO-C and designated representatives to determine that:

- a. Contractual requirements are being met.
- b. Materials, articles and related activities are of satisfactory quality and meet the intended design.

1.5.2 Assignment of Government Quality Representatives

SNPO-C, or designated representatives, may be assigned on a resident or itinerant basis at WANL or supplier facilities. The responsibilities and authorities of these representatives will be defined by the SNPO-C contracting officer and made known to WANL.

1.5.3 WANL Support to Government Quality Representatives

WANL will provide the representatives with information, documents, records, inspection equipment, samples, materials and reasonable facilities and assistance for the safety and convenience of the representatives in the performance of their duties.

1.6 REVISIONS

Revisions to contractual and/or governing documents which affect this program plan will be reviewed by WANL to determine impact on the scope of work. Where revisions are outside the scope of the current contract, any resulting revisions to this program plan will be negotiated as a contract change. All revisions to this plan are submitted to ANSC/SNPO-C for approval.

2.0 BASIC REQUIREMENTS

2.1 GENERAL

The quality program is planned in conjunction with all other program functions and integrated with other activities so as to assure the achievements of all contractual requirements. In addition to specific quality requirements, particular emphasis is placed on safety and reliability related requirements and how their achievement can be affected by hardware quality.

In order to achieve the high reliability and safety requirements, emphasis is placed on quality in the engineering design, component development, and other design definition phases as well as in the later hardware acquisition phases. The quality program, therefore, provides for consideration of all quality aspects in the design and assures that quality is maintained in the fabricated articles. It also provides for early detection and correction of any problem, marginal condition, deficiency, or trend which could compromise the reliability or safety. The effort to detect any potential problems starts with Quality Engineering analysis in the design phase and will expand into the reporting and analysis of actual problems in the hardware phase. Positive reporting of problems and failures, corrective action assurance and reporting of corrective action status for both potential and actual problems will be provided.

Objective evidence of configuration and quality conformance, including records of inspections and tests, is provided on development, prequalification, and qualification hardware and end items.

2.2 PROGRAM DOCUMENTATION

2.2.1 Documentation Description

Quality program documentation includes the plans, procedures, forms, instructions which define how the product assurance program is implemented. It also includes the reports, records, and data which are generated by the product assurance program.

Maximum use is made of standard procedures including WANL Divisional Procedures.

Quality Methods and Procedures (QMP's), which are referenced in Data Item P017, are the instructions to all project personnel on the implementation of the policies and procedures defined in P017. QMP's are issued by Quality Assurance and approved by the Product Assurance Manager. QMP's and other WANL procedures applicable to the NERVA Product Assurance Program are listed in Appendix B.

The major items of quality documentation are summarized in the following table. The table identifies the paragraph in this plan which describes the document and indicates the action relative to submittal.

Item	P017 Reference Paragraph	Data Item Number	Action
Product Assurance Program Plan and Revisions	3.1.1.1	P017 (WANL Supplement)	Submit for approval
Quality Procedures (QMP's)	2.2.1		Submit for review
Quality Inspection Procedures	7.3.1		Submit for information
Results of special measuring and test equipment evaluations	9.4.2		Submit for review
Reactor End Item Report	11.6		Submit for information within 30 days of shipment.
Test and Verification Plans T-101, T-102	7.4.2.1		Submit as Prescribed by M-001
Assembly Process Outlines	7.3.1 (b) 7.4.1.1		Available for information
Procedures for Certification of Personnel Performing Special Inspections	13.2.1		Submit for information
List of Suppliers and Subcontractors	5.9		Available for information
Process Control Procedures (WANL Process Specifications)	7.5.4.1 4.2.1.2		Submit for review
Progress Reports (NSS Quarterly Report and Weekly Significant Events Report)	14.2.1		Submit for information in accordance with Contract Work Statements
Corrective Action Status	14.3.2 14.3.3		Submit for information

Item	P017 Reference Paragraph	Data Item Number	Action
Inspection Records	5.6.2, 7.4.2.3		Available for information
End Item Test and Inspection Procedures	7.4.2.2		Submit for review
Completed Item Report	14.2.4		Submit for approval by EIRB

2.2.2 Document Submittal Terms

Documents are submitted for approval, review, or information within the terms stated below:

a. Documents Submitted for Approval

ANSC/SNPO-C approval or disapproval will be submitted in writing within 30 days from transmittal date. WANL shall not implement documents in this category until ANSC/SNPO-C approval is granted, except in emergency, in which case the ANSC/SNPO-C Product Assurance Representatives shall be notified. Neither approval, nor waiver of such approval, shall relieve WANL of the obligation to meet requirements of the contract.

b. Documents Submitted for Review

Documents in this category will be submitted to ANSC/SNPO-C a minimum of two weeks prior to their use by WANL. If WANL has not been notified of disapproval within this period, implementation may proceed.

Should an emergency require it, WANL may — based on its own best judgment — take action within the two-week review period; but with the knowledge of the ANSC/SNPO-C Product Assurance Residents. In this case, advance copies of the pertinent document will be provided to the Residents.

c. Documents Submitted for Information

Documents in this category shall be transmitted for the purpose of communicating current Product Assurance Program status, progress, and future planning. These documents, which include the NSS Quarterly Report and the Weekly Significant Events Report, are transmitted in accordance with program schedules and work statements.

2.3 CHANGE CONTROL

A formal system is provided for change control of all documents affecting quality of the NSS. The system is defined in the Configuration Management Plan, Data Item C-018. Effectivity of changes controlled by the Configuration Management Plan is described in that plan.

The Configuration Management Plan provides for a Product Assurance representative on the Configuration Control Board where Engineering Change Proposals (ECP's) are reviewed. All Engineering Release Change Orders (ERCO's) are reviewed by Quality Engineering.

Quality Engineering reviews changes to design and process documents to assure adequate definition of characteristics to control quality, appropriate effectivity, and prompt removal of obsolete documents. It also assures that new or additional equipment, procedures, and personnel will be available if required by the proposed change. Procurement documents that implement changes are reviewed by Quality Engineering, and new inspection plans are prepared as necessary. These functions are described in the appropriate sections and in referenced QMP's throughout this program plan.

3.0 MANAGEMENT

3.1 PLANNING

The WANL Management Plan, Data Item M-001, governs the overall management of the NERVA Nuclear Subsystem (NSS) program, and the Product Assurance Program Plan is a subsidiary plan to M-001. Product Assurance personnel participate in establishing M-001 to assure adequate planning of all activities relating to or affecting end item reliability, quality or safety. M-001 details Product Assurance responsibility relative to other subsidiary plans. See Section 1.3

The Product Assurance Program Plan establishes the WANL policy and overall procedures for planning and maintaining an effectively and timely program, planned and developed in conjunction with all other WANL functions to satisfy the requirements of Subcontract NP-1. A functional flow diagram, drawing number 615549, shows the major product assurance program functions relative to other program activities. The program plan provides for and includes, as management policy, the following:

- a. Recognition of the quality aspects of the subcontract and the provision of an organized approach to achieve them.
- b. Assurance that quality requirements are determined and satisfied throughout all phases of contract performance, including preliminary and engineering design, development, fabrication, processing, assembly, inspection, test, checkout, packaging, shipping, storage, maintenance, and use.
- c. Assurance that quality aspects are fully included in all designs and are continuously maintained in the fabricated articles and during operation.
- d. Detection of actual or potential deficiencies, system incompatibility, marginal quality, and trends or conditions which could result in unsatisfactory quality.
- e. Implementation of timely and effective remedial and preventive action.
- f. Maintenance of objective evidence of inspections and tests to document quality status.

3.1.1 Program Plan Submission

3.1.1.1 WANL Product Assurance Plan Supplement

This Product Assurance Program Plan satisfies the Subcontract NP-1 requirements for the preparation, submittal and maintenance of a quality program plan. The plan and any revisions are submitted to ANSC/SNPO-C for approval.

3.1.1.2 NTO Product Assurance Program Plan Supplement

The NERVA Quality Assurance activities at NRDS are described in the NTO Product Assurance Program Plan Supplement. The plan and revisions are prepared by NTO and require the approval of ANSC, WANL and SNPO-C. NTO management has the primary responsibility to ensure that the NTO Plan and its implementation are adequate to achieve the NERVA program quality objectives. WANL Product Assurance has a responsibility through reviews and audits to ensure that the NTO Plan and its implementation meet the requirements of the NSS.

3.2 ORGANIZATION

The WANL Product Assurance Manager is responsible for the management of the NSS Product Assurance Program in accordance with the approved plan and with WANL Divisional policies and procedures. The Product Assurance Manager reports to the WANL Division General Manager, and has the organizational freedom to recognize and assess quality problems and to initiate or assure appropriate corrective actions. He has direct unimpeded access to NERVA and WANL Divisional top management. The Product Assurance Manager participates in the NERVA Program Manager's weekly staff meetings to assure regular reporting to top NERVA program management on the adequacy and status of the Product Assurance Program.

It is the Product Assurance Manager's responsibility to assure that WANL personnel in any activity, performing functions of this program plan shall have sufficient, well-defined responsibility and the organizational freedom to assess problems and to recommend and/or effect solutions to the problems. He also has the responsibility of assuring that the policies of this program plan are transmitted to and followed by all WANL personnel working on the NERVA Program.

The organization of the Product Assurance Department will be varied to be most effective as the NERVA Program progresses. The current organization includes the following functions:

QUALITY ASSURANCE, which is responsible for Quality Engineering, Inspection and Surveillance activities.

RELIABILITY, which in addition to other functions not covered in this program plan, is responsible for problem failure reporting and resolution system, human factors, and statistical evaluation of quality systems.

The Product Assurance organization and responsibilities, as applied to the NERVA Program is shown in QMP 3-1.

4.0 DESIGN AND DEVELOPMENT CONTROL

4.1 GENERAL

The achievement of high quality is a major factor in the NSS design and development program. Quality Engineering efforts start in the requirements definition phase through review of the NPRD and through the review of CEI/ECC specifications. The knowledge of program requirements through these reviews and other similar activities provides a base for the design and development controls by Quality Engineering.

Quality Engineers review conceptual drawings and participate in trade studies to provide recommendations on the designs relative to controllability, anticipated problems, and previous quality history. As the designs mature, Quality Engineers identify problem areas such as needed NDT development or special process controls and make recommendations or initiate programs to solve the problems. Concurrent with the design effort, quality control planning is initiated and documented to provide the confidence that the designs will be controlled so as to meet their objectives. QMP 2-2, Preparation of Quality Control Plans, will define the method for documenting this planning.

Quality Engineers review development test plans and specify the level of quality control needed on the test hardware to assure that the test objectives will be met. Plans are also established for the monitoring of test operations, and for the verification and documentation of test results. Plans for the quality review of development test plans and the planning of related quality operations will be covered in QMP 4-5.

4.1.1 Quality Rating of Designs

All designs for NSS components are reviewed by Quality Engineering to determine the reliability with which the component can be controlled (R_Q). Quality Engineering uses Failure Mode Analyses (FMA), the Failure Mode Effects and Criticality Analyses (FMECA), and the Single Point Failure Listing as a baseline for this rating. Quality Engineering identifies those characteristics of the design which affect the critical mode of failure and determines

those inspections or tests which determine the conformity to the design characteristics. These inspections or tests are individually rated as to the reliability of the inspection/test to identify all discrepant parts for the characteristics being tested. Initially, these ratings will be qualitative. As the program progresses, and data becomes available, the ratings will be made more quantitative, expressing the probability that designs can be converted to hardware without critical errors.

The R_Q analysis results form a basis for the development of inspection methods and other quality control procedures. In addition, they form a basis for conducting analyses of quality control operations to detect where risk of error is incompatible with reliability requirements so that actions, such as redundant inspections, can be incorporated to minimize the risk. In evaluating risk of error, consideration is given to human errors, errors in inspection or test equipment, and errors in documentation or data which could adversely affect hardware quality.

Preliminary quality rating, or R_Q , analysis will be completed by Preliminary Design Review (PDR) and will be further developed and updated as the program progresses. The procedures for conducting R_Q analyses or ratings will be shown in QMP 4-4.

4.2 DRAWING AND SPECIFICATION REVIEW

4.2.1 General

Quality Engineering reviews all Code 1, 2, and 3 drawings (see Section 4.2.1.1 for explanation of code system) and all specifications to assure that characteristics which determine the quality of the component are adequately defined and that criteria are provided to determine the degree of conformance to these characteristics. It further assures that the design can be inspected or tested and that it meets contractual quality requirements. The review is based upon the end use of the item, and the maturity of the design. The results of quality reviews are documented as described in QMP 4-2.

4.2.1.1 Quality Surveillance Codes

The degree of quality control applied to material, component parts, sub-assembly or assembly is based on the end objectives and use of the item. It is the responsibility of the ordering organization to assign a surveillance code to the procurement of the item in accordance with the guidelines established by QMP 5-3. Usually this code is the same as the

drawing code applied to the drawing of the item. Quality Engineering reviews the procurement documents to ascertain that the code is properly identified and that it is correct for the application of the item. Quality Surveillance Code 1 is assigned to the most critical or prime items and the numbers increase with decreasing criticality. The least critical classification is Code 4. QMP 5-3 amplifies the above policy and provides examples of code assignments to be used as a guide in establishing the proper Quality Surveillance Codes for new items.

4.2.1.2 Drawing and Specification Approval

Quality Engineering approval of Code 1, 2, and 3 drawings and specifications is required prior to release. Approval by Quality Engineering signifies that the drawings or specifications contain adequate information for determining and controlling quality of all items. The information shall include identification of the article in accordance with Section 4.4, characteristics which influence quality, inspection and test methods where applicable. The approval also signifies that the appropriate R_Q analyses or ratings have been completed as well as the appropriate quality review checklists. Any deficiencies are made known to the originator and assistance is provided in correcting them. Detailed procedures for reviewing drawings and specifications are in QMP 4-1 and QMP 4-2.

4.2.2 Qualified and Preferred Parts

The Quality Engineering review of designs and specifications considers the availability of parts and materials which have been qualified as meeting the performance, safety, reliability and quality requirements of the NERVA Program. Data developed on the NERVA Program, or on other programs, will be used when appropriate to determine parts and materials which are preferred on the basis of past experience. This includes any government furnished preferred parts list. Feedback to the designers will be provided on problems with similar or related designs when such information is available.

Action will be taken by Quality Engineering to recommend for removal from the design any parts or materials suspected on the basis of past experience or quality records to be inadequate. Where new parts or materials with unknown qualification status are included, Quality Engineering will aid in planning part and material qualification and inspection programs.

4.2.3 Design and Program Document Review

4.2.3.1 Design Review and Trade Study Review

Design reviews are conducted on specific portions of the NSS design at various points in the program to assure that all program requirements will be satisfied. Quality Engineering participates in the design reviews to assure that all factors affecting quality are adequately included in the design as appropriate to the maturity of the design.

Trade Study reports describing design concept studies include input by Quality Engineering when the Quality Assurance Manager judges the concept to be sufficiently mature to include quality considerations. The Quality Engineering review is concerned primarily with determination of differences in the designs which would affect the reliability with which the resulting hardware can be controlled. The results of these reviews are included in the trade study reports.

4.2.3.2 Program Document Review

Program documents affecting hardware quality such as maintainability plans, production plans, safety plans, storage plans, are reviewed by Quality Engineering in accordance with the Management Plan, Data Item M-001, to assure that all factors affecting the definition of criteria and associated verification methods are adequate to control quality and to minimize risk of error in all program phases. The review of these program documents is used to initiate appropriate quality planning activities and to provide any required quality input to the originator of the document.

4.2.4 Planning

The Quality Engineering review of drawings, specifications, and other documents is utilized to initiate planning for equipment and procedures, and to identify the need for development of new equipment or methods. The Quality Control Plan for the items being reviewed is initiated at this time in accordance with QMP 2-2.

If precision measurement exceeding the state-of-the-art capability is required, Test Information Sheets (TIS) are prepared to inform the Government of the need and plan necessary development effort.

Due to the high reliability requirements of the NSS and the dependence of reliability on structural integrity and material properties, extensive use will be made of NDT techniques to evaluate the properties of components. Quality Engineering, in conjunction with Design Engineering and Materials, will describe on drawings and specifications the specific defects (or indications) which will compromise component reliability. Where existing techniques are not compatible with design requirements, TIS's will be prepared to define the need and plan the necessary development effort. Results of the development will be published as a Data Item and incorporated into the applicable drawings, specifications and procedures.

4.3 QUALIFICATION TESTS

4.3.1 General

A qualification test program is conducted to verify that the design is capable of meeting specified requirements. The qualification test planning is the primary responsibility of Design Engineering with input by Quality Engineering.

Prequalification and qualification test plans are prepared in the form of TIS's which require Quality Engineering review including the following:

- a. Provisions for Quality Assurance monitoring and verification of test results,
- b. Inclusion of criteria for success,
- c. Data reporting requirements, and
- d. Post test inspection or analysis requirements.

At the time of the review, Quality Engineering plans necessary monitoring activities to verify that test requirements have been met.

All hardware subjected to prequalification and qualification testing is stringently controlled in accordance with the established Quality Control Plan for the item to assure that conformance to design is achieved and documented. Any discrepancies in the test hardware are dispositioned by MRB in accordance with the provisions of Section 8.0. Failures or problems occurring in test operations or discovered in post test analysis of the hardware are reported and dispositioned in accordance with Section 14.3.

4.3.2 Materials, Parts and Processes

Quality Engineering reviews the need for qualification tests on materials, parts, and processes. Normally, qualification of these items is accomplished through review of inspection, processing, and test data from the same or similar items. Where need for special qualification tests is indicated, Quality Engineering will notify the responsible organizations, and provide follow up to assure that qualification tests are planned. Drawing and specification review (Section 4.2) will consider the status of required qualification tests.

4.3.3 CEI's and ECC's

The provisions for qualifying CEI's and ECC's are contained in the specifications covering those items. Test Information Sheets are prepared for the qualification tests and the tests are conducted as prescribed in Data Items T-101 or T-102. Quality Engineering reviews these documents for adequacy in verifying that the article meets the specification requirements. It also assures that the quality and process control plans to be used on the test article are adequate and that they are representative of the controls which will be used on the delivered items.

4.3.4 Requalification Tests

Requalification tests are required on previously qualified articles when: changes are made in the design, fabrication, or process operations; source of procurement has changed; articles have a history of repeated failures or an increasing rate of rejects in inspection operations. Quality Engineering will recommend requalification when it detects one of the above conditions. It will review any requalification plans to assure that the condition causing the need for requalification is adequately tested and verified.

4.3.5 Qualification Status

Qualification of ECC's and CEI's is accomplished as prescribed in Data Items T-101 and T-102. Qualification status is indicated by the test results as reported in Data Item T-119.

4.4 IDENTIFICATION

One of the basic requirements for identification of NERVA articles as defined in C-018, Configuration Management Plan, is to provide positive traceability throughout all phases of development, fabrication and testing.

As an aid to effective control of hardware, serial numbers are used for positive identification of each part. The serial number individually identifies even separate parts manufactured to the same part number. The number is assigned to a part at the earliest point in the manufacturing cycle that it becomes an individual part and is retained by that part through all succeeding steps in its manufacture, even those requiring a change in part numbers. In certain cases, where individual circumstances dictate, lot serial numbers may replace individual serial numbers, with the approval of Quality Engineering. This usage is kept to a minimum and is generally employed only on small parts where individual identification and control would be too costly and is not warranted.

The type of serialization to be employed is specified on the drawing. The Manufacturing organization is responsible for the actual assignment of serial numbers to the item. This is done by listing the serial numbers to be utilized on the ordering documentation. Quality Engineering maintains a surveillance over the assignment of serial numbers. The serial number is the basis for traceability of the part in the Quality Data System.

The details of serial number assignment procedures are defined in QMP 4-3.

5.0 CONTROL OF CONTRACTOR-PROCURED MATERIAL

5.1 GENERAL

A program is provided to assure control by WANL over the quality of all material, parts and equipment. The program includes:

- a) Selection of qualified procurement sources.
- b) Review of procurement documents to assure the inclusion of all design, reliability, and quality requirements.
- c) Inspection and evaluation of procured items.
- d) Provisions for early information feedback and correction of deficiencies.
- e) Technical assistance to suppliers when necessary to achieve desired quality and reliability.

Fuel elements supplied by Westinghouse Astronuclear Core Operations (WNCO) and by the Y-12 Facility at Oakridge National Laboratories are treated, for the purposes of this program plan, as contractor-procured material to the point of receipt at WANL and release for assembly or other use. The applicable functions covered in the following paragraphs of this section are applied to the control of fuel element procurement. QMP 7-4 details the responsibilities relating to the release of fuel elements to assembly operations.

An extensive supplier quality awareness program will be implemented to assure that suppliers are aware of NERVA quality/reliability requirements. This will be accomplished by procurement documents (Section 5.3) and by periodic visits to supplier locations by Product Assurance personnel.

The provisions of Section 5.0 apply to Inter Work Requisitions (IWR) which are used to procure parts, materials and equipment from other Westinghouse locations.

5.2 SELECTION OF PROCUREMENT SOURCES

5.2.1 General

Evaluation and approval/disapproval of procurement sources is accomplished primarily on the basis of WANL survey results and WANL quality history records. Surveys are performed

in accordance with QMP 5-1 and will include as a minimum evaluation of the following:

- a) The supplier's quality control and/or inspection organization
- b) The supplier's inspection and test equipment
- c) The type of work with which the supplier is familiar
- d) History of supplier's quality performance.

A survey may not be performed, at the discretion of the Quality Assurance Manager, in cases where the contract price is small; technical problems are not considered likely; the criticality of the item does not warrant; and the material can be completely evaluated at WANL.

WANL Quality Assurance evaluates each supplier's quality control and/or inspection capability and classifies the supplier as "approved" or "disapproved." A supplier approval status list will be maintained by Quality Assurance and transmitted to the Purchasing Department in writing. Purchase orders shall normally be placed only with approved suppliers. Placement of an order with an unapproved supplier may be made only with the specific approval of the Quality Assurance Manager. In such cases, Quality Assurance will assure that sufficient surveillance or other actions as necessary are provided to eliminate any undue risk to the program.

5.2.2 Records

Quality Assurance maintains history records for each supplier. These records include summaries of inspection and discrepancy documents and are maintained and reviewed to detect trends in supplier's performance.

5.3 PROCUREMENT DOCUMENTS

5.3.1 Contents

All Purchase Requisitions (PR) and Inter Work Requisitions (IWR) designated Quality Surveillance Codes 1, 2, or 3 (see QMP 5-3) include provisions for the following, as applicable:

- a) Basic Technical Requirements. All drawings, specifications, reliability requirements and other technical information are referenced in the PR and made available to the supplier.

b) Government Source Inspection Requirements. When Government source inspection is required, the following statement will be included in the PR:

"All work on this order is subject to inspection and test by the Government at all times (including the period of performance) and places; and, in any event, prior to shipment. The Government representative who normally services your plant should be notified forty-eight (48) hours in advance of the time articles or processes are ready for inspection or test."

The authority of the Government to perform source inspection on all other orders is established by the application of NE-1, "Terms and Conditions."

c) Contractor Source Inspection. Contractor source inspection, when required, will be indicated on the Procurement Quality Requirement (PQR) document, which is a part of the WANL purchase order (see QMP 5-2).

d) Supplier Quality Programs. The supplier's responsibility in regard to establishing quality programs is stated in Specification WANL QC-101, which is based on the requirements of NPC 200-2 and NPC 200-3.

e) Supplier Submittals. The requirement for supplier submittals of inspection plans, nondestructive testing procedures, special processing procedures, etc., is stated in the PQR. The requirement for submittal of actual inspection and test results is also stated in the PQR.

f) Identification. Materials and parts are identified by a combination of drawing, specification, WANL Serial or Lot Numbers, and supplier raw material identification numbers. These systems of identification are described in WANL Divisional Procedures and QMP 4-3.

g) Age Control. Materials and articles having definitive characteristics of quality degradation or drift with age and/or use are indicated on WANL drawings or specifications. These documents establish the requirements for submittal of data necessary for assuring that the materials and articles are not used past their useful life.

h) Resubmission of Rejected Material. The procedure defining resubmittal of rejected material is stated in WANL QC-101.

i) Articles of Supplier Design. The requirements relating to control of suppliers' design drawings are stated in WANL QC-101. This requires that the supplier incorporate basic identification and change features for control purposes.

5.3.2 Review

Prior to placement of purchase orders designated Quality Surveillance Codes 1, 2, or 3, the purchase requisitions are reviewed by the Quality Engineer to assure that the requirements as stated in paragraph 5.3.1 above are included in the order. The Quality Engineer prepares PQR's for purchase orders as required. The PQR specifies that one or more of the following are applicable:

- a) Quality Assurance Specification WANL QC-101 applies totally or in part.
- b) Supplier submittals of inspection plans, nondestructive testing procedures, special processing procedures, etc. These submittals shall be made on Approval Request (AR) forms. QMP 5-6 defines the use of this form.
- c) Source inspection and the extent to which it will be applied.
- d) Source inspection data to be submitted by the supplier.

5.4 GOVERNMENT SOURCE INSPECTION

Government source inspection does not, in any way, replace WANL source inspection, or relieve WANL of its responsibilities for ensuring the quality of procured articles. If Government source inspection is required, it will be included in the order in the manner stated in paragraph 5.3.1 above. This will be accomplished by coordinating the Quality Engineering review with the review by Government representatives to incorporate Government source inspection requirements and eliminate delays in placing purchase orders.

5.5 CONTRACTOR SOURCE INSPECTION

Source inspection is performed by Quality Assurance when required by the PQR per the applicable inspection instructions prepared by Quality Engineering. Source inspection is performed for the following reasons:

- a) Facilities or equipment to inspect items at WANL are not available.
- b) Drop Shipments - material being shipped from a supplier direct to another supplier in lieu of shipping to WANL.

c) To verify that characteristics which will later be unmeasurable meet the design requirements.

d) To determine acceptability of material in the most economical manner. Discrepancies discovered by source inspection are submitted by the supplier to WANL on a Variation Request (VR) form for disposition. The use of this form is described in QMP 8-2.

5.6 RECEIVING INSPECTION

5.6.1 Planning and Inspection

5.6.1.1 General.

Receiving inspection operations are provided by Quality Assurance and are coordinated with source inspection operations to assure that all characteristics are inspected in the most cost effective manner, and to provide the maximum feasible assurance in the quality, consistent with the reliability requirements.

Receiving inspections are planned by Quality Engineers as stated in QMP 7-2. Utilizing these plans, receiving inspection is performed by Inspectors, following the procedure in QMP 5-5. Inspectors performing nondestructive testing are certified per QMP 13-1 to assure that a consistent, adequate level of performance is obtained.

5.6.1.2 Planning. Quality Engineering functions:

a) Prepare inspection and test plans to assure that articles are properly inspected and evaluated against the applicable drawing or specification. Inspection plans may be written for source inspection as well as receiving inspection. The quality and degree of inspection planned and performed is consistent with the criticality of the article and the results of previous inspections (part history). Sampling plans are specified by the Quality Engineer, when applicable, in accordance with Section 12.0.

b) Specify inspection and test equipment required to perform necessary tests and inspections. Where the cost of equipment is considered prohibitive, source inspection may be substituted.

c) Specify that procured articles subject to age deterioration include an indication of the date that the critical life of the article was initiated or the date at which the useful life will be expended.

d) Specify that chemical analyses and physical tests necessary to verify that raw materials and components conform to design requirements.

e) Specify any special requirements for storage environment.

5.6.1.3 Inspection Function.

a) Perform required inspection and evaluations to assure procured product meets all requirements in accordance with drawings/specification requirements and inspection instructions prepared by Quality Engineering.

b) Separate received material into the categories of:
1) awaiting inspection or test, 2) conforming material, or 3) nonconforming material (unless size prohibits) and assure that all material is clearly marked to indicate such status.

5.6.2 Documentation of Inspection Results

Inspection results are documented on Inspection Instruction and Data Sheets (IIDS) and Inspection and Material Disposition Reports (IMDR) to provide variables or attribute data and quality status. This documentation is retained on file in a manner that is easily recalled for review purposes.

5.6.3 Control of Nonconforming Items

Nonconforming articles are segregated for disposition and processed in accordance with Section 8.

5.7 IDENTIFICATION

All materials, parts, and equipment received at WANL are identified in accordance with Section 4.4. Identification is maintained throughout all stages of inspection, assembly, testing and shipment. Acceptance status of procured material is maintained at all times in accordance with QMP 5-5.

5.8 FAILURE AND DEFICIENCY FEEDBACK

Quality Engineering initiates and maintains recurring defect history records of NSS components and assemblies. This information is incorporated into the Quality Data System. Information regarding recurring nonconformities is identified to the Design, Manufacturing, Purchasing and supplier activities. Details of the corrective action program are found in Sections 8.1 and 14.3.2.

5.9 SUPPLIER RATING AND PREFERRED SOURCE LISTS

Quality Assurance conducts periodic reviews of suppliers' performance for the purpose of rating the quality of their work. This review includes: a) number of waivers (VR's); b) number of defects found in WANL inspections; c) corrective action response; and d) quality trends. Information from these reviews is factored into the supplier approval status list and transmitted to Purchasing (Section 5.2). Where performance ratings indicate significant differences in suppliers, the preferred suppliers will be so indicated.

5.10 COORDINATION OF CONTRACTOR SUPPLIED MEASURING AND TEST EQUIPMENT AND STANDARDS

When deemed necessary by Quality Assurance, measuring and test equipment and standards will be coordinated between WANL and suppliers to assure compatibility of equipment and techniques.

5.11 ANSC-FURNISHED MATERIAL

ANSC-furnished material will be inspected upon receipt to detect damage in shipment and completeness for the intended use. Accompanying documentation will be reviewed for evidence of acceptance by ANSC Quality Control. Any nonconformities not dispositioned at the source will be brought to the attention of the ANSC Product Assurance Resident at the time of receipt, unpacking, or inspection of ANSC-furnished material or as requested by the resident.

6.0 CONTROL OF GOVERNMENT-FURNISHED PROPERTY

6.1 DEFINITION OF GOVERNMENT-FURNISHED PROPERTY

Government-Furnished Property (GFP), for the purposes of the NERVA Program at WANL, is defined as property delivered to WANL by the Government for use in the manufacture and testing of the NERVA NSS and associated support equipment. This shall include all related data and information as WANL may request which may reasonably be required for the intended use of such property.

6.2 INSPECTION OF GOVERNMENT-FURNISHED PROPERTY

Quality Engineering will issue instructions to inspect all GFP to the extent practical to detect transportation damage and to determine the property is complete, of the proper type, size, and grade, and is identified properly. Inspection is responsible for controlling GFP, while in the Inspection areas, to insure that damage and/or deterioration do not occur. Details on the inspection and control of GFP are shown in QMP 6-1. The SNPO-C Product Assurance Representative will be notified upon receipt of Government-Furnished Property.

6.3 DEFECTIVE GOVERNMENT-FURNISHED PROPERTY

When it has been determined that GFP is defective, Quality Assurance will document the deficiency, in accordance with established WANL procedure QMP 8-1, Nonconforming Material Disposition. Quality Assurance will then advise the SNPO-C Product Assurance Representative of the defective condition and request disposition instructions.

7.0 CONTROL OF CONTRACTOR-FABRICATED ARTICLES

7.1 GENERAL

The Quality Assurance Program utilized in the WANL fabrication and assembly areas is designed to provide maximum assurance that all applicable contract, drawing, and specification requirements are obtained and maintained.

The control activities are initiated by the review and approval of all manufacturing plans and work orders by Quality Engineering. At the time of this review, the appropriate inspections or tests are determined, and inspection planning in the form of Inspection Instruction and Data Sheets (IIDS) or Quality Inspection Procedures (QIP) is prepared in accordance with QMP 7-2, Inspection and Test Planning.

All activities in the WANL fabrication, assembly, storage, and related areas are planned and conducted to achieve maximum confidence that all applicable contractual, drawing and specification requirements are achieved and maintained. These activities are coordinated with procurement control activities to assure that all characteristics are inspected and verified at the appropriate time in the item's life cycle. The control activities are designed to assure that all items are in a condition suitable to perform their required function. Documented evidence of quality status is maintained for rapid review.

7.2 CONFORMANCE CRITERIA

The criteria for determining conformance of all articles produced or assembled by WANL is included in drawings, specifications, and workmanship standards. These documents are available at the time of the fabrication and the inspection. One facet of the conformance criteria is to control the configuration in accordance with the Configuration Plan, Data Item C-018.

Quality Assurance will assure that criteria are included in drawings, specifications, and standards and that the documents are available for inspection operations.

7.3 INSPECTION AND TEST PLANNING

Inspection and test plans are prepared for all fabrication and assembly operations within WANL which are classified as Quality Surveillance Codes 1 and 2. Inspection and test plans are also prepared for Code 3 fabrication and assembly operations within WANL when Quality Assurance witnesses or performs inspections or tests on such items at the prior request of Engineering.

A complete listing of inspection and test plans and procedures for each part, sub-assembly and assembly will be maintained by Quality Assurance. The list will include final inspections and critical in-process inspections at supplier locations. Where an inspection is a part of another document (e.g., Section 7.3.1 b) the appropriate paragraph(s) of that document will be referenced. The updated list, current for a specific reactor build, will be referenced as a part of the end item documentation for that reactor.

7.3.1 Inspection and Test Procedures

Inspection plans are prepared as two distinct types and can be considered as: a) inspection plans, or b) assembly inspection plans. All inspection plans relating to fabrication and assembly of end items will, as the program develops, be integrated into an overall Quality Control Plan keyed to the procurement, fabrication, assembly, and test operations. The inspections and hold points will be shown in relation to these operations and the governing procedures or instructions, as discussed below, will be referenced.

a) Inspection Plans. Inspection plans are prepared by Quality Engineering as QIP's or IIDS's, depending upon the complexity of the inspection plans. The QIP's and IIDS's are used in evaluating products being fabricated, monitoring tests conducted by other than Quality Assurance activities, and inspection of items before and after test. QMP 7-2 defines the preparation, distribution, and control of these inspection plans. The QIP is utilized for complex instructions and is a detailed, narrative type document specifying, as a minimum, the following:

- 1) Identification of the article to be inspected or tested (e. g., part number, applicable specification, system involved, and nomenclature).
- 2) Objectives of the inspection or test.

- 3) Measuring and test equipment to be used -- specifying range, accuracy, and type.
- 4) Detailed operations to be performed by the test operator, including operational checks or calibrations of the test equipment.
- 5) Conditions that must be maintained during inspection and test, including ambient or environmental, and precautions to be observed to prevent damage to personnel, test items, instruments involved. Safety precautions are required if applicable.
- 6) Criteria for passing or failing the test or for determining conformance or rejection of the article including reference to inspection standards.
- 7) Sampling plans to be used if applicable.
- 8) The recording forms required and instructions for filling out the form.
- 9) Identification of control points requiring specific Quality Assurance actions to assess quality status and acceptability.
- 10) Identification of Government designated control points.

The Inspection Instruction and Data Sheet (IIDS) is utilized for simple component-part types of inspection. This type of approach emphasizes defining the characteristics to be inspected, using standard gaging techniques. The cognizant Quality Engineer, at his option, may elect to write into the work order simple instructions such as "inspect to drawing," rather than using an inspection instruction. This is covered by criteria in QMP 7-2.

b) Assembly Inspection Plans. Assembly inspection plans are written by Quality Assurance in the form of QIP's in accordance with the previous paragraph, except for reactor assembly inspection procedures. The inspection requirements for assembly operations are incorporated in an Assembly Process Outline (APO). The APO then becomes a combined assembly and inspection instruction instructional document, and is issued by the Assembly Department with the concurrence of Quality Assurance. Each APO will include, as a minimum, the same content noted above as the requirement for a QIP.

7.3.2 Establishment of Values to be Observed in Support of the Trend Data Program

The responsibility for establishing the Trend Data Program is the function of Design Engineering and NERVA Reliability. Quality Assurance will participate in establishing the program and identifying characteristics which can be monitored to indicate degradation or incipient failure. Quality Assurance will also plan and perform the inspections, monitor and report on Trend Data Characteristics (TDC). When TDC's have been identified, the measurement requirements for these characteristics will be incorporated into the inspection planning. Measurement of TDC's will require in all cases recording of actual data. The Trend Data will be reported to NERVA Reliability who will monitor the data for establishment of trends. Details of the Quality Assurance participation in the Trend Data Program will be contained in QMP 14-5.

7.3.3 Workmanship Standards

The Workmanship Standards Manual, QWS-1, which complies with NASA Quality Publication NPC 200-4, will be applied as a workmanship standard on electrical and electronic material inspection. This document includes visual standards photographs. Visual standards are also prepared for all other inspection operations when it is felt that the drawing or specification is not sufficiently descriptive to allow adequate judgments of product quality to be made. Additional workmanship standards will be prepared where necessary to adequately convey information on acceptance criteria. QWS-1 and any new standards created will be submitted to ANSC and SNPO-C Product Assurance representatives for review.

7.4 INSPECTION AND TEST PERFORMANCE

7.4.1 In-Process Inspection and Test

All fabrication instructions are issued in the form of a Route Card and Work Order, (W)Form 59747. This form is reviewed and approved by Quality Engineering. The RC/WO contains a step by step routing from raw material to completed article. At each of the steps the appropriate Quality Assurance input is provided. When the Quality Assurance input at a particular step requires more than a single operation (i. e., final dimensional inspection) the Quality Engineer prepares an Inspection Instruction and Data Sheet (IIDS) delineating the characteristics to be inspected and the method for performing the inspection.

7.4.1.1 Assembly and Disassembly Control

Assembly of the NSS is controlled by Assembly Process Outlines (APO). The APO is prepared jointly by Assembly Engineering and Quality Engineering and requires a Quality Engineering approval. The APO is a step by step procedure describing the operations to be accomplished in the assembly of the NSS. Each assembly step is accompanied by an appropriate inspection step. The assembly technician and the inspector sign or stamp their respective steps.

7.4.1.2 Test Area Control

The need to control the area in which a test is being conducted is identified in the TIS, drawings and specifications. When such a need is identified, Quality Assurance will monitor the environment in the test area in the same manner as other test parameters. In the event the area should fall outside of the control limits, the area supervisor will be notified that test data developed under those conditions will be invalid.

In addition, the calibration of all test equipment and instrumentation is monitored by Quality Assurance.

7.4.2 Tests and Final Inspection

7.4.2.1 Test Plans and Reports

The requirements for testing of an item are enumerated in the Engineering Component Specification and further described in Data Item T-101, NERVA Program Test Plan. The requirements for individual component tests are documented on Test Information Sheets (TIS). The TIS is a two phase document; Phase I is known as the planning phase and is prepared by the functional organization having a need for the information, Phase II is known as the procedural phase and is prepared by the activity responsible for the performance of the test. The total of these TIS's for the NERVA Program is Data Item T-102, Category I Test Plans/Procedures. These TIS's are reviewed by Quality Engineering to assure that conditions are satisfied. The test performance is monitored as required to assure conformance to the TIS. Informal Test Plans not covered in T-101 and T-102 are reviewed by Quality Engineering in the same manner.

The results of completed tests are documented on Data Item T-119, Test Reports-Development and Qualification.

7.4.2.2 Tests and Inspections

The requirements for final tests and inspections of an item are identified on the final assembly drawing and in the specifications. The sequence of this testing with regard to its place in the assembly is identified in the Assembly Process Outline (APO), and where required, the performance of the test is per Quality Inspection Procedures (QIP) prepared in accordance with QMP 7-2. The APO also identifies the final inspections required to certify the acceptability of the end item.

In the event the end item fails to pass any of the required tests, the anomaly is documented on an Inspection Material Disposition Request (IMDR) and dispositioned in accordance with QMP 8-1, Nonconforming Material Disposition.

7.4.2.3 Documents and Records

All inspection records are maintained at WANL and are available for review by responsible ANSC and SNPO-C representatives. In addition, all end items being shipped from WANL to another facility are accompanied by end item documentation as described in paragraph 14.2.4.

7.4.2.4 Modifications after Final Tests and Inspection

Modifications to the end item after final tests and inspection can only be performed at the direction of the appropriate change board or a MRB as a disposition to an IMDR. Upon completion of such a modification, inspections will be performed as directed by the IMDR to confirm capability with the requirements of the IMDR.

7.5 FABRICATION CONTROLS

7.5.1 Production Tooling and Fabrication Equipment

Production tooling, jigs, fixtures, and other fabrication equipment which control dimensions, contours, or locating fabrication operations on Surveillance Code 1 or 2 items are calibrated and controlled by Quality Assurance to ensure initial and continuing accuracy. Code 3 items will be inspected by and controlled by Quality Assurance when the items affect product quality. Other Code 3 items will be inspected when requested by Engineering.

7.5.2 Material Control

Materials and parts undergoing fabrication or assembly are identified and controlled throughout the processing and includes age control and environmental control. The part number and serial or lot number identification system, discussed in paragraph 4.4, Identification, is used to identify and control all materials and parts. The identifying numbers are either stamped or etched on the parts, or a system of stickers, tags, or travel cards are attached to the parts or the part containers. Consideration is given to the marking or identification system to assure that the materials or parts will not be damaged. The release of reactor parts from Stores to the Assembly Department and the subsequent control and usage is defined in QMP 7-4.

7.5.3 Control of Cleanliness of Fabrication and Test Areas

Cleanliness requirements for various fabrication operations are established by Process Specifications and by Data Item S-021, "Contamination and Corrosion Control Plan." Quality Assurance conducts periodic checks to assure that cleanliness requirements are met and maintained. When it is determined that specified cleanliness requirements are not being met, Quality Assurance is authorized to stop all operations until corrective action is completed and determined to be effective.

7.5.4 Process Control

Special processes, where the nature is such that the completed article cannot be inspected by normal means to ensure proper quality, are controlled by the use of process specifications, equipment qualification, and operator qualification. Similarly, special inspection processes are controlled to ensure a uniformity of performance to acceptable standards by operator certification.

Operators are required to requalify at specified intervals. These intervals are specified in the qualification process specification. Continued poor performance on the part of an operator will result in loss of certification.

7.5.4.1 Process Control Procedures

Special processes such as welding, brazing, bonding, heat treating, plating or coating are controlled by process specifications. These specifications define the conditions that must be satisfied to successfully complete the designated process. Quality Assurance monitors these processes to assure that all of the specified parameters are met and that they are met in the proper sequence.

7.5.4.2 Process Environments

When the nature of a particular process dictates that special environmental conditions must prevail, during performance of that process, those environmental conditions are specified in the process specification as a part of the process parameters and are monitored by Quality Assurance in the manner stated in paragraph 7.5.4.1 above.

7.5.4.3 Process Certification

When the criticality of a particular process requires certification of the operators performing the process, the requirement will be identified in the process specification. The certification procedure is administered by Quality Assurance. In a like manner, nondestructive testing operators for performing liquid penetrant, ultrasonic, eddy current and radiographic testing are also certified to demonstrate process capability and operator proficiency.

Records of individual certifications and performance records are maintained and administered by Quality Assurance. These records are available for review by the ANSC and SNPO-C representatives.

Equipment and procedures are also evaluated and certified as a part of the man - machine system which affects the output of the process. Evaluation of equipment is covered in section 9.4 and evaluation or qualification of processes is covered in Section 4.3.2.

8.0 NONCONFORMING MATERIAL

8.1 MATERIAL REVIEW

When any NERVA article or material is found not to conform to applicable drawings or specifications, it is identified as nonconforming, segregated to the extent practicable, and held for review action. The primary purpose of these actions is to prevent nonconforming material from being further procured, assembled or delivered until it has been properly reviewed and dispositioned by personnel of sufficient technical competence and authority. An additional purpose is to initiate analysis and corrective action to prevent recurrence.

Quality Assurance is responsible for the systems of control, review and disposition of nonconformances. QMP 8-1 describes procedures for the review of all nonconforming material at WANL. QMP 8-2 describes the procedures for suppliers to report nonconformities for review at WANL.

The interface between nonconforming material review and the Failure Resolution Board (FRB) is described in Section 14.3. Under certain conditions, described in that section, nonconformances are reported as failures or problems for direct review and follow-up by the FRB. All nonconformances are reported on a summary report for review by WANL management of the disposition and necessary corrective action.

8.1.1 Material Review by Suppliers

WANL suppliers are not delegated the responsibility to disposition nonconforming material. QMP 8-2 provides procedures for suppliers to submit nonconformities to WANL for review.

8.2 APPROVAL OF CONTRACTING OFFICER

In any case where WANL recommends a "use as is" or "repair" disposition which adversely affects safety, reliability, durability, performance, interchangeability, weight, or basic objectives of the contract, written requests will be submitted to the SNPO-C Contracting

Officer. Such requests will be submitted by the Quality Assurance Manager through the Material Review Board (MRB) which includes representatives of SNPO-C and ANSC. The nonconforming material will be withheld from further processing or delivery until written approval is obtained.

8.3 CONTROL OF NONCONFORMING MATERIAL

All nonconforming material is segregated from other material, where feasible. Such material is uniquely identified as discrepant until such time as dispositioning by ERB/MRB action allows full use of the material in the same manner as nondiscrepant material. The standard inspection documentation established in QMP 5-5 and QMP 8-1 provides a means for PRA, ERB, or MRB action, as applicable.

Engineering Review Board (ERB) action is used to disposition nonconformities in hardware intended for development testing. Material Review Board (MRB) action is used to disposition nonconformities in hardware designated for qualification or delivery. Nonconformities on development hardware are submitted to MRB action when, in the judgment of Quality Assurance, the use of the nonconformity may adversely affect the objectives of the contract. ANSC or SNPO-C representatives have the right to review all ERB documents and call for MRB action within two weeks of the transmittal of ERB documents.

8.3.1 Engineering Review Board (ERB)

As a minimum, the ERB consists of the cognizant Design Engineer and Quality Engineer. Representatives of other departments may participate in the ERB at the request of either permanent member of the ERB. All ERB decisions include a statement justifying the disposition made.

8.3.2 Material Review Board (MRB)

The MRB consists of the members of the ERB and representatives of SNPO-C and ANSC. These representatives will be provided with written requests for each action determined by Quality Assurance to need ANSC/SNPO-C disposition.

8.3.3 Preliminary Review Action (PRA)

A Preliminary Review Action with limited authority is provided for dispositioning nonconforming material in specific cases. The PRA consists of a Manufacturing Engineer and the Inspection Supervisor. The PRA dispositions are limited to:

- a) Rework to meet drawing requirements, by established procedures and operations.
- b) Reject
- c) Submit to ERB

Preliminary Review Actions are documented in accordance with QMP 5-5 and QMP 8-1.

8.3.4 Standard Repair Authority

Repair of nonconforming hardware can only be accomplished when directed by Engineering Review Board or Material Review Board action.

8.4 REWORK WITHOUT REVIEW BOARD ACTION

Disposition of nonconforming material in the category "return for completion for operation," or "return for rework to drawing" is accomplished by the PRA. This is done only in cases when operations were obviously missed or rework (as opposed to repair as defined in QMP 8-1) can correct a discrepancy. In all cases the rework must be accomplished in accordance with established procedures or operations.

9.0 INSPECTION, MEASURING AND TEST EQUIPMENT

9.1 GENERAL

All inspection, measuring and test equipment used on the NERVA Program is evaluated to determine its accuracy and adequacy for its intended use and is maintained in a calibrated condition, traceable to certified standards. Quality Assurance is responsible for the selection, evaluation, approval, maintenance, and control of all inspection standards, gages, measuring and test equipment necessary to determine conformance with specification, drawing, and contract requirements. This includes special automated test and checkout equipment, which performs an inspection measuring or test function. For the purpose of this program plan, tools, jigs, or fixtures which are used to obtain measurements that are criteria for acceptance or rejection by Quality Assurance shall be considered gages. QMP's 9-2 and 9-3 set forth the detailed procedures governing calibration and control of inspection gages, measuring instruments and test equipment.

9.2 CALIBRATION

All inspection gages, measuring instruments, and test equipment used in inspection or tests are calibrated at established intervals against certified standards to insure continued accuracy is maintained within prescribed limits. Each piece of equipment is identified by an identification number applied to the body, chassis or case. Each piece of equipment is also tagged with a sticker showing the last date of calibration and the date of the next required calibration. A record system provides for the following, as a minimum:

- a) Positive identification of the piece of equipment.
- b) Results of initial calibration and periodic recalibration, including applicable dates and the name of the individual performing the evaluation and calibration.
- c) A computer system for positive recall for calibration and routine maintenance.
- d) A record of all repairs performed.
- e) Removal from service of defective equipment.

9.3 CALIBRATION FACILITIES AND STANDARDS

Calibration facilities at WANL provide an environment that is sufficiently controlled to allow each piece of inspection, measuring, and test equipment to be evaluated and calibrated to its design accuracy. The dimensional gage laboratory is essentially dust-free and the temperature and humidity are maintained at 68 degrees $\pm$ 2 degrees F and maximum 50 percent relative humidity, respectively. Within state-of-the-art limitations, the standards used for calibration of inspection, measuring, and test equipment will have a tolerance no greater than 10 percent of the allowable tolerance for the equipment being calibrated and will be traceable to the National Bureau of Standards. Approved commercial laboratories are utilized for calibrations when necessary.

9.4 EVALUATION

9.4.1 Commercial Equipment

Commercial inspection, measuring and test equipment is initially calibrated to assure that the error, throughout the entire range of operation, is within the manufacturer's stated limits. Evaluations other than the initial calibration will also be performed on commercial equipment when additional information regarding accuracy, stability and repeatability is considered necessary by Quality Assurance to adequately assess the capability of the equipment for its intended use.

9.4.2 Special Equipment

Special equipment (e.g., automated test and checkout equipment, fuel element non-destructive test equipment) designed to provide specific measurements for determining acceptability of NERVA Nuclear Subsystem hardware are evaluated to determine accuracy, repeatability, compatibility with hardware, ease of operation, and adequacy of operating instructions. Statistical methods and comparisons with destructive test data are utilized for such evaluations when appropriate. Methods for periodic maintenance and calibrating against standards are included in the evaluations. Analysis of failure modes and human error factors are also included as appropriate.

Results of special test equipment evaluations are documented in reports, are subject to review by Product Assurance management and are submitted to ANSC/SNPO-C Product Assurance representatives for review prior to the use of the equipment.

9.5 MAINTENANCE AND CONTROL

All inspection, measuring and test equipment is maintained in a manner that will provide assurance that the original calibration accuracy and capability of the equipment is retained. Any defective inspection, measuring and test equipment is removed from service and not made available for reuse until adequate repairs and re-evaluation assure that the equipment is again accurate and capable. Quality Assurance audits the maintenance status of such equipment.

9.6 WRITTEN PROCEDURES

Policy and procedural instructions for maintaining calibration for inspection, measuring, testing, equipment are based on Military Standards such as MIL Standard 120, and are supplemented by calibration instructions written by Quality Engineering. These instructions are available for review by the SNPO-C Resident Quality Assurance Representative.

9.7 RECORDS

Records are maintained on all inspection, measuring and test equipment showing results of calibrations, evaluations, and repair history. The records also indicate calibration status and due dates for next calibration. Quality Assurance periodically reviews records for test equipment not under its direct control.

An EDP system is used by Quality Assurance to maintain calibration records and serves as a basis for gage recall and calibration. Gage History Cards are maintained showing variable data of calibration results and repair history. A tool and gage checkout card system is also employed, which is used in the determination of gage calibration interval and frequency.

10.0 INSPECTION STAMPS

The acceptability status of parts or materials is indicated by the use of tags, stickers, and copies of inspection documents attached to the part or its product container. Stamps (rubber and steel) are provided to each inspector for use on the tags, stickers, and inspection documents for identification purposes. The stamps are provided in several designs to clearly indicate inspection status, and each stamp is numbered and traceable to an individual inspector. QMP 10-1 provides a detailed description of the design, use, and control of the inspection stamps.

11.0 PRESERVATION, PACKAGING, HANDLING, STORAGE AND SHIPPING

11.1 GENERAL

The controls exercised to prevent degradation of reliability in procurement and fabrication are continued through handling, storage and shipping operations. The specifying of requirements and procedures for preservation, packaging, handling and storage is a primary responsibility of Design Engineering and Manufacturing Engineering. Quality Engineering also has a responsibility for assuring that requirements and procedures are specified when part history or analyses by Quality Engineering indicate the need for special requirements to prevent degradation of reliability. Quality Engineering reviews all specifications covering preservation, packaging, handling, storage and shipping to assure that criteria are specified to permit control and verification of the procedures. It also assures that the necessary inspection and surveillance actions are performed to assure compliance with the requirements. The shipping and technical documentation accompanying shipments of end items are described in Section 14.

11.2 PRESERVATION

The need for special procedures to preserve components during periods of storage prior to their use is specified by Design Engineering. As a minimum, each component has a designated cleaning procedure which is applied to the component after it has been released by Quality Assurance and before it is placed in Stores. Special cleaning and preservation procedures are prepared as Process Specifications. Quality Assurance witnesses all component cleaning and preservation operations to assure compliance to the proper specifications and procedures.

11.3 PACKAGING

The requirements for packaging of materials or components and end items are described in WANL Division Procedure 752. This procedure states that the Engineering Release/Change Order (ERCO) will specify the packaging class applied to the component.

WANL utilizes three packaging classes plus a special class for nuclear or radioactive materials which are covered under nuclear accountability procedures which are directed by the AEC.

The three non-nuclear classes are:

- Class I A special handling and packaging directed by Design Engineering in the form of a Process Specification referenced on the drawing.
- Class II A packaging grade superior to general commercial packaging standards. This class is directed by Manufacturing Engineering in the form of packaging procedures and, where required, packaging drawings.
- Class III A good grade of commercial packaging as deemed adequate by the Shipping Department at WANL or the supplier.

Packaging Class I and Class II require surveillance by Quality Assurance to assure compliance with requirements. Class III packaging is inspected at WANL either in Shipping or Receiving to determine the quality of packaging.

11.4 HANDLING

The need for special handling of components is described in much the same way as packaging requirements, although without the formal classification. Reactor Design or Manufacturing Engineering describes the need for special handling and, where required, Manufacturing Engineering designs handling fixtures and/or tools. This design may be accomplished at WANL or added to the procurement of components from a supplier. In either of these cases, Quality Engineering approves the design and Inspection inspects the fixtures.

During assembly operations in a like manner the need for handling fixtures and tooling is identified by Manufacturing who procures the fixtures and tooling. Quality Assurance reviews and approves tooling drawings and inspects the complete articles.

11.5 STORAGE

In storage, most items are preserved, packaged, and handled as prescribed in the preceding paragraphs. When the nature of the item is such that the storage environment must be changed at prescribed intervals, this information will be identified by Reactor Design on

the drawing or ERCO. Quality Assurance monitors the Storeroom to determine special environmental conditions are maintained and to assure no degradation of the material has taken place.

11.6 SHIPPING

All shipments originating at WANL are reviewed by Quality Assurance to ensure that:

- 1) Adequate evidence of acceptability exists
- 2) The items are complete and of the type described on the shipping documents,
- 3) The proper packaging is used,
- 4) The proper documentation is included with the shipment.

If the articles being shipped constitute an end item, then an End Item Review Board (EIRB) is convened and judges the acceptability of the item to be shipped. The makeup and detailed operation of an EIRB is described in QMP 11-1, Shipments of End Items. Documentation required for shipment of an NSS is described in QMP 14-1, Reactor End Item Reports.

12.0 STATISTICAL PLANNING, ANALYSIS AND QUALITY CONTROL

12.1 GENERAL

Statistical techniques will be utilized whenever advantageous, in providing higher confidence and where a maximum of useful data can be obtained at less cost and time.

12.2 STATISTICAL ANALYSIS AND TEST PLANNING

Statistical methods such as design of experiments, analysis of variance and regression analysis will be utilized to the maximum feasible extent in planning inspection and test operations and in analyzing causes of problems and trends. Emphasis will be placed on statistical techniques in the evaluation of special test equipment, particularly in the areas of comparing nondestructive tests with destructive tests. In addition, statistical techniques are used in determining the probability of error in various quality control operations and to establish an adequate level of confidence in the operations. These activities are conducted by, or are reviewed by the Reliability group in Product Assurance.

12.3 SAMPLING PLANS

Sampling inspection plans are used when inspections or tests are destructive, or when historical data, inherent characteristics, or the noncritical application of an article or material indicate that quality, reliability or design intent will not be compromised. Quality Engineering is responsible for establishing sampling plans. Wherever possible, these plans will be defined in MIL-STD-105, MIL-STD-414, or Handbooks H106, H107 and H108. Sampling plans may be used by suppliers only when reviewed and approved by Quality Engineering. Sampling plans which are devised by Quality Engineering or suppliers which are not based on the Government specifications stated above, will be submitted to ANSC/SNPO-C for approval prior to implementation.

All sampling plans used on hardware designated for qualification or delivery will be submitted to ANSC/SNPO-C for approval.

12.4 STATISTICAL QUALITY CONTROL CHARTS

Statistical quality control charts will be used where they are determined to be useful in maintaining or improving hardware quality. They will be used where they will enhance process control or will assist in early detection of adverse trends.

13.0 TRAINING AND CERTIFICATION OF PERSONNEL

13.1 TRAINING

Training programs are conducted to achieve and maintain a high level of competence in all personnel implementing the quality program and in all personnel having an effect on quality. The training of Inspection and Quality Engineering personnel is the responsibility of the Product Assurance Department. Product Assurance also determines the need for training in other activities such as engineering, fabrication, procurement, having an effect on hardware quality. The need for such training is reported to the manager of the department concerned and follow up is provided to assure training is conducted.

13.2 CERTIFICATION OF FABRICATION AND INSPECTION PERSONNEL

13.2.1 WANL Personnel

Certification is required for personnel performing specialized operations such as welding, soldering, radiography, and dye penetrant. Certification procedures include oral, written, and proficiency testing. Periodic evaluation of inspections, tests, and quality audits establish the need for additional training and recertification. Records are maintained of all individuals certified with the dates of effectivity of the certification. A card is issued for evidence of certification and is to be carried by the individual performing tests. QMP 13-1 provides details for certification of personnel in liquid penetrant, ultrasonic, and radiographic inspection. The basic provisions apply to all certifications.

13.2.2 Certification of Suppliers' Procedures and Personnel

Requirements of certifications are extended to WANL suppliers by Process Specification PS 294584. The need for certification is established at the Quality Engineering review of the procurement document and applied to the purchase order by PQR. This review considers the critical nature of the part and specialized fabrication/inspection operations having a significant effect upon the quality of the delivered article.

14.0 DATA REPORTING AND CORRECTIVE ACTION

14.1 GENERAL

Data is collected, analyzed and reported to aid in the effective management of the quality program, to provide information to aid in the engineering definition of the NSS, and to aid in top management decisions. The data is also used in the selection and certification of hardware for qualification or delivery. Emphasis is placed on data such as quality trends and reject rates to indicate areas where corrective action is required.

Quality data is used to provide objective evidence of quality status and/or hardware condition in support of readiness reviews, end item reviews, etc. For this reason, quality data is stored in a readily retrievable and traceable manner in the Quality Data System. The Quality Data System interfaces with the overall data system as defined in the Data Management Plan, Data Item C-100, to prevent duplication of effort and to provide management visibility of the quality data. It is the responsibility of Product Assurance to assure that the Data Management Plan meets, and provides for the objectives of, the quality data requirements.

14.2 DATA REPORTING

14.2.1 Quality Status Reports

Quality program status and problems are reported on a weekly basis to WANL management through internal reports and staff meetings. A weekly significant events report, including quality program events, is transmitted to ANSC/SNPO by Program Management. Quarterly reporting of quality progress is reported in the NSS Quarterly Report, submitted as described in Section 2.2.

14.2.2 Laboratory and Experimental Data

The design engineer has the responsibility to prepare simulation models and to conduct experimental testing to determine feasibility of design concepts. Hardware for such testing may be designated Code 3, with limited inspection and control when this facilitates

the objectives of the program. Quality Engineering must concur with the use of limited quality control in these cases. In general, data from such testing is not used for major design decisions and it is not used for prequalification or qualification without complete inspection and reporting and traceability of the hardware condition to assure verification by Quality Assurance. In any case of a qualification where the Government may desire to use data which Product Assurance cannot adequately verify, the Government will be requested to provide, in writing, a waiver to use the data.

Quality Assurance inspects and controls laboratory and experimental hardware in accordance with the approved test plans. It documents and reports data to Engineering from inspections or other quality tests in support of the experiment.

14.2.3 Quality Data

14.2.3.1 General

Results of all inspections and tests performed throughout the testing, fabrication and assembly process are documented and stored in the Quality Data System. The records are traceable to serialized hardware and rapid reference and cross reference is enhanced by an automated data traceability system. Prime features of this system provide:

- a) An index to Quality Assurance documents from the material stage to the finished product.
- b) A method for auditing the Quality Assurance records to ensure completeness and accuracy.
- c) A method for rapidly and easily determining the quality status of any part assigned a WANL serial number or lot number.
- d) Ability to sort data under various headings to provide data in support of other activities, e. g., ERB/MRB.

The Quality Data System is described in QMP 14-6.

14.2.3.2 Selection and Certification of Articles Readied for Qualification And Delivery

Prior to delivery of any articles for qualification, a Completed End Item Report is prepared (Section 14.2.4). In addition, Quality Assurance certifies the following:

- a) The articles conform to the specified configuration description as shown in the applicable drawings, List of Parts, etc., including all authorized changes.
- b) The required inspections, tests, and associated activities have been performed and documented.
- c) The nonconformities, failures, problems on the articles, have been reviewed to determine that they were adequately evaluated and accepted. Also, that failures or problems on like articles, which could affect the articles being considered have been evaluated and accepted.
- d) The total operating time on life-limited articles is documented and is within the specified limits.
- e) Qualification status.

The inspection and test plans and procedures (Quality Control Plan) for the article are made available to document the methods by which the article was controlled. The inspection and test data is made available on short notice to document and support the quality status of the article.

Where it is desired by the Government to select one of several articles for qualification or delivery, Quality Assurance will provide the necessary inspection and test data to make the selection.

14.2.4 Completed Item Report

All NERVA articles being shipped from WANL to NRDS or other facilities designated by SNPO, including the test articles, test facilities, support equipment or any other NERVA article, will be accompanied with the following minimum documentation:

- a) Identification and configuration description of the end item.
- b) Evidence of acceptability.
- c) Description of nonconformities applying to the items.
- d) Required inspection data for interfaces as defined by Interface Control Drawings.
- e) Descriptions of any uncompleted tests or inspections which must be completed by the receiving facility.

- f) Total operating time on life-limited items.

QMP's 11-1 and 14-1 provide a detailed description of shipment documentation.

The Inspection Test Plan (Section 7.3) and detail inspection data for each article is available at WANL to supplement the end item documentation.

14.2.5 Operational Data

The Quality Data System is designed to incorporate operational data from field test sites, launch site and from flight operations. Correlation of operational data with inspection and test data will be provided to determine the effectiveness of the quality control operations and to indicate areas where improvements are needed. In addition, operational data will be used to determine product effectiveness i.e. to compare operating characteristics with NPRD requirements.

14.2.6 Trend Data Program

A Trend Data Program will be established by Design Engineering and NERVA Reliability to identify characteristics which can be monitored to indicate degradation and potential failure. Quality Assurance will participate in establishing the program, plan the inspections, monitor and report on Trend Data Characteristics. Details on the Trend Data reporting by Quality Assurance will be contained in QMP 14-5.

14.3 FAILURE REPORTING AND CORRECTIVE ACTION

14.3.1 Policy

A closed-loop reporting and corrective action system is provided for all problems, failures and discrepancies. The system provides for action by line management to assure that appropriate corrective action is taken. In addition, a Failure Resolution Board (FRB) reviews the effectiveness of the corrective actions taken by line management. The FRB also resolves any differences between line management as to corrective action responsibility or adequacy of corrective action.

A failure is defined as the inability of a part or subsystem to meet specification requirements following acceptance of the part or subsystem. Examples are as follows:

- a) inability to meet requirements in a component prequalification or qualification test,
- b) inability to meet requirements in a reactor test, c) malfunctions or non-scheduled adjustments.

Failures in tests when parts are deliberately stressed to failure are not reportable unless the part fails at lower than specification requirements.

A problem is defined as the actual or potential inability of a procedure or operation to consistently obtain the desired results. A fabrication or assembly procedure which results in recurring defective material will be reported as a problem. Critical single discrepancies will also be reported as a problem.

A discrepancy is defined as a nonconformance to requirements detected during normal inspection or acceptance testing.

14.3.2 Problem Failure Reports

Problems and failures as defined above are reported by a Problem/Failure Report (PFR) form. These reports are normally initiated by Quality Assurance, but may be initiated by any person recognizing a problem or failure. When an item of hardware is involved, Quality Assurance immediately takes control of the part or component to prevent any further use or testing of the component until decisions are made regarding failure analysis or other disposition. Consistent with safety requirements, every effort is made not to disturb failed components so that the nature and cause of the failure can be analyzed.

Copies of the Problem/Failure Reports are sent by Quality Assurance to the cognizant engineering manager, and NERVA Reliability for analysis and corrective action. Product Assurance periodically issues a listing of all PFR's with the corrective action status. All PFR's are carried on the list as open items until removed by the FRB. The board periodically reviews all PFR's and the corrective action taken.

Where failure analyses are required to determine cause of failure, Product Assurance will require written procedures for such analyses, prior to start of the analyses. Quality Assurance will assure that the analysis is conducted in accordance with the procedures and will certify results and observations.

The Quality Data System will maintain records of all PFR's with results of analyses and corrective action status. The records will be retrievable for readiness reviews.

Detail procedures for the operations of the PFR system and the FRB will be established in conjunction with ANSC to meet the requirements of the NPRD.

14.3.3 Deficiency Reporting and Corrective Action

Reporting of deficiencies is accomplished primarily through nonconforming material reports, Section 8.0. These reports will be summarized on EDP tab runs to aid in identifying recurring deficiencies requiring corrective action. Copies of the tab runs will be sent to the FRB secretary for review by the Board. Recurring deficiencies and critical single deficiencies will be reported as problems per Section 14.3.2.

Quality Assurance will take prompt action to correct conditions at WANL or at suppliers' plants whenever conditions result, or might result in deficient parts and materials. QMP's 5-4 and 14-3 provide for corrective action at suppliers' plants and WANL activities, respectively.

15.0 AUDIT PROGRAM

15.1 PERFORMANCE OF AUDITS

A program will be established to audit the activities, including those at NRDS, which affect the reliability and quality of the nuclear subsystem (NSS). Formal audits to be conducted at NRDS will be coordinated, in advance, with ANSC to prevent duplication of effort. Audits will be made by teams including some personnel not having line responsibility for the area being audited. The Manager of Quality Assurance is responsible for the Audit Program. As the NERVA Program progresses, this responsibility will be assigned to an audit group within Product Assurance. When required for the effectiveness of a specific audit, assistance will be requested of other departments at WANL. Audit programs cover the adequacy of procedures and systems, and the compliance to the established procedures and systems. The audit program will include, but not be limited to, the following:

- a) Effectiveness of feedback and corrective action.
- b) Existence and adequacy of quality assurance procedures and instructions governing inspections and tests.
- c) Existence of, and adequacy of, process instructions and process controls.
- d) Certification of personnel.
- e) Effectiveness of problem failure reporting and resolution system.
- f) Availability of required documentation for any operation.
- g) Familiarity of personnel with required documents.
- h) Effectiveness of the Engineering Review Board (ERB) and Material Review Board (MRB) actions.
- i) Effectiveness of configuration control system.
- j) Effectiveness of data reporting system.
- k) Effectiveness of training programs.
- l) Use of quality history data reported to Engineering.

The auditors may require reinspection of work as required to determine the effectiveness of a quality assurance operation.

Follow-up audits are made when needed to assure that effective action is taken to correct any deficiencies.

The primary responsibility for auditing engineering with respect to reliability functions, such as Failure Mode Analysis, will be assigned to the reliability activity in Product Assurance. QMP 15-1 describes the audit operations.

15.2 AUDIT REPORTS

The results of each audit are first discussed with the responsible organization, then presented formally along with recommended corrective action to the manager of the area being audited; the NERVA Program Manager; and the Product Assurance Manager. Reports are available to the SNPO and ANSC Residents for information. Summaries of audit results are submitted as a part of the NERVA Nuclear Subsystem Quarterly Progress Report.

16.0 FLIGHT READINESS

Product Assurance supports all activities related to assuring or determining the readiness of the NSS for flight. The Product Assurance effort in these activities encompasses three major areas:

- a) The prevention of degradation of any characteristic affecting safety or reliability.
- b) Providing data to assist in the determination of readiness status.
- c) Providing data feedback from test/launch/flight activities to improve the quality of NSS and support hardware.

As the program progresses, Product Assurance will establish interfaces with Government and vehicle contractors' reliability and quality activities in accordance with contractual requirements.

Product Assurance program planning and definition is based on satisfying eventual flight readiness review requirements. Until such requirements are specified, Product Assurance will base its planning on the best available information on future requirements.

APPENDIX B
LIST OF REFERENCED DOCUMENTS

<u>Document Title</u>	<u>Document No.</u>	<u>Issue Date</u>	<u>Referenced on Page Numbers</u>
<u>NASA AND SNPO-C DOCUMENTS:</u>			
Quality Program Provisions for Space System Contractors	NPC 200-2	April 1962	1-1, 1-2, 5-3
Inspection System Provisions for Space System Contractors	NPC 200-3	April 1962	5-3
Requirements for Soldered Electrical Connections	NPC 200-4	May 1968	7-4
NERVA Program Requirements Document	SNPO-NPRD-1	June 1968	1-1, 1-2
<u>OTHER GOVERNMENT DOCUMENTS:</u>			
Sampling Procedures and Tables for Inspection by Attributes	MIL-STD-105	March 1964	12-1
Gage Inspection	MIL-STD-120	Dec. 1950	9-3
Sampling Procedures and Tables for Inspection by Variables for Percent Defective	MIL-STD-414	June 1957	12-1
Multi-Level Continuous Sampling Procedures	Hdbk. H106	Oct. 1958	12-1
Inspection and Quality Control Single Level Continuous Sampling Procedures and Tables for Inspection by Attributes	Hdbk. H107	April 1959	12-1
Quality Control and Reliability Sampling Procedures and Tables for Life and Reliability Testing	Hdbk. H108	April 1964	12-1
<u>WANL DIVISIONAL PROCEDURES:</u>			
Packaging Standards for Nonradioactive, Nonexplosive Material	DP 752	Jan. 1968	11-1

APPENDIX B (CONTINUED)

<u>Document Title</u>	<u>Document No.</u>	<u>Issue Date</u>	<u>Referenced on Pg. No.</u>
NERVA Management Plan, WANL Supplement	M-001		1-1, 1-2, 2-4, 3-1, 4-4
NERVA Configuration Management Plan	C-018		1-2, 2-4, 4-7, 7-1
NERVA Data and Document Management Plan	C-100		1-2, 14-1
Product Plan	P-013		1-2
NERVA Reliability Program Plan	R-101		1-2
NERVA Maintainability Program Plan	R-102		1-2
Reliability Test and Evaluation Plan	R-106		1-2
NERVA Safety Plan	S-019		1-3
Contamination and Corrosion Control Plan, WANL Supplement	S-021		1-3, 7-7
System Test Plan	T-101		1-2, 1-3, 4-6, 7-5
Test Plan/Procedures	T-102		4-6, 7-5
Test Reports	T-119		4-6, 7-5
<u>WANL QUALITY METHODS AND PROCEDURES:</u>			
Preparation of Quality Control Plans	QMP 2-2		4-1, 4-4
Organization of Quality Assurance	QMP 3-1	March 1969	3-3
Drawing Review	QMP 4-1	Jan. 1969	4-2, 4-3
Specification Review	QMP 4-2	Jan. 1969	4-3
Identification of Material, Detail Parts, Subassemblies and Assemblies by Serial or Lot Numbers	QMP 4-3	May 1970	4-7, 5-3
Quality Rating of Designs (R_Q)	QMP 4-4		4-2
Quality Monitoring and Control of Component Testing	QMP 4-5		4-1
Supplier Quality Survey and Evaluation	QMP 5-1	March 1969	5-2

APPENDIX B (CONTINUED)

<u>Document Title</u>	<u>Document No.</u>	<u>Issue Date</u>	<u>Referenced on Pg. No.</u>
Quality Requirements for Procurement Documents	QMP 5-2	Jan. 1969	5-3
Quality Surveillance Codes	QMP 5-3	Mar. 1969	4-2, 5-2
Corrective Action at Suppliers	QMP 5-4	Mar. 1969	14-6
Inspection at WANL	QMP 5-5	May 1970	5-5, 5-6, 8-2, 8-3
Approval Requests	QMP 5-6	Mar. 1969	5-4
Control of Government-Furnished Property	QMP 6-1	Mar. 1969	6-1
Inspection and Test Planning	QMP 7-2	May 1970	5-5, 7-1, 7-2, 7-3, 7-6
In-Process Inspection - Reactor Assembly	QMP 7-4	May 1970	5-1, 7-7
Nonconforming Material Disposition	QMP 8-1	June 1970	6-1, 7-5, 7-6, 8-1, 8-2, 8-3
Variation Request	QMP 8-2	Jan. 1969	5-5, 8-1
Calibration and Control of Inspection Gages	QMP 9-2	Mar. 1969	9-1
Calibration and Control of Test Equipment	QMP 9-3	Mar. 1969	9-1
Stamp Control	QMP 10-1	Mar. 1969	10-1
Shipments of End Items	QMP 11-1	May 1970	11-3
Nondestructive Certification Procedure	QMP 13-1	Mar. 1969	5-5, 13-1
Reactor End Item Reports	QMP 14-1	Mar. 1969	11-3
Internal Corrective Action	QMP 14-3	July 1966	14-6
Trend Data Program	QMP 14-5		7-4, 14-4
Quality Data System	QMP 14-6		14-2
Product Assurance Audit	QMP 15-1		15-2

OTHER WANL QUALITY ASSURANCE DOCUMENTS:

WANL Quality Control Requirements for Suppliers	WANL QC-101	Sept. 1962	5-3, 5-4
Quality Workmanship Standards Manual Electrical/Electronic	QWS-1	May 1968	7-4