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MASTER

FFTF PNL

RELIABILITY ASSURANCE PROGRAM PLAN

FOR THE FFTF

W. G. Albert

November 1967

AEC RESEARCH &
DEVELOPMENT REPORT

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FAST FLUX TEST FACILITY

PNL RELIABILITY ASSURANCE PROGRAM PLAN
FOR THE FFTF

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PNL RELIABILITY ASSURANCE PROGRAM PLAN FOR FFTFSECTION 1.0 INTRODUCTION

This plan describes the Reliability Assurance Program to be used by the PNL/FFTF project organization.

1.1 PURPOSE

The PNL Reliability Assurance Program for the Fast Flux Test Facility has been established to provide a uniform administrative policy for those engineering activities affecting the reliability of the FFTF. Full implementation of this program will assure that the FFTF meets the objective of "reliable plant performance" as provided by the Division of Reactor Development and Technology (RDT) program directive, "FFTF - Program Direction."⁽¹⁾ This Reliability Assurance Program Plan states the actions necessary to make the success of the FFTF Project more predictable -- from definition and clear understanding of goals, plans and means of measuring progress, through all the directed, positive and disciplined methods that must be employed to make certain that the engineering aspects of the undertaking are proceeding as planned.

1.2 SCOPE

The PNL Reliability Assurance Program constitutes a formal method for:

- . Providing objective review of FFTF design, testing and supporting activities.
- . Controlling design and test activities of PNL and PNL contractors to ensure effective implementation of the Reliability Assurance Requirements for the FFTF.⁽²⁾

This Reliability Assurance Program Plan defines responsibilities and describes reliability assurance tasks to be performed by PNL/FFTF Design Engineering, Development, Nuclear and System Engineering, Operations Planning and Review, Product Assurance, and Program Programming and Analysis organizations. This program plan, along with detailed reliability assurance procedures required for implementing tasks described in Sections 3.0 through 7.0 of this plan will be incorporated into a PNL Reliability Assurance Manual for the FFTF. These procedures will be developed for internal use within the PNL/FFTF Project and will be accepted by the managers of Design Engineering, Development, Nuclear and Systems Engineering, Operations Planning and Review, Product Assurance, and Project Programming and Analysis prior to being approved for use by the PNL/FFTF Project manager. Appendix "A" defines terms used in this Program Plan.

1.3 RELATIONSHIP TO TOTAL RELIABILITY ASSURANCE PROGRAM FOR FFTF

This program plan for PNL is part of the total Reliability Assurance Program for the FFTF (PNL and contractors) which is managed in accordance with the direction provided in this document and other sources as follows:

- . PNL/FFTF Reliability Assurance Procedures
- . PNL/FFTF Baseline Reliability Assurance Requirements
- . Reliability Assurance Requirements for the FFTF⁽²⁾ applicable to PNL contractors
- . Contract provisions which control the applicability of Reliability Assurance Requirements for the FFTF or provide additional requirements
- . Reliability Assurance Program Plans and Procedures of PNL contractors.

1.4 IMPLEMENTATION

The Reliability Assurance Program Plan is to be implemented by cognizant PNL/FFTF project organizations through individual

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1.4 IMPLEMENTATION

The Reliability Assurance Program Plan is to be implemented by cognizant PNL/FFTF project organizations through individual

actions keyed to major project decision points. The PNL/FFTF designer is primarily responsible for the reliability of FFTF systems and will assure that appropriate design requirements are incorporated into the drawings and specifications. When necessary, such requirements will be supported and verified by analysis or testing.

This reliability program will function throughout pre-operational and initial power test phases of the project but is not applicable to the FFTF operating phase. However, it will assure that a data base is provided on which a reliability assurance program for the operating phase can be developed.

Formal design review by PNL is the focal point of most Reliability Assurance activities described in sections 3.0, 4.0 and 5.0 of this plan. The accomplishment of this formal review and the approval of the design by PNL and the design descriptions by the AEC at the end of the preliminary and final design phases constitutes "baselining" of the design. (See Configuration Management Plan).⁽⁴⁾ The information for PNL's review comes from sources such as:

- . The contractor's design review report
- . The reports by the PNL engineering representative at the contractor's plant
- . System drawings, specifications and calculations
- . Failure modes and effects analysis
- . The review of interface problems identified in the design descriptions
- . Definition of operating requirements
- . Reports on materials applications
- . The reports on results of development and qualification testing
- . The analysis of system reliability

SECTION 2.0 PROGRAM MANAGEMENT

Management of the Reliability Assurance Program is an integrated FFTF Project function. The PNL/FFTF Product Assurance Section of the FFTF Project, functions as a monitor of the implementation of the PNL Reliability Assurance Plan and as an auditor of the plans of PNL contractors.

2.1 RESPONSIBILITY

Primary organizational responsibilities for implementation of the procedures for various tasks of the Reliability Assurance Program Plan are described in Sections 3.0 through 7.0 of this plan.

The tasks identified in this plan will be performed by PNL/FFTF Design Engineering, Development, Nuclear and Systems Engineering, Operations Planning and Review, Product Assurance, or Project Programming and Analysis organizations, as appropriate. Appendix "B" lists the procedures assigned to each organizational component. The reliability assurance procedures for each task will define supporting functional responsibilities and interfaces.

Organization for the project is shown in Figures 1 and 2. Figure 3 shows organization of the Product Assurance Section.

The following paragraphs define the broad technical responsibilities within FFTF for managing reliability assurance tasks. Details of these broad responsibilities will be defined by the reliability assurance procedures or the Project Manager as necessary.

- . PNL/FFTF Design Engineering shall have overall FFTF reliability assurance functional responsibility for design of products that are to be part of the FFTF.

This responsibility includes assuring that development and analytical requirements needed to support FFTF design are defined. Design Engineering shall also be responsible for maintaining technical review of, and concurrence with, the implementation efforts of PNL/FFTF Development, Nuclear and Systems Engineering, and Product Assurance to the extent required to assure compatibility of the effort as it relates to the design of products for installation in the FFTF. The design review process shall constitute a mechanism for periodic evaluation of these implementation efforts. Any nonconcurrences shall be resolved in a timely manner without stoppage of work in progress.

- . PNL/FFTF Development shall have overall FFTF Reliability Assurance functional responsibility for performance of cognizant development test programs on materials, components, systems, and equipment. PNL/FFTF Development is also responsible for advising all FFTF organizations (PNL and contractors) on materials applications.
- . PNL/FFTF Nuclear and Systems Engineering shall have overall FFTF functional responsibility for performing analytical work in support of design and test activities. Nuclear and Systems Engineering shall also have conceptual design and development responsibilities for FFTF fuel and shall be responsible for the preparation of reactor safeguards reports and supporting safety analyses.

The responsibility assignments in Sections 3.0 through 7.0 are for determining the content of the Reliability Assurance procedures and putting these procedures into effect.

2.2 PNL/FFTF RELIABILITY ASSURANCE ORGANIZATION

The function of the Reliability Assurance Unit in the FFTF Project organization (Figure 3) is that of providing surveillance of the activities defined in Section 1.2.

Figure 1

FIGURE 2

FIGURE 3

In addition, the unit will:

- . Develop PNL procedures for implementation of the Reliability Assurance Program tasks described herein.
- . Periodically review PNL and contractors' reliability assurance programs, plans, and procedures, and initiate changes as required.
- . Develop orientation and training programs as part of the implementation of the Reliability Assurance Program.
- . Assist in the review of design and test criteria.
- . Prepare proposed contractual direction as necessary to implement the Reliability Assurance Requirements for the FFTF.⁽²⁾
- . Evaluate reliability assurance capability of proposed contractors.
- . Provide liaison with other LMFBR Program activities in the field of reliability assurance to ensure maximum benefit to FFTF from such activities.

The Reliability Assurance Unit shall concur in all design and test review documents. This concurrence means the cognizant design or test organization has complied with the reliability assurance program requirements and that these reviews have adequately defined design risks and action items.

2.3 RELIABILITY ANALYSIS

The function of reliability analysis is assigned to the Reliability Analysis Unit under the Deputy Project Manager for Nuclear and Systems Engineering (Figure 1). Functions of the Reliability Analysis Unit include apportionment, prediction and assessment of quantitative reliability and the technical interpretation of these functions to provide engineering guidance to cognizant PNL organizations for appropriate application. These functions, in direct support of PNL Engineering and Safeguards efforts, may be described as:

- . The performance of Reliability and Availability Analysis of systems and alternate designs, including reactor fuel.
- . Allocation of system reliability goals to meet the overall availability goal of 75% for FFTF. Provide Design Engineering with definitions of engineering requirements necessary to reach these goals.
- . Development of mathematical models which will represent the current reliability status of the FFTF.
- . Assist in the development of test programs by applying statistical design of experiment techniques where applicable.
- . Incorporate reliability test and operational information into PNL analytical models.
- . Develop and implement a reporting system for growth of FFTF reliability.
- . Perform analyses in support of reactor safeguards studies.
- . Assist cognizant PNL organization in control of reliability analysis efforts of PNL/FITF contractors.

A technical reliability program for FFTF will be prepared by Nuclear and Systems Engineering.

2.4 PROGRAM RELATIONSHIPS

Besides the Reliability Assurance Program, other PNL/FITF management programs have been defined to provide an integrated approach to management of the FFTF Project. Interfaces between these programs and the Reliability Assurance Program are as follows:

- . The Reliability Assurance Program Plan and the Quality Assurance Program Plan are complementary. The Reliability Assurance Program for FFTF is oriented to the development and demonstration of a reliable design while the Quality Assurance Program is oriented to the quality of FFTF hardware. The coordination of interfaces is assured by

placing the reliability assurance and quality assurance functions in the same organizational component (Product Assurance Section).

- . This program plan also complements the Configuration Management Plan⁽⁴⁾ which is primarily directed to the identification, control, and accounting of engineering release and changes. The Configuration Management Plan will describe those controls on the flow of data and approval documents necessary to establish that a design or program change represents an integrated project position. The Reliability Assurance Program provides methods for assuring the technical adequacy of proposed engineering releases or changes by formal design review.
- . Interfaces between the PNL and contractors' Reliability Assurance program plans are controlled by the requirement upon contractors that their program plans be submitted for PNL approval. The PNL plan is directed to overall PNL project management; the contractors' plans are directed toward implementation of reliability assurance functions in actual design and test activities to the extent stated in the specific contract.
- . Interfaces with other PNL programs such as Procurement, Management Information Systems, etc., will be coordinated as necessary by written policy or procedures.

2.5 CONTROL OF LOWLR TIER CONTRACTORS

PNL contractors (ALC subcontractors) will maintain control of their contractors in accordance with the applicable portions of the Reliability Assurance Requirements for the FPIF.⁽²⁾ These requirements provide for PNL approval of reliability assurance contractual provisions which the PNL contractor proposes to invoke on his contractors. Provisions for PNL audit of subcontractors of any lower tier are provided.

SECTION 3.0 CONTROL OF PNL/FFTF CONTRACTORS

Management control of PNL/FFTF contractor reliability assurance activities is outlined in the task descriptions of this section.

3.1 EVALUATION OF CONTRACTOR RELIABILITY ASSURANCE PROGRAM PLAN

Each major PNL/FFTF contractor (i.e., A-E/CM, RPD) will be required by contract to submit a Reliability Assurance Program Plan for PNL approval within 60 days of contract award.

Formal control of the contractors' program plans will be implemented by defining PNL's approval, review and monitoring functions in contractual provisions. This control will include:

- . Initial approval of contractor program plans
- . Periodic review of contractor program plans
- . Monitoring implementation of contractor program plans
- . Initiation and implementation of necessary corrective action for discrepancies found during review and monitoring.

The PNL/FFTF procedure for review and approval of PNL contractor program plans will ensure a project-wide review with written comments. The procedure will ensure that all comments are resolved within FFTF before being transmitted to the contractor and will provide for review and agreement on replies before final FFTF approval of the contractor's plan.

The Product Assurance Section has the primary responsibility for the content and implementation of a reliability assurance procedure titled "Evaluation of Contractor Reliability Assurance Program Plan."

5.2 CONTROL OF CONTRACTOR TESTING

Contractor development and qualification test documentation consisting of programs, specifications, procedures, and results shall be reviewed and approved by PNL/FFTF organizations.

Review of test specifications will provide assurance that appropriate recommendations of design review evaluation boards have been included. The review of test results will determine whether design changes or test changes are necessary. The feedback between design and testing is an important element of this reliability assurance task.

Contractor implementation of development and qualification test procedures will be audited by PNL/FFTF Development in cognizant areas to ensure conformance to programs, specifications, and procedures.

PNL/FFTF Development is responsible for the content of a procedure describing this task. The reliability assurance procedure title will be "Control of Contractor Testing."

5.3 REVIEW OF CONTRACTOR DESIGN DOCUMENTATION

A procedure shall describe PNL review and approval of contractors' component and system designs, drawings, specifications, calculations, analyses and descriptions. The procedure will also describe how PNL/FFTF will ensure completeness of contractors' design documentation.

PNL/FFTF Design Engineering is responsible for the content of a reliability assurance procedure titled, "Review of Contractor Design Documentation."

5.4 PARTICIPATION IN CONTRACTOR DESIGN REVIEWS

A PNL/FFTF Reliability Assurance procedure shall provide for PNL audit of the contractors' internal design reviews. The

PNL procedure will provide for followup of contractor design review action items or other contractor commitments.

The scheduling of contractor design reviews shall be coordinated by PNL to ensure that the contractor reviews are completed prior to the basic decision points requiring formalization of the design within PNL by PNL design review.

The task procedure shall provide for the use of PNL's design review checklist by the PNL auditor and provide for monitoring of adherence to PNL instructions on the development of failure mode and effects analysis (Section 4.4 and Appendix "C").

Monitoring, scheduling, and participation in contractor's design reviews shall be the responsibility of the PNL organization having cognizance over technical administration of the contract or alternates designated by the manager of that organization.

PNL Design Engineering shall be responsible for the content of this reliability assurance procedure titled "Participation in Contractor Design Reviews."

3.5 REVIEW OF CONTRACTOR ANALYTICAL WORK

A procedure shall define the duties and responsibilities of each PNL/FFTF organization to review and approve analytical work by contractors in areas of their technical responsibility. For instance, the review of stress analyses will normally be performed by Design Engineering and most nuclear safety analyses will normally be performed by Nuclear and Systems Engineering. Design Engineering has the responsibility for content of a reliability assurance procedure titled "Review of Contractor Analytical Work."

3.6 CONTROL OF CONTRACTOR MATERIALS APPLICATION

The contractors' materials selection program, materials lists, materials specifications, and materials applications reviews shall be evaluated by PNL to ensure that satisfactory materials have been selected for FFTF construction.

PNL will participate in selected materials applications reviews of contractors, will develop materials qualification standards and will issue a Design Data Book for reference use by FFTF designers.

A PNL materials control procedure will define the process of reviewing and qualifying a new material in a given application. The procedure shall assure that the design contractor has investigated such items as:

- . Mechanical properties
- . Previous application of materials
- . Available corrosion data
- . Dependability of data sources
- . Environmental conditions
- . Fabricability, weldability
- . Necessary development testing
- . In-service inspectability problems
- . Compatibility with cleaners and decontaminants, etc.

PNL Development has responsibility for content and implementation of reliability assurance procedure titled "Control of Contractor Materials Applications."

3.7 DEVELOPMENT OF DESIGN REQUIREMENTS DEFINING QUANTITATIVE PRODUCT RELIABILITY

The PNL/FFTF Reliability Analysis Unit will determine the quantitative goal for the desired reliability of certain systems or system components. This goal will be described for the design contractor in terms of product design requirements, desired performance or how performance is to be demonstrated by test.

PNL/FFTF Design Engineering is responsible for the content of a reliability assurance procedure titled "Development of Design Requirements Defining Quantitative Product Reliability."

3.8 SPECIFICATION OF DATA REQUIRED FOR FFTF OPERATION

Data requirements from contractors shall be established for the FFTF operating organization.

These data consist of such items as:

- . Operating and maintenance procedures
- . As-built drawings
- . Spare parts lists and specifications
- . Operator training material
- . Regulatory documents
- . Test data

The FFTF Operations Planning and Review group has the responsibility for determining the extent of the data required from design contractors and incorporating these data requirements in contracts. A procedure will be prepared only if it is determined to be necessary for proper implementation of the task.

3.9 PREAWARD EVALUATION OF DESIGN CONTRACTORS

A procedure and checklist for preaward evaluation of contractor capability in reliability assurance work will be issued to provide for uniform evaluation of different organizations. The checklist will be oriented to the "Reliability Assurance Requirements for the FFTF"⁽²⁾ and will review past work as well as organization and capability for future work.

Responsibility for content and implementation of a procedure rests with PNL/FFTF Product Assurance.

This procedure will be titled "Preaward Evaluation of Design Contractors."

SECTION 4.0 PNL DESIGN REVIEW

The tasks described in this section (4.0) outline PNL's design review activities for designs produced by contractors and PNL/FFTF "in-house" organizations.

A formal design review shall be accomplished for each of the FFTF systems (See Appendix "D"). Additional design reviews, formal or informal, may be conducted for the inter-face operation of two or more systems, for facilities or components or for any problem that might be defined and require analysis. As a minimum, formal design reviews shall be held as part of the approval of preliminary and detailed system designs. The tasks described in this section should not be interpreted as precluding informal or day-to-day communications between the design contractor and cognizant PNL personnel.

Unless otherwise noted, the primary responsibility for implementation of tasks described in this section (4.0) shall rest with Design Engineering except for specific design responsibilities assigned to Nuclear and Systems Engineering.

Design Engineering has the responsibility for the content and implementation of procedures for the following design review tasks unless otherwise noted.

4.1 CONDUCTING PNL DESIGN REVIEW

The procedure for this task shall define how and when design reviews will be scheduled, who will participate (make-up of design review evaluation boards) and shall include a comprehensive checklist which will serve as a guide for preparing and guiding meeting agendas.

The procedure shall ensure that all information for the review is received, organized, and reviewed in depth prior to any meeting. Advance information shall be used by participants to determine position and answer questions relative to the proposed design. Written comments and written resolutions shall be developed prior to any meeting to save time and allow concentration on issues of major contention.

The control of action items or commitments resulting from PNL or contractor design reviews shall include the assignment and acceptance of responsibility for action and the determination of end dates for actions.

The procedures shall include a definition of functions of the design review evaluation boards including the duties and responsibilities of the members and chairman. The title of the reliability assurance procedure will be "Conducting PNL Design Reviews."

4.2 EVALUATION OF PROPOSED DESIGN CHANGES

The procedure for this task shall describe how design changes will be evaluated. The procedure shall ensure that the change evaluation is as thorough as the initial review of the subject design feature.

A design change is any change to a previously established RDT/PNL baseline. Also, any change to material submitted to the AEC's Division of Reactor Licensing (DRL) shall be a design change whether or not a previous design baseline is affected.

The title of the reliability assurance procedure for this task will be "Evaluation of Proposed Design Changes."

The documentation of changes to a baselined design are subject to control by the Configuration Management Plan.⁽⁴⁾

4.3 CONTROL OF DESIGN INTERFACES

A primary management function in PNL is ensuring that design interfaces between contractors and between systems or work packages are identified, controlled, and evaluated. A procedure for ensuring compatible designs across these interfaces shall be prepared. PNL/FFTF Design Engineering is responsible for identification and management of design interfaces and for the implementation and content of reliability assurance procedure titled "Control of Design Interfaces."

The actual control of documentation flow covering design interfaces will be covered in the Configuration Management Plan⁽⁴⁾ and is the responsibility of the PNL Project Programming and Analysis Section.

4.4 PREPARATION OF FAILURE MODE AND EFFECTS ANALYSIS

A procedure for the preparation of Failure Mode and Effects Analyses (FMA) by PNL design organizations will be issued. This procedure will guide the cognizant PNL systems engineer in the evaluation of FMA's prepared by contractors. The procedure will also be used to prepare FMA's for designs (i.e., fuel development) which are prepared "in-house" by PNL.

The Failure Mode and Effects Analysis is designed to provide a specific input to the design review process by identifying:

- . Modes of Failure
- . Causes of Failure
- . Preventive Design Features
- . Effects on other systems
- . Designers' recommendations for tests or analyses to establish adequacy of preventive design features
- . A basis for determination and estimation of failure rates where practicable.

The procedure for this task shall specify when in the design process the FMA is prepared, how it will be revised and who performs the work.

Nuclear and Systems Engineering shall have primary responsibility for content of this reliability assurance procedure titled "Preparation of Failure Mode and Effects Analysis." Appendix "C" contains descriptive material which provides further guidance on preparation and use of Failure Mode and Effects Analysis.

4.5 ACCEPTANCE AND EVALUATION OF DESIGN RISKS

The system designer (PNL or contractor) shall identify design risks during or prior to design review. Accepted design risks are those design decisions made without benefit of objective evidence which provides verification of the design. After bringing the best judgment possible to bear on a problem, identified design risks are sometimes taken because:

- . Effects on the project safety or reliability are negligible
- . The cost of design verification is prohibitive because of effects on schedule or cost
- . A technically acceptable test cannot be performed to verify design prior to reactor operation
- . The system is accessible for maintenance without prohibitive reactor outage time or cost
- . No alternate design course is feasible.

Approval of the design by PNL and the AEC indicates acceptance of the identified design risks. A reliability assurance procedure shall be issued with the title of "Acceptance and Evaluation of Design Risks."

4.6 APPLICATION OF PUBLISHED STANDARDS, CODES, AND SPECIFICATIONS

In the process of establishing design requirements, each designer shall clearly identify the planned use of published standards, codes, and specifications. Uniform application of such documents will be achieved by comparison with interfacing systems, and where useful, approved lists of such documents shall be prepared for designers (contractors or PNL). The reliability assurance task in this area is to ensure clear identification of published standards, codes, and specifications used in design and ensure uniform application of these documents. If necessary, a reliability assurance procedure will be developed controlling the format and detail of identification and the method for establishing and changing approved lists of standards, codes, and specifications.

SECTION 5.0 PNL/FFTF TESTING

FFTF Testing categories which develop assurance of reliability are:

- . Development tests
- . Qualification tests
- . Preoperational tests for systems
- . Initial power tests for reactor.

Other tests relating to quality of manufactured products are described in the Quality Assurance Program Plan and Procedures.

In the following tasks the development and qualification testing for FFTF fuel is the specific responsibility of Nuclear and Systems Engineering. Consequently, implementation of testing tasks and procedures for fuel is the responsibility of Nuclear and Systems Engineering rather than the organizations indicated in the following tasks.

5.1 CONTROL OF FFTF TESTING

PNL/FFTF will conduct development and qualification test reviews and will periodically review test programs for FFTF.

The reliability assurance procedure for this task will provide for:

- . Uniform and complete reviews
- . Documentation of results of reviews
- . Feedback between design and test activities
- . Test programming in accord with design activities.

PNL/FFTF Development or Design Engineering has the primary responsibility for implementation of this reliability assurance procedure in cognizant areas. PNL/FFTF Development

has primary responsibility for content of this reliability assurance procedure titled "Control of FFTF Testing."

5.2 DEFINITION OF TEST REQUIREMENTS AND MEASUREMENT OF RELIABILITY

Design Engineering shall specifically define test requirements so that the preparation and review of test specifications, test procedures and test reports can be objective.

These test requirements will then be implemented by PNL/FFTF Development in cognizant test programs. Individual test specifications shall be supported, as necessary, by statistical analyses performed by Nuclear and Systems Engineering to assure that the maximum valid information is obtained. Following the test, the reports will be analyzed by PNL/FFTF Development to determine conformance to established requirements and by PNL/FFTF Design Engineering to evaluate applicability to design. Test data shall be used where possible to form an assessment of reliability, along with a confidence level for the system, subsystem, or component under consideration. This assessment will be made by the Reliability Analysis Unit of Nuclear and Systems Engineering to determine the degree of conformance to any previously established reliability goals. Also the quantitative assessment of reliability will become an input into design review by PNL.

The content of this procedure titled "Definition of Test Requirements and Measurement of Reliability" will be the responsibility of PNL/FFTF Design Engineering.

5.3 PREOPERATIONAL AND INITIAL POWER TESTING

The Reliability Assurance Program during preoperational and initial reactor power testing shall:

- . Assure that the content and control in the test procedures is consistent with the design requirements of the component or system

- . Assure the feedback and complete analysis of test malfunctions to determine what design or manufacturing features caused the problem and how future malfunctions can be prevented
- . Assure the feedback and analysis of all system test data for the development and demonstration of reactor operating and maintenance procedures
- . Assure the development of initial operating specifications.

Preoperational and initial power testing assures that completed FFTF systems and reactor operating procedures meet design requirements. Implementation of tasks in this area will be described in an outline of a program. The actual procedures will be developed prior to the start of preoperational testing.

The content of this outline plan will be the responsibility of PNL/FFTF Operations Planning and Review.

5.4 TEST FAILURE RECURRENCE CONTROL

The follow up on failures in development and qualification testing will be described in a reliability assurance procedures titled "Failure Recurrence Control." The procedure will provide for reviewing the cause of failure and implementing corrective action to prevent recurrence. This reliability assurance procedure shall also specify the methods and responsibilities for providing necessary design changes to equipment under test. PNL/FFTF Development is responsible for determining the content and implementing this procedure. Design Engineering will be responsible for making necessary design changes and changes to test requirements.

SECTION 6.0 TRAINING

The effectiveness of the PNL Reliability Assurance Program is dependent on adequate indoctrination of those PNL/FFTF personnel performing reliability assurance tasks. Necessary indoctrination will be conducted. Details will be described in a procedure on reliability assurance indoctrination. Product Assurance Section has the responsibility for the content of this procedure titled "Reliability Assurance Training."

SECTION 7.0 DOCUMENTATION

The categories of reliability assurance documentation submitted by PNL contractors are as follows:

- . Documentation requiring PNL approval prior to the contractor implementing such documents
- . Documentation submitted to PNL for information for the purpose of reporting on current design, analytical and test programs, progress, and planning. PNL has the option of disapproving actions by the PNL contractor which are reported in "information" documents.

Data, including the reliability assurance required documentation submitted by PNL contractors, will be processed within the PNL/FFTF Configuration and Data Management Unit of the Project Programming and Analysis Section. Data and reports shall be maintained by data control personnel within the Configuration and Data Management Unit. The details of how the data are processed and handled will be described in the PNL/FFTF Program Documentation Requirements Plan. Reliability Assurance Program related documents, which are submitted to PNL for approval and information, are listed in Appendix "E".

7.1 CONTROL OF CHANGES TO DOCUMENTATION

Changes to data requiring PNL approval prior to implementation shall be processed and coordinated by PNL's Configuration and Data Management Unit. The scope of the data and the details of how this is accomplished will be described in the PNL Configuration Management Plan for FFTF. The Reliability Assurance Unit is responsible for monitoring and determining documentation changes when approval category, content, frequency, or necessity of issue are considered to be inadequate.

Changes to documentation requirements shall have the concurrence of all cognizant PNL organizations.

Any necessary procedures will be developed as part of the Configuration Management Plan.

7.2 INITIATION OF ENGINEERING CORRECTIVE ACTION

A reporting system will be developed for providing project personnel with a mechanism for informing cognizant FFTF organizations of any observed design, development or test deficiencies. Coordination of this task within PNL will be described in a procedure titled "Engineering Corrective Action Request." This procedure shall include provisions for initiation of the Engineering Corrective Action Request (ECAR); signoff of the ECAR by the initiator's unit manager; processing of the ECAR through the Configuration and Data Management Unit to the cognizant engineering activity for action; and follow up by the Reliability Assurance Unit to assure timely implementation of necessary corrective action. In order that such reporting be constructive, a recommendation for solution should accompany the original report. Product Assurance Section shall be responsible for the content of this procedure. However, the procedure itself will be included as part of the Configuration Management Plan.

REFERENCES

1. Letter, M. Shaw to D. G. Williams, "Fast Flux Test Facility - Program Direction," January 28, 1966.
2. "Reliability Assurance Requirements for the FFTF," July 28, 1967.
3. "Quality Assurance Requirements for the FFTF," August 4, 1967.
4. "FFTF Configuration Management Plan," November 15, 1967.

APPENDIX A

GLOSSARY OF TERMS

APPENDIX A

GLOSSARY OF TERMSACTION ITEM

Any assigned task or commitment resulting from a design review which must be completed before referring the design to higher authority. An unresolved action item at the time of referral to higher authority must be reported as a design risk.

BASLLINE

An approved and defined point of departure for the control of future changes in system or equipment performance and design. A baseline is documented by specification and other documents and is technically defined by formal approval of them.

CONTRACTOR

Any person, partnership, company or corporation (or any combination of these) which is a party to a contract with PNL.

DESIGN REVIEW

The process consisting of examination, comment, evaluation, and resolution which ensures that any given design (drawing, specifications, or analyses) describes hardware meeting desired performance characteristics.

DESIGN RISK

An identified design characteristic which has been incorporated into a design without sufficient objective evidence verifying design adequacy. Design risks are to be specifically identified in design descriptions.

DESIGN SPECIFICATION

A document prescribing criteria to be satisfied in designing a particular part, component, subsystem, system, or facility. Typical criteria include performance requirements under specified environmental conditions, interface requirements, size, weight, ruggedness, etc.

DEVELOPMENT TESTING

Early materials or product testing done to establish confidence in design and determine functional capabilities of parts or assemblies. Hardware is generally of bread-board or custom-made origin.

FFTF

The USAEC's Fast Flux Test Facility being built as a part of the Commission's Liquid Metal Fast Breeder Reactor Program (LMFBR).

MATERIAL REVIEW

The process of examination, comment, evaluation, and resolution which ensures that any specification of materials for any FFTF component or system is adequate for the application.

PNL

Pacific Northwest Laboratory operated by Battelle Memorial Institute. "PNL/FFTF" refers to the Fast Flux Test Facility Project organization within the Pacific Northwest Laboratory.

PREVENTIVE DESIGN FEATURE

Any feature of a component or system design which precludes occurrence or mitigates the consequences of a possible failure.

QUALIFICATION TESTING

Component testing used to demonstrate adequacy of both production process and design. Production drawings, tooling and processes are used in fabrication of components for qualification testing.

RELIABILITY

The capability of a facility, system, subsystem, component, or part to perform its intended functions during its design life without failure. (Note: The mathematical definition is a probability of performance without failure for a specified period of operating time.)

RELIABILITY ANALYSIS

The analytical function which applies engineering and statistical analysis to the improvement of system reliability by use of failure and operating data from all phases of development, design, production, and operation.

RELIABILITY ASSURANCE

A systematic approach to the design, development, and test effort to assure that parts, components, subsystems, systems, and facilities are obtained with a high degree of reliability.

SYSTEM

One of the principal functioning entities comprising project hardware and related operational services within the FFTF Project. Ordinarily, a system is the first major subdivision of project work. Similarly, a subsystem is a major functioning entity within a system. (A system may also be an organized and disciplined approach to accomplish a task, e.g., a failure reporting system.)

TEST REVIEW

The process consisting of examination, comment, evaluation, and resolution which ensures that any given test program, specification, procedure or result adequately defines or reports on test requirements.

APPENDIX B

RELIABILITY ASSURANCE TASKS AND PROCEDURES

APPENDIX B

RELIABILITY ASSURANCE TASKS AND PROCEDURESDESIGN ENGINEERING

- . Review of contractor design documentation (3.3)
- . Participation in contractor design reviews (3.4)
- . Review of contractor analytical work (3.5)
- . Development of design requirements defining quantitative product reliability (3.7)
- . Conducting PNL design review (4.1)
- . Evaluation of proposed design changes (4.2)
- . Control of design interfaces (4.3)
- . Acceptance and evaluation of design risks (4.5)
- . Application of published standards, codes, and specifications (4.6)
- . Definition of test requirements and measurement of reliability (5.2)

NUCLEAR AND SYSTEMS ENGINEERING

- . Preparation of failure mode and effects analysis (4.4)

DEVELOPMENT

- . Control of contractor testing (3.2)
- . Control of contractor materials application (3.6)
- . Control of FFTF Testing (5.1)
- . Test failure recurrence control (5.4)

PROJECT PROGRAMMING AND ANALYSIS (OPERATIONS)

- . Specification of data required for FFTF operation (3.8)
- . Preoperational and Initial Power testing (5.3)
- . Control of changes to documentation (7.1)

PRODUCT ASSURANCE

- . Evaluation of contractor reliability assurance program plan (3.1)
- . Preaward evaluation of design contractors (3.9)
- . Training (6.0)
- . Initiation of engineering corrective action (7.2)

APPENDIX C

PREPARATION AND USE OF FAILURE
MODE AND EFFECTS ANALYSIS

APPENDIX C

PREPARATION AND USE OF
FAILURE MODE AND EFFECTS ANALYSIS

The following descriptive material is included here to guide the preparation of a procedure for this task.

The Failure Mode and Effects Analysis (FMA) is the primary means, prior to occurrence of failure modes in testing, of identifying potential failure modes and reviewing adequacy of preventative design features. It is the means of determining the probable effect of all failures on reactor operation, including those identified by analysis and those identified by previous test failures. This permits the focusing of maximum effort by all project disciplines on the most critical problem areas as determined by a systematic analysis technique and evaluation of preventative design features. The Failure Mode and Effects Analysis therefore forms the basis for the overall system of identifying and correcting design, fabrication and construction problems. It will be revised and updated based on test results, operating reports, failure reports, design reviews, etc., to further define failure modes and the status of corrective action to remove their causes. The object of the FMA is to ensure that all critical failure modes, and their respective causes, are identified and preventive design features provided prior to critical points in the program. The FMA will serve as a basis for design review, for test planning, as well as for determining the adequacy of design for the next higher order component or system. Thus, the satisfactory resolution of all problems indicated in the FMA will be requisite to design completion.

PNL/FFTF will coordinate efforts with principle PNL contractors to ensure that analyses are consistent, particularly on items affecting interfaces and successful operation. Development and use of Failure Mode and Effects Analyses during a reactor design-build-use cycle will be implemented in the following manner: At the Preliminary Design, preliminary FMA's will be utilized as input to design reviews and design selection. As the design progresses, the FMA's will be updated. The FMA for an item (component, subassembly) will be completed prior to assembly, assuring the timely input of results of this effort into a final design review for the item in question. The procedure will define when and how FMA's are to be noted as events on individual PNL PERT fragnets. Performance of Failure Mode and Effects Analysis includes:

- (1) Identification of the parts, component, subsystem or system
- (2) Determination of the function for each item
- (3) Determination of possible modes of failure
- (4) Determination of the effects of each failure mode at the system level of investigation and at a higher level, where appropriate
- (5) Determination of possible causes of each failure mode
- (6) Estimating the probability of a component failure mode when so directed by PNL systems engineer
- (7) Providing recommendations or comments relative to removal of the failure mode cause (preventive design features)
- (8) Documentation of analyses on suitable forms and transmittal of results to cognizant organizations
- (9) Obtaining feedback on recommendations resulting from the analyses
- (10) Issuing status reports.

Failure Mode and Effects Analysis will be used for the following:

- (1) Serve as a checklist item in design reviews to ensure that all critical failure modes have adequate preventive design features.
- (2) Provide input to safety evaluations.
- (3) Provide guidance for development and qualification test planning.
- (4) Provide a basis of total system evaluation, including the facilities necessary for testing.
- (5) Develop requirements for further evaluation.
- (6) Provide an input to the various Quality Assurance activities.
- (7) Provide input to Reliability Analysis for prediction of system and plant availability.

APPENDIX D

FFTF SYSTEMS

APPENDIX D

FFTF SYSTEMSGroup 10 Electrical Systems

- 11 Primary Electrical Power System
- 12 Building Electrical Power System
- 13 Reactor Safety System
- 15 Communications System
- 16 Lighting System
- 17 Wiring System

Group 20 Structures, Utilities and Containment

- 21 Structures
- 22 Site Facilities
- 23 Service Piping Systems
- 24 Radioactive Waste System
- 25 Heating and Ventilation System
- 26 Plant Fire Protection System
- 27 Reactor Containment System

Group 30 Reactor

- 31 Reactor Core Component
- 32 Reactor Vessel and Shielding Components
- 33 Reactor Nuclear Control System
- 34 Nuclear Proof Test Facility
- 35 Fuel Subassembly Component

Group 40 Fuel Handling and Radioactive Maintenance Systems

- 41 Reactor Refueling System
- 42 Nonirradiated Fuel Handling System
- 43 Irradiated Fuel Handling System
- 44 Radioactive Maintenance System

Group 50 Heat Transport Systems

- 51 Primary Heat Transport System
- 52 Secondary Heat Transport System
- 5X Emergency Cooling System
- 5Y Fuel Decay Storage Cooling System

Group 60 Irradiation Test Facilities

- 61 Closed Loop System (Mark I)
- 67 Open Test Position Facility
- 68 Short-Term Irradiation Facility

Group 70 Examination Facilities

- 71 Inert Gas Cell Examination Facility
- 72 Underwater Cell Examination Facility
- 74 Water Treatment System for Underwater
 Examination Facility

Group 80 Sodium and Inert Gas Receiving and Processing Systems

- 81 Sodium Receiving and Processing Systems
- 82 Inert Gas Receiving and Processing Systems

Group 90 Instrumentation and Control Systems

- 91 Control and Data Handling System
- 92 Reactor Channel and Vessel Instrumentation System
- 93 Plant Instrumentation Components
- 94 Fuel Failure Monitoring System
- 95 Flux Monitoring and Control System
- 96 Radiation Monitoring System

APPENDIX E

SUMMARY OF TECHNICAL DOCUMENTATION

APPENDIX E

SUMMARY OF TECHNICAL DOCUMENTATION

The following list summarizes various items of documentation and their revisions required of FFTF contractors by the Reliability Assurance Requirements for the FFTF.⁽²⁾

ITEMS FOR PNL APPROVAL

- Design Drawings
- Data on Subcontractors Selected after Approval of Reliability Program Plan
- Reliability Program Plan
- Design Descriptions
- Design Specifications
- Analytical Computer Program Methods and Assumptions
- Design Analysis Reports
- Construction, Fabrication, Inspection and Procurement Specifications
- Approved Materials Lists
- Test Program
- Test Specifications, Test Procedures and Test Reports
- Failure Corrective Action Report
- Other Items as Specified by Contract

ITEMS FOR PNL INFORMATION

- Design Calculations
- Reliability Program Review
- Failure Mode and Effects Analysis
- Maintenance Procedures
- As-Built Drawings
- Recommended Spare Parts Lists
- Design Review Reports (PNL Contractors)
- Design Review Reports (PNL Subcontractors)
- Failure Reports
- Failure Analysis Reports

Materials Program Progress Report
Materials Application Reviews
Test Program Review Reports
Progress Reports
Other Items as Specified by Contract