Pacific Northwest
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FFTF Acceptance and Startup Testing for GAIN

March 2022

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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Executive Summary

The Fast Flux Test Facility (FFTF) is the most recent liquid metal reactor (LMR) to be designed, constructed, and operated by the U.S. Department of Energy (DOE). The 400-MWt sodium-cooled, fast-neutron flux reactor plant was designed for irradiation testing of nuclear reactor fuels and materials for liquid metal fast breeder reactors. Following the demise of the breeder reactor program in the United States, FFTF continued to play a key role in providing a test bed for demonstrating performance of advanced fuel designs and demonstrating operation, maintenance, and safety of advanced liquid metal reactors. FFTF operations ceased in April 1992 after a determination by DOE that no combination of proposed missions was financially feasible over a ten-year period. The reactor is currently deactivated and in a long-term surveillance and maintenance (S&M) mode.

This report provides information on the extensive and rigorous process that was used to conduct turnover from construction followed by acceptance and startup testing of the FFTF. This paper is in support of the Gateway for Accelerated Innovation in Nuclear (GAIN), which provides the nuclear energy community with access to the technical, regulatory, and financial support necessary to move new or advanced nuclear reactor designs toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet. The information obtained from the design, startup, and operation of the FFTF provides valuable insight for follow-on reactor projects, such as the Versatile Test Reactor (VTR), in the areas of plant system and component design, component fabrication, fuel design and performance, prototype testing, site construction, reactor startup and operations, and reactor deactivation and decommissioning (D&D). The focus of this report is on the process used to startup the FFTF and to ensure that operations could be conducted efficiently and safely. A reference section is provided of documents detailing the successful turnover and testing process implemented for startup of the reactor and its supporting systems. The documents listed can be retrieved upon request and are believed useful for future reactor startup endeavors.

Acronyms and Abbreviations

AI	Atomics International
AMCO	Aerojet Manufacturing Company
ARD	Advanced Reactor Division
CT	Construction Test
DOE	U.S. Department of Energy
DR	Data Report
DTRF	Data Transmittal and Routing Form
ECN	Engineering Change Notice
ER	Evaluation Report
ERDA	Energy Research and Development Administration
FFTF	Fast Flux Test Facility
FFTFPO	Fast Flux Test Facility Project Office
FSAR	Final Safety Analysis Report
FTE	FFTF Test Engineering
GAIN	Gateway for Accelerated Innovation in Nuclear
GCTP	General Construction Test Procedure
HEDL	Hanford Engineering Development Laboratory
KCTP	Key Construction Test Procedure
LMR	Liquid Metal Reactor
LMFBR	Liquid Metal Fast Breeder Reactor
MTER	Multi-Test Evaluation Report
MW	Megawatt
NE	Nuclear Energy
NR	Nonconformance Report
P&ID	Piping and Instrumentation Diagram
PRB	Project Review Board
QA	Quality Assurance
QC	Quality Control
RP	Release Point
SDD	System Design Description
SRRC	Standing Results Review Committee
TRRT	Test Results Review Team
TI	Test Instruction
VTR	Versatile Test Reactor
WHC	Westinghouse Hanford Company

Contents

1.0 Introduction

The Fast Flux Test Facility (FFTF) underwent a systematic and comprehensive startup of each plant system to verify that the design, documentation, installation, and operation conformed to the design and safety requirements specified in the System Design Documents (SDDs) and the Final Safety Analysis Report (FSAR). Formal testing began in 1978 with some preliminary testing conducted as early as 1974. The Acceptance Test Program was officially completed in 1982. The architect-engineer and prime constructor of FFTF was the Bechtel Corporation, who was also the design contractor for some of the plant auxiliary systems. The main design contractor for the reactor was the Westinghouse Advanced Reactor Division (ARD) with many of the reactor support systems designed by Atomics International (AI) and Aerojet Manufacturing Company (AMCO). When the AI and AMCO designs were completed, the Hanford Engineering Development Laboratory (HEDL) assumed responsibility for their designs through the construction and startup phases. The overall startup activities were controlled by the Westinghouse Hanford Company (WHC), which managed HEDL for the U.S. Department of Energy (DOE). The DOE project control of FFTF was managed through a local project office, the FFTFPO. A Testing and Operations Organization was established to manage and direct the startup activities which included the following key groups: FFTF Test Engineering (FTE), FFTF Operations, and FFTF Maintenance. The testing process consisted of three types of tests: construction tests, pre-turnover engineering tests and acceptance tests. The first two types of tests were conducted prior to formal turnover of a plant system from Bechtel to HEDL and the acceptance tests were then performed after turnover. Because the timing of system turnovers varied, it was not uncommon for all three types of tests to be concurrently run during the startup period. The overall project direction from DOE was to establish the minimum scope and time span needed to complete the acceptance testing in a safe and technically adequate manner to achieve a full-power demonstration run as early as possible. The goal was to make the reactor available to test sponsors for irradiation testing. This report provides an overview of the entire test program and discusses key processes and documents that were implemented for the successful startup of the reactor facility.

2.0 FFTF Test Plan

The main document for control of the FFTF startup testing was MG-35, *The FFTF Startup Test Plan* (Reference 1), which describes the administrative procedures used and the general responsibilities of the various organizations involved. Test Instruction (TI) documents provided added details to the requirements stated within the Test Plan. TIs were prepared by the FFTF Test Engineering (FTE) organization, reviewed by FFTF Operations, Maintenance, and Engineering, as well as by HEDL Quality Assurance and organizations such as Bechtel and Safety, as determined to be necessary. The TIs were submitted to DOE for information following this review and approval process. Ten TIs were used during the Acceptance Test Program at FFTF, including:

TI-1 FFTF Test Instruction Turnover

This test instruction describes the procedure used for the turnover of FFTF systems and facilities from the construction contractor, Bechtel, to HEDL following completion of construction testing. Turnover represented the transfer of custody (responsibility for operation, maintenance, and safety) of a portion of the plant from the construction contractor to the operating contractor, HEDL. The transmittal and acceptance of a Bechtel prepared turnover package provided a sharp, well-defined interface for transfer of responsibility following the completion of construction and the evaluation of construction test results by Bechtel. Custody was turned over to HEDL by means of a Turnover Package Release which was part of the turnover package. This process is described in detail in Reference 2.

TI-2 Performance of Pre-Turnover Engineering Tests During FFTF Construction

This test instruction established the guidelines that were followed preparing for and conducting pre-turnover engineering tests at FFTF. Pre-turnover engineering tests were those tests performed during plant construction which did not clearly fall in the established categories of Construction Testing or Acceptance Testing because they were performed by a combination of Bechtel and HEDL personnel. These were tests that had to be performed before system turnover, at a particular step in the construction sequence, before further assembly made later testing and correction of problems impractical or impossible. They were performed under HEDL direction because of the close intertie with subsequent acceptance testing, the need for special equipment, and the design verification nature of the tests. Examples of pre-turnover engineering tests include measurement of the reactor cavity liner venting capability, head compartment component seal leak rate tests, and special dimensional surveys. The requirements for this type of test are described in detail in Reference 3.

TI-3 FFTF Acceptance Test Execution Guidelines

This instruction (Reference 4) provided specific directions to be followed by participating organizations in executing their responsibilities related to acceptance testing at FFTF. Topics include preparations for testing (e.g., test procedures, test equipment) and

conduct of testing (e.g., witnessing, test exceptions, procedure compliance and change control, retesting, and documentation of test completion).

TI-4 Processing of Test Specifications and Test Procedures

This test instruction (Reference 5) established the guidelines to be followed in processing acceptance test specifications and procedures from initial preparation to initial approval. The purpose of TI-4 was to communicate to all acceptance test program participants the prescribed instructions for the handling of test documents, and to provide guidelines on how to prepare and review these documents to ensure control document quality. The acceptance tests were divided into four categories (A, B, C, and D) to clearly define the responsibility for the preparation, review, and approval of test documents. The category designated generally reflected the effect a particular test had on the overall plant operation. All test specifications for Category A, B and C tests were submitted by FFTF Engineering to the Energy Research and Development Administration (ERDA) for technical approval following the prescribed HEDL approvals. All test procedures were approved by FFTF Test Engineering (FTE). However, certain acceptance tests were identified for special approval action by ERDA and by FFTF Engineering and HEDL Safety Analysis. These tests generally had nuclear safety implications and were identified in each case by joint agreement between the approving organization and FTE. A list of these test procedures is provided in Appendix C of Reference 5.

TI-5 Use of FFTF Tagout Procedures for Acceptance Testing

This test instruction (Reference 6) describes the tag-out procedures used at FFTF and how the test engineer was to use these procedures in conjunction with the test program. Attached to this instruction are the tag-out procedures used by Bechtel and HEDL and samples of the tags used by both organizations at FFTF. Some of these tags included: 1) Bechtel green status “Turnover Tags” that identified equipment released and turned over to HEDL for test and operations, 2) HEDL red status “Hold Tags” that HEDL used in conjunction with a nonconformance report (NR) to identify nonconforming equipment, and 3) Bechtel safety tags such as “Danger – Do Not Operate” to prohibit operation of equipment that could cause injury.

TI-6 Test Logs and Data Collection

This test instruction (Reference 7) outlines the procedures that were followed in documenting the performance of an acceptance test in FFTF. Included are guidelines that were used to prepare and maintain test logs and for recording and collecting data during the performance of FFTF acceptance testing. These instructions applied to all tests performed during the acceptance testing period.

TI-7 Preparation and Processing of Test Reports

This test instruction (Reference 8) defined the preparation and processing of Data Reports (DR’s) and Evaluation Reports (ER’s) developed in the acceptance test

program. The general contents of these reports and directions on how they were prepared and processed for review and approval are discussed.

TI-8 Startup System Scoping Instruction

This instruction (Reference 9) defines the philosophy and mechanics of scoping and the responsibilities of Bechtel and FFTF Test Engineering (FTE). Scoping subdivided the FFTF Piping and Instrumentation Diagrams (P&ID's), electrical single line drawings, electrical schematics, instrument loop diagrams, pull block diagrams, and preheat heater control drawings into startup systems. The startup systems were subsystems of SDD systems which were developed to further break down the SDD boundaries as necessary for construction tests and turnover packages. Since the criteria for selecting startup system boundaries was somewhat different than for design purposes, startup system boundaries in some cases crossed SDD boundaries.

TI-9 FFTF Calibration, Grooming & Alignment Program

This test instruction (Reference 10) defines the initial FFTF calibration, grooming and alignment program. Included are the instructions used for scheduling, conducting, and documenting the calibration, grooming and alignment of FFTF components and systems during the FFTF acceptance testing period. Group and individual personnel responsibilities were also delineated in this test instruction.

TI-10 Obtaining of Test Fixtures to Support FFTF Testing

This test instruction (Reference 11) describes the procedure that was used for defining, designing, and obtaining special test fixtures required to support FFTF construction and the acceptance test program. These test fixtures did not become part of the permanent plant equipment so the procedures for design and procurement were less stringent than those for permanent plant components.

3.0 Construction Testing

Construction testing was conducted by Bechtel on all portions of the FFTF to assure that construction was completed in accordance with the drawings and specifications. Construction testing did not require operation of any equipment or performance of any system operations. Successful construction testing was a prerequisite for acceptance of portions of the FFTF by HEDL from Bechtel. Following this turnover, further testing to provide confirmation of design, performance and operating procedures was performed by HEDL during plant acceptance testing.

The Bechtel construction organization included: Bechtel Field Construction who prepared procedures, system test matrices, conducted testing, and submitted test results to HEDL; Bechtel Field Quality Assurance/Quality Control reviewed procedures, conducted field inspections, maintained auditable test results, conducted compliance audits, and verified test completions; and Bechtel Engineering provided technical requirements for construction tests specified in SDDs, design specifications and drawings, and prepared Key Construction Specification procedures. Bechtel's method of conducting the FFTF Construction Test Program is delineated in I-204, *FFTF Site Construction Test Program Documentation Instruction* (Reference 15), and the methods used for planning, preparation, implementation and reporting of test results are discussed within this section.

3.1 Construction Test Documents

Bechtel had responsibility for preparation of all construction related test program documents. HEDL's responsibility was to approve the Construction Test Index (Reference 14), construction test procedures, construction test specifications and to review reports of completed construction tests.

3.1.1 Generic Construction Test Procedure

A Generic Construction Test Procedure (GCTP) provided directions for conducting a general construction test (CT) and for recording the test data. Examples of this type of test include tests of power circuits, control circuit functional tests, and coupling alignment tests. Attachment 1 shows the format for the GCTP that Bechtel used at FFTF. The GCTP contained test directions with adequate detail for any application of the test procedure (e.g., for every application of a test). It also indicated what data needed to be recorded and provided any necessary data sheets. Each GCTP was submitted to HEDL (FTE) for approval.

3.1.2 Key Construction Test Procedure

Some of the CT's were designated as "key" construction tests by HEDL because of their critical or sensitive nature. For these tests, a Key Construction Test

Procedure (KCTP) was prepared providing specific step-by-step instructions on how to conduct and record data from the test of an individual system or component. Examples of KCTP's are procedures describing the pneumatic pressure tests which satisfied ASME Section III code requirements. Bechtel prepared the KCTP's and submitted them to HEDL for approval. FTE would then obtain the necessary reviews and approvals by appropriate HEDL groups (e.g., Operations and Safety) and provided final HEDL approval for each KCTP.

3.1.3 Construction Test Index

The Construction Test Index identifies all the construction tests performed at FFTF. The index (Reference 14) is presented in a matrix format that lists the startup systems and the construction tests that were required on each startup system. All applicable GCTP's and KCTP's are shown in the index. Bechtel prepared the index and HEDL reviewed and approved it, thus documenting HEDL/Bechtel agreement on the scope of the construction testing program.

3.1.4 System Test Matrix

The System Test Matrix was the working tool Bechtel Field Construction used to implement and record the completion of construction tests on specific components within a start-up system. The document was prepared from the Construction Test Index using scoped drawings and listed specific system components in a matrix format which identified the appropriate CT's to be performed on each component. As a result, the complete test procedure package for each startup system consisted of this test matrix supplemented by the applicable GCTP's and KCTP's. The Bechtel Field Organization responsible for a specific system turnover would prepare and monitor the System Test Matrix through completion. HEDL would review and provide comments on the System Test Matrix, but their approval was not required.

3.1.5 Construction Test Schedule

Bechtel scheduled and controlled all construction test activities. The schedules were published by Bechtel to provide the information to the project. HEDL used the information for planning purposes and reviewed the overall construction schedule to verify consistency with the system turnover schedule.

3.2 Construction Test Implementation

Construction testing was conducted by Bechtel or their subcontractors in accordance with HEDL-approved GCTP's or KCTP's as referenced in the System Test Matrix.

Bechtel Field QA/QC verified the inspection steps defined in the CT's. Forty-eight hours prior to a construction test, Bechtel Field Construction would notify HEDL, via a Construction Test Notification Sheet.

A System Test Book was assembled and maintained by Bechtel Field Construction for each start-up system where the test results for the components tested within the startup system were documented. The Test Book was subdivided into sections on Electrical, Mechanical, Piping, Instrumentation, and any other relevant system. The front pages of the Test Book contained the applicable System Test Matrix followed by copies of the construction test data sheets, marked-up system Piping and Instrument diagrams, marked-up system Electrical Line/Schematic diagrams, and any other relevant data that recorded the results of construction testing.

After completion of a construction test, the results recorded on the test data sheets that were included in the GCTP's would be turned over to QA/QC for filing in the QA/QC vault. A copy of the test results data sheet would be retained by Bechtel Field Construction for inclusion in the applicable System Test Book. After completing a KCTP, a similar process was followed except that a copy of the results was submitted to HEDL for information via a DTRF (Data Transmittal and Routing Form). Bechtel QA/QC would audit the completion of required construction tests for a start-up system prior to turn over of the system to HEDL. The QA/QC supervisor would document this audit, which was a prerequisite to turnover. HEDL was responsible for witnessing selected key construction testing activities identified in advance by Bechtel, and to spot check the remaining testing as required to assure control of the effort. FTE reviewed the completeness and technical adequacy of construction testing results for HEDL as part of the turnover process.

4.0 Pre-Turnover Engineering Tests

These tests were conducted on systems or components prior to turnover. They closely resembled acceptance tests as they were often design confirmation tests by nature, but they were performed before turnover to allow optimum sequencing with the acceptance test program while minimizing impact to construction/installation activities. As previously indicated in Section 2.0 (TI-2), these tests had to be performed at a particular step in the construction sequence before further assembly made later testing and correction of problems impractical or impossible. They were performed under HEDL direction because of the close intertie with subsequent acceptance testing, the need for special equipment, and the design verification nature of the tests.

Pre-turnover engineering tests were performed using test methods and procedures in a format generally conforming to that of an acceptance test procedure. FTE was responsible for preparing the test procedure, which was then reviewed internally by FFTF Engineering, QA, HEDL Safety groups as appropriate, and by Bechtel. The Pre-turnover engineering tests were performed by Bechtel, or by Bechtel's subcontractors, under the technical direction of FTE. HEDL supplied the required test equipment and oversaw its proper transport, pre-test calibration and installation in the plant, and Bechtel or its subcontractor crafts supplied the necessary in-plant handling. Throughout the testing, these crafts operated the test equipment on which they were deemed qualified and based on a joint FTE/Bechtel agreement. Otherwise, FTE personnel operated the test equipment. FFTF Operations personnel operated all HEDL-owned plant equipment required to support this testing. Recording of test data and all pertinent test record keeping was the responsibility of FTE. The results of this testing were evaluated by FTE and the appropriate design organization and reported by FTE.

5.0 Turnover

Turnover was the transfer of custody, including responsibility for operation, maintenance, and safety, of a portion of the plant from the construction contractor (Bechtel) to the operating contractor (HEDL). Custody was turned over to HEDL with a turnover package that covered all or part of a startup system or a facility. The transmittal and acceptance of a Bechtel-prepared turnover package permitted a sharp, well-defined interface for transfer of responsibility, following the completion of construction and associated testing by Bechtel.

Correction of a construction or installation deficiency or a design error after turnover was arranged by FFTF Operations. TI-3 (Reference 4) describes how these nonconformances and the test exceptions were identified, tracked, and resolved. In some cases, HEDL crafts were used and in other cases it was necessary to turn the system back to Bechtel for remedial action. In this latter case, a formal Turnback Procedure was followed.

Bechtel was responsible for preparation of the turnover documents, including the definition of package boundaries, required records and reports, and any outstanding nonconformances and open items. The package cover sheet (called the Turnover Package Release) contained the appropriate Bechtel signatures attesting to the accuracy and completeness status of the startup system or facility. Instructions for processing the Turnover Package Release, as well as the method for processing a turnback to Bechtel, are found in TI-1 (Reference 2).

After Bechtel prepared the turnover package, FFTF Construction would provide the initial review of the package information and have the appropriate HEDL organizations including FFTF Engineering, Maintenance, Quality Assurance, Operations, and FTE then review the package and participate in a formal walkthrough of the system to be turned over. Following favorable recommendations from these organizations to accept the turnover (by means of appropriate signatures on the Turnover Package Release), the Manager of FFTF Construction would accept the turnover for HEDL. Even though Turnover acceptance was documented by FFTF Construction, custody of the system or facility was transferred from Bechtel to FFTF Operations, who then assumed responsibility for safety and operation of the system or facility and for assuring that the facility was adequately maintained.

6.0 Acceptance Testing

Acceptance testing was conducted by HEDL personnel following completion of construction testing and turnover to provide confirmation of design, construction, and functional performance of the FFTF. The documentation requirements for the testing program and for individual acceptance tests, as well as the responsibilities of the key startup groups are described in this section.

Acceptance testing was divided into five phases for test planning and scheduling purposes. The phase designation in the individual test number generally classified each test as to its applicability and area of interest. Following is a description of each of the five phases:

Phase 1 – Preoperational Tests

Preoperational tests were performed on components or portions of systems to determine whether the components were ready to support subsequent system tests. They included items such as checking out the operation of individual components to the extent permissible under existing conditions (e.g., checking for correct electric motor rotation, adjusting set points and limit switches, calibration of instrumentation, and the grooming and alignment of electrical and control systems).

Phase 2 – System Startup Tests

System Startup Tests were those tests performed on individual startup systems or portions of systems prior to the preoperational tests and prior to sodium fill and hot functional testing. They were tests to demonstrate that the system design was satisfactory at the test conditions and that each system was ready to support subsequent phases of acceptance testing.

Phase 3 – Hot Functional Tests

Hot Functional Tests were those performed on the overall plant, or on individual systems, that required the presence of sodium in the plant systems. These tests were used to demonstrate that overall non-nuclear plant performance was acceptable and FFTF was ready for the initial loading of fuel.

Phase 4 – Nuclear Startup Tests

Nuclear Startup Tests were those performed to demonstrate satisfactory system performance and overall plant operation at low reactor power levels. Phase 4 commenced with the initial loading of fuel and extended through initial criticality to reactor power levels up to 10% of full power.

Phase 5 – Power Ascension Tests

Power Ascension Tests included those required to demonstrate satisfactory system performance and overall plant operation at reactor power levels above 10% up to and including 100% power.

Acceptance Test Categories were also designated to segregate acceptance tests into groups that reflected, in a general way, the effect the test had on the overall plant and the type of plant system involved. The required reviews and approvals were determined by the assigned test category. These four categories are defined below:

Category A – Tests conducted on reactor plant systems designed by ARD and that had a direct effect on reactor operation.

Category B – Tests conducted on reactor plant systems designed by Bechtel, HEDL, AI, or AMCO and that had a direct effect on reactor operation.

Category C – Tests conducted on auxiliary systems that had a limited effect on reactor operation.

Category D – Tests conducted on auxiliary systems that had no effect on reactor operation.

The above phase and category identifications were part of the unique number assigned to each acceptance test.

6.1 Acceptance Test Documents

Following is a description of the different types of documents that comprised the Acceptance Testing Program:

Test Resume

The test resume provided the mechanism for the initial identification of required tests by the cognizant system or component designer. The test resume contained a brief description of test objectives, the plant status required for testing, and a listing of special test equipment. By editing (and in many cases combining or grouping) the many test resumes, the scope of each individual acceptance test was determined by HEDL. The compilation and screening of the test resumes from all designers allowed early definition of acceptance test program scope and a test sequence. Once this was compiled, the test resumes were typically not re-issued or otherwise perpetuated. Subsequent changes that were made to the corresponding test specification and test procedure that were prepared following the test resume were not incorporated into the resume. Preparation of the test resumes and submittal to HEDL was the responsibility of the cognizant design organization. HEDL FTE approved all test resumes before they were collectively submitted to DOE for review and overall approval. Approved test resumes were returned to the cognizant design organization by HEDL to be used as the basis for preparation of the acceptance test specification.

Acceptance Test Specification

A test specification was prepared for each acceptance test delineating the purpose of the test and listing the test requirements, which allowed the scope of the testing to be defined. The test requirements were statements of the design requirements that were to be confirmed and demonstrated during testing as well as any requirements to record base reference data needed for FFTF operation and characterization. The Purpose and Requirements sections were supplemented by sections containing the acceptance criteria, data required, plant conditions, special test equipment and any test predictions which the designer deemed necessary. Additional information which the designer believed to be of special value to the preparer of the test procedure was also included.

The test specification was prepared by the organization that was assigned design responsibility for the system(s) that were being tested. All test specifications were engineering documents and were the responsibility of FFTF Engineering, who prepared those specifications that were not assigned to another design contractor. Following HEDL's review of each test specification, FFTF Engineering would assemble the comments with assistance from FTE as required. Approval action on all test specifications was by FTE and FFTF Engineering as well as by HEDL Safety Analysis, as determined to be necessary. All Category A, B, and C test specifications were submitted to DOE by FFTF Engineering for technical approval. DOE comments were resolved and copies of the test specification package (containing review comments and resolutions as attachments to be used for the test procedure preparation – a revised test specification typically wasn't issued) to be used for test procedure preparation were provided to DOE for information.

An approved test specification was required for each acceptance test as the predecessor for the test procedure. All comments that were made on the test specification would be appropriately incorporated into the test procedure as it was prepared. The content of two or more test specifications could be combined into one test procedure. Proposed changes to Category A, B, or C test specifications that were already approved by DOE but before the test procedure was approved had to be approved by FFTF Engineering and DOE. A proposed change could be identified as a revision to the test specification in the case of a major change of scope, as an addendum to the test specification for something like a change to a test requirement, or as a cover page item on the test procedure if the change resulted from the test procedure preparation effort.

When the test procedure was approved, the test specification was no longer perpetuated as an active test program document. However, if a change to the test procedure affected acceptance criteria, operating limits, or scope and were derived from a design disclosure or base document, an Engineering Change Notice (ECN) had to be issued to revise that design disclosure or base document. WHAN-M-17 (Reference 16), *Instructions for Submittal and Control of FFTF Design Documents and Design-Related Documentation*, provided the system and requirements for management of FFTF technical data prepared by HEDL and design contractors (AI, AMCO, ARD, and Bechtel), the construction contractor (Bechtel Field), and lower tier equipment suppliers.

WHAN-M-17 contains provisions for review, approval, release, change control, and accounting of FFTF design disclosure and base documentation (also called “design documents”) and design-related documentation.

Acceptance Test Procedure

The test procedure described how a test was to be conducted and how the plant was operated to accomplish the testing objectives. The test procedure contents were based on the approved test specification and applicable design data and descriptions, with emphasis placed on satisfying the test requirements delineated in these documents. The test procedure used operating procedures as much as possible for procedure verification. The test procedure included the acceptance criteria required for test data evaluation, identified what data needed to be recorded during the test, and provided safety precautions and operating limits when required. The test procedure also identified any requirements that would take the plant, system, or component beyond normal operating limits. Any testing that was outside the technical specification limits required specific DOE approval for waiver of the limit. If it was known in advance that an evaluation report (discussed later in this section) was required, that requirement was also stated in the test procedure.

The FFTF Testing and Operations group was responsible for preparation and issuance of test procedures. FFTF Operations and FTE prepared the test procedures with major assistance from FFTF Engineering. The preparation details and specifics were governed by appropriate administrative instructions. FTE was responsible for the test procedure reviews, resolved comments, and provided approval action for HEDL on all test procedures. The approval requirements for the test procedures are identified in TI-4 (Reference 5). Following the formal approval action for the test procedure, FTE completed a pre-test review just prior to test performance to assure that the test procedure was complete and contained current information (e.g., reflecting all system design changes and changes in interfacing procedures). FTE made any necessary changes before FFTF Operations released the TP for testing. During actual testing, FTE would prepare any necessary changes and obtain approvals as specified in TI-3 (Reference 4).

Test Operating Procedure

Test operating procedures provided detailed instructions for conducting repetitive operations during acceptance testing that weren’t contained in other HEDL procedures. FTE was responsible for identifying this type of procedure and for obtaining them.

Calibration Procedure

Before the start of an acceptance test, FTE would assess the calibration requirements of the system and were responsible for obtaining and approving any necessary calibration procedures. These were either generic procedures that were applicable to a class of instruments (e.g., pressure transmitters, temperature recorders) or were

specific procedures based on design data and/or the manufacturer's instruction manuals for a given piece of equipment or instrument loop.

Data Report

When an acceptance test was completed, FTE was responsible for the preparation and distribution of a data report (DR). The data report contained all data and information collected during the test that were useful in performing the evaluation of the component or system. Exceptions found during testing were listed in the data report, nonconformances or open items which were potential constraints on subsequent tests were identified and required dates for completion of remedial actions to assure testing continuity were identified. The data report also identified the need for further evaluation of unexpected or unsatisfactory test results.

Evaluation Report

An evaluation report (ER) was prepared by the cognizant design organization when the need for the designer's evaluation of test results was identified in the test specification or test procedure.

6.2 FTF Release Point Review Plan

A plan was established to review the adequacy of test results and documentation from the acceptance test program. Four DOE/HEDL release points, RP-1 through RP-4, were established to ensure readiness of the plant to proceed to the next major startup stage. A release point review process (Reference 31) was developed which established a Standing Results Review Committee (SRRC) to provide a thorough assessment of acceptance test results for each release point and established a senior-level review board, the FFTF Project Review Board (PRB), under the sponsorship of the FFTF Project Manager to assure that all aspects of "readiness-to-proceed" were met at each release point. These two new functions were intended to augment and facilitate the review of test data and overview of project readiness already provided through line functions by Safety Analysis, Quality Assurance, and the Safeguards Council. Additionally, Test Results Review Teams (TRRTs) were added to the review process. The SRRC included members from all interfacing organizations, including Quality Assurance, Safety Analysis, Testing and Operations, and each of the technical subdivisions of Engineering. The SRRC established specific Test Results Review Teams with responsibility for review of groupings of related Test Data Reports. The grouping of reports assigned to a TRRT was usually the same grouping that comprised a Multi-Test Evaluation Report (MTER). When the individual review by the TRRT was completed, FFTF Engineering prepared the MTER, an additional brief report emphasizing the interfaces between the tests. The TRRT was normally chaired by the cognizant FFTF Engineering manager, and included the cognizant engineer(s), and additional members selected as appropriate to the subject at hand. All TRRT reports and MTERs were then submitted to the SRRC for review and action as required, and then presented to the FFTF Project Review Board as a major part of the technical assurance that Release Point readiness had been achieved.

Following is a brief discussion of the five release points that controlled the procession of plant startup testing:

RP-1 – Initiation of Inerting, Preheating, and Sodium Fill Operations

The objective of RP-1 was to assure that each of the plant operations associated with sodium fill (including inerting and preheating) were conducted safely and without damage to plant systems. Essentially all of Phase II testing was completed prior to RP-1. To support this release point, the release of key events through the sodium fill process was controlled by five separate releases:

RP-1A – Distribution of inert gas in the plant

RP-1B – Preheat and sodium fill of secondary sodium storage tank T-44

RP-1C – Preheat and sodium fill of secondary sodium system loop 3

RP-1D – Fill of NaK systems

RP-1E – Sodium fill of the reactor vessel and three primary heat transport loops

The release points identified above were also augmented with five additional HEDL internal release points (H-1 through H-5). Reference 31 shows the operations in matrix form that were conducted to inert, preheat, and fill the many systems of the plant, and this same information is shown in Test Sequence format, along with the interactions between the Standing Results Review process and the Multi-Test Evaluation Reports.

RP-2 – Fuel Loading and Criticality

RP-2 constrained the loading of any fueled assembly into the reactor vessel and included the period through initial criticality and early low power reactivity and characterization measurements. This Release Point constrained the start of Test Period T-12.

RP-3 – Power Ascension

This Release Point constrained operation of the reactor at power levels beyond those required for the active reactor characterization experiments noted for Test Periods T-12 and T-13. RP-3 also constrained the start of T-16.

RP-4 – End of the Acceptance Test Program

This release point defined the end of the Acceptance Test Program and the start of irradiation testing in Cycle 1.

7.0 Conclusions

Documentation of the rigorous and successful Acceptance Testing and Startup Testing Program at FFTF between 1978 (official start) and 1982 (official end) was thorough and immense. Each of the document types discussed in this report (e.g., Test Resumes, Test Specifications, Test Procedures, Data Reports, MTERS, etc.) for each plant system are retrievable. Copies of the key documents either discussed in this report or referenced in Section 8.0, can be retrieved upon request. The reference citations provide document number, title, originating organization, in some cases the retrieving organization, and date issued. Authors are not listed as they were not available for these documents. It should be noted that many of the referenced documents are classified as limited release, and either were not reviewed for clearance (internal official use only) or are designated as Applied Technology.

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