

HEDL--7303

DE84 008500

UNITED STATES DEPARTMENT OF ENERGY  
BREEDER REACTOR STAFF TRAINING  
DOMESTIC PROGRAM

MASTER

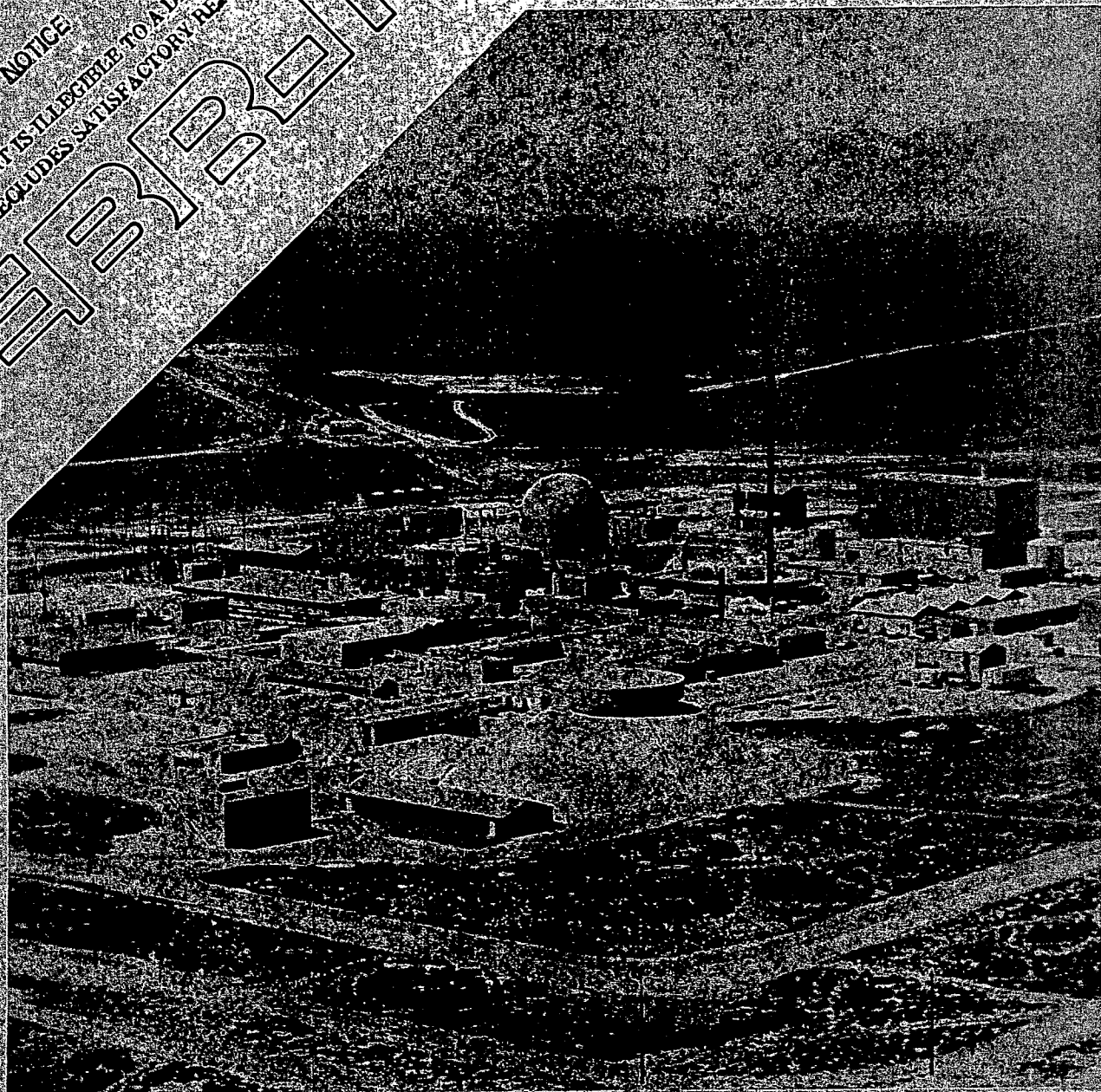
## **DISCLAIMER**

**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.**

NOTICE  
THIS REPORT IS ILLEGIBLE TO A DEGREE  
THAT PRECLUDES SATISFACTORY REPRODUCTION





## INTRODUCTION

Two U.S. Department of Energy projects in the Pacific Northwest offer unique on-the-scene training opportunities at sodium-cooled fast-reactor plants. These sites offer a wealth of information concerning liquid-metal fast-breeder reactors.

Instructional courses provide a rare opportunity for personnel in the nuclear industry to become closely familiar with the many features involved in sodium-cooled fast-reactor systems, plant operation and related scientific technology.

The sites are:

- The Fast Flux Test Facility (FFTF) near Richland, Washington, which has operated successfully in a wide range of irradiation test programs since 1980.
- The Experimental Breeder Reactor II (EBR-II) near Idaho Falls, Idaho, which has been in operation for approximately 20 years.

Training programs have been especially designed to take advantage of this plant experience. Available courses (shown in Table I) are described in more detail on subsequent pages. Additional instruction may be arranged by special request.

Courses will be tailored to suit the needs of specific users, including fixed or flexible lengths of time for instruction, and oral or written examinations as requested. Training schedules will be designed to avoid interference with scheduled plant operations.



EXHIBIT

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

**TABLE 1. AVAILABLE COURSES**

<u>Course</u>	<u>EBR-II</u>	<u>FFTF</u>
General Orientation	X	X
Basic Knowledge Training		X
Control Room Operator	X	X
Plant Operator		X
Radiation Control Engineering		X
Refueling		X
Examination and Decontamination Services		X
Special Emphasis		X

Training for any one group is intended to be conducted at a single location, although unique features exist in each plant. Therefore, training at both locations may be arranged at special request. Examples of the unique capabilities are:

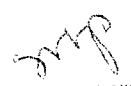
EBR-II - Steam and Electrical Generating Systems

EBR-II - Pool-Type Reactor Plant

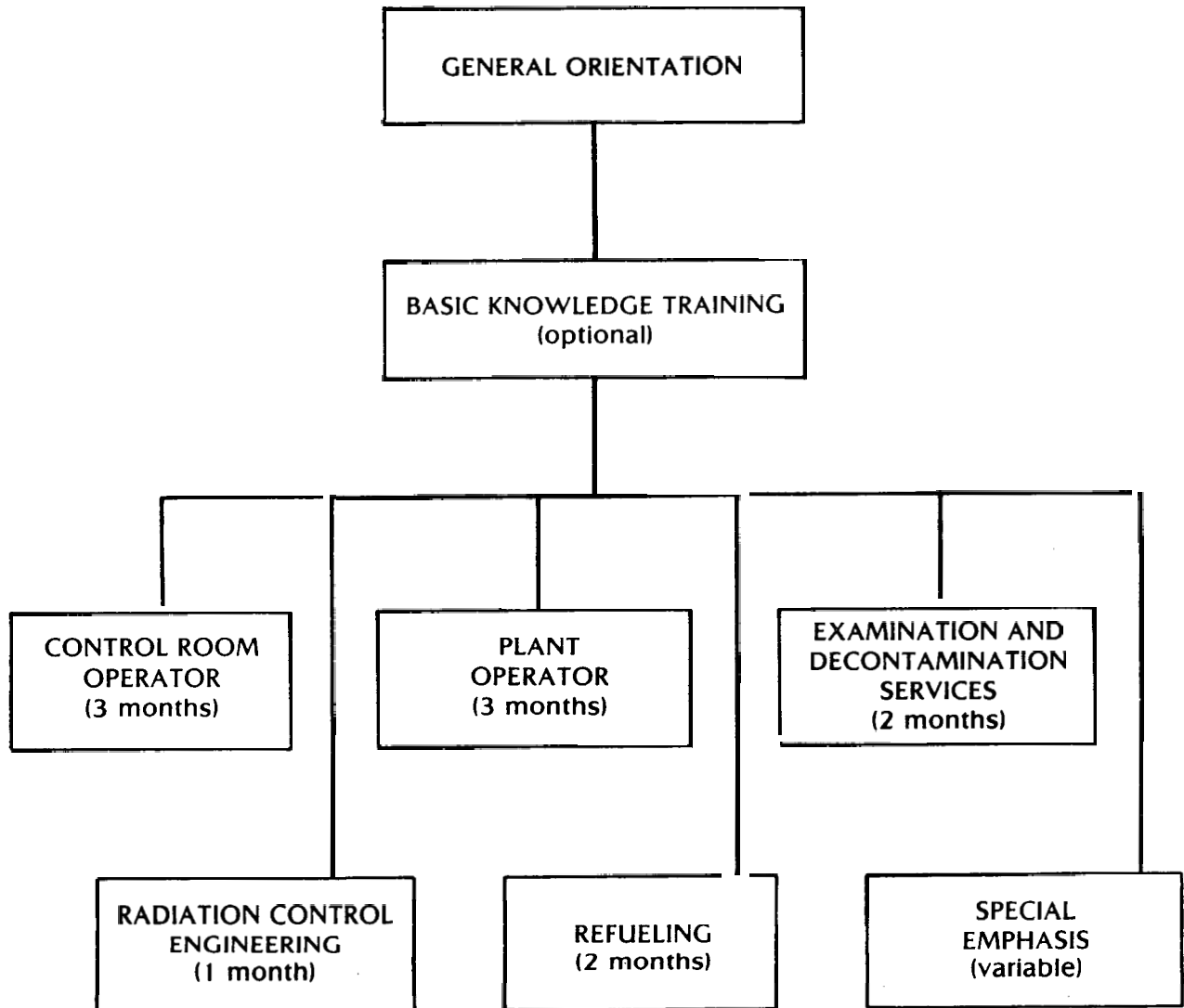
FFTF - Control Room Training Simulator

FFTF - Loop-Type Reactor Plant with Full-Scale Components

Security clearances are required for all trainees before they arrive on site. Any delay in the receipt of security applications or clearances will result in unnecessary costs and training delays.

  
DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

## LMFBR TRAINING PROGRAMS



## **PLANT OVERVIEW**

### **FAST FLUX TEST FACILITY**

**Location:** Hanford Engineering Development Laboratory, Richland, Washington.

**Operator:** Westinghouse Hanford Company.

**Status:** Operational.

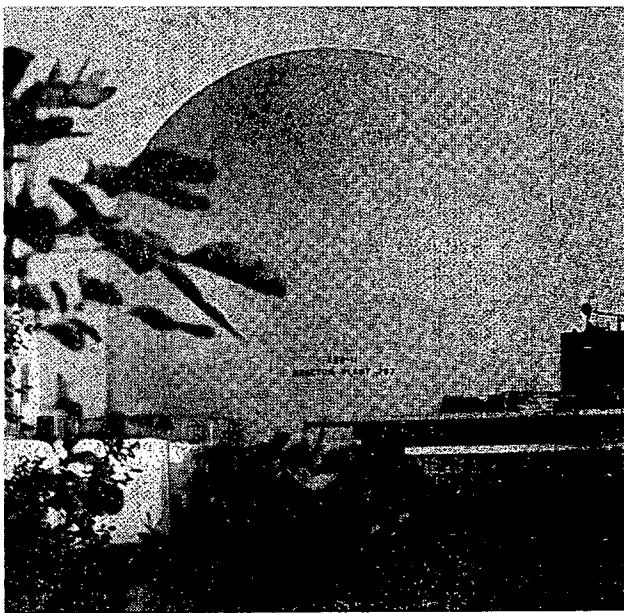
**Facility Description:** The FFTF is a sodium-cooled fast-reactor plant, producing 400 MWt. Reactor cooling is provided by a three-loop heat transport system, and heat is released to the atmosphere through sodium-to-air dump heat exchangers. During its first major operating period, the FFTF established a U.S. record for the longest consecutive full-power operation of a sodium-cooled fast-reactor plant. (Basic design characteristics are shown in Table 2.)

**Test Capability:** The FFTF provides a large-scale test bed for demonstrating and evaluating the performance of future LMFBR fuel and core designs. Full-size fuel, blanket and absorber assemblies can be tested in various reactor locations. Special instrumentation is available at eight core positions, providing extensive monitoring capability for experiment conditions. A closed-loop testing capability could be added to FFTF in which fuel can be tested under off-normal conditions.

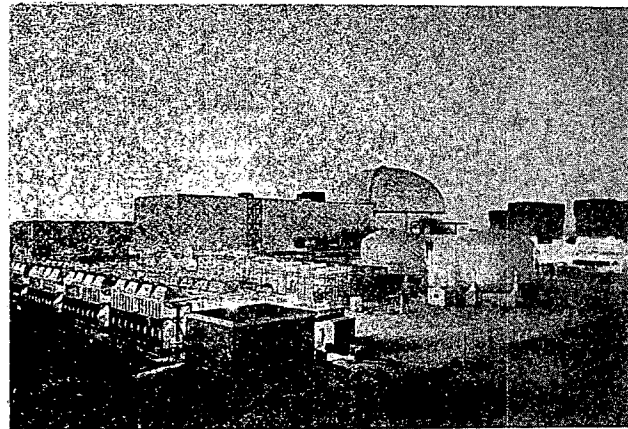
The FFTF provides a prototypic and well-instrumented fast-reactor environment to:

- Irradiate and evaluate fuel, blanket, control and structural materials for use in future sodium-cooled fast reactors.
- Develop, test and evaluate components and systems for use in full-scale LMFBR plants.
- Gain valuable experience with breeder reactor components, operating systems and maintenance.





EBR-II



FFTF

**TABLE 2. BASIC DESIGN CHARACTERISTICS**

HEAT TRANSPORT SYSTEM	EBR-II	FFTF
REACTOR POWER	62.5 MW	400 MW
REACTOR OUTLET TEMPERATURE	883°F	938°F
REACTOR INLET TEMPERATURE	700°F	680°F
FUEL ASSEMBLY OUTLET TEMPERATURE	923°F (nom.)	980°F (nom.)
$\Delta T$ REACTOR	183°F	258°F
TOTAL COOLANT FLOW	9,340 gpm	43,500 gpm
SODIUM SYSTEMS COVER GAS	argon	argon
ELECTRIC GENERATING CAPACITY	20 MW	N/A
DUMP HEAT EXCHANGERS	N/A	12 at 33 MW
CONTAINMENT BUILDING DIAMETER	80 ft	135 ft
CONTAINMENT BUILDING HEIGHT	140 ft	187 ft



## **PLANT OVERVIEW**

### **EXPERIMENTAL BREEDER REACTOR II**

**Location:** Idaho National Engineering Laboratory, Idaho Falls.

**Operator:** Argonne National Laboratory.

**Status:** Operational.

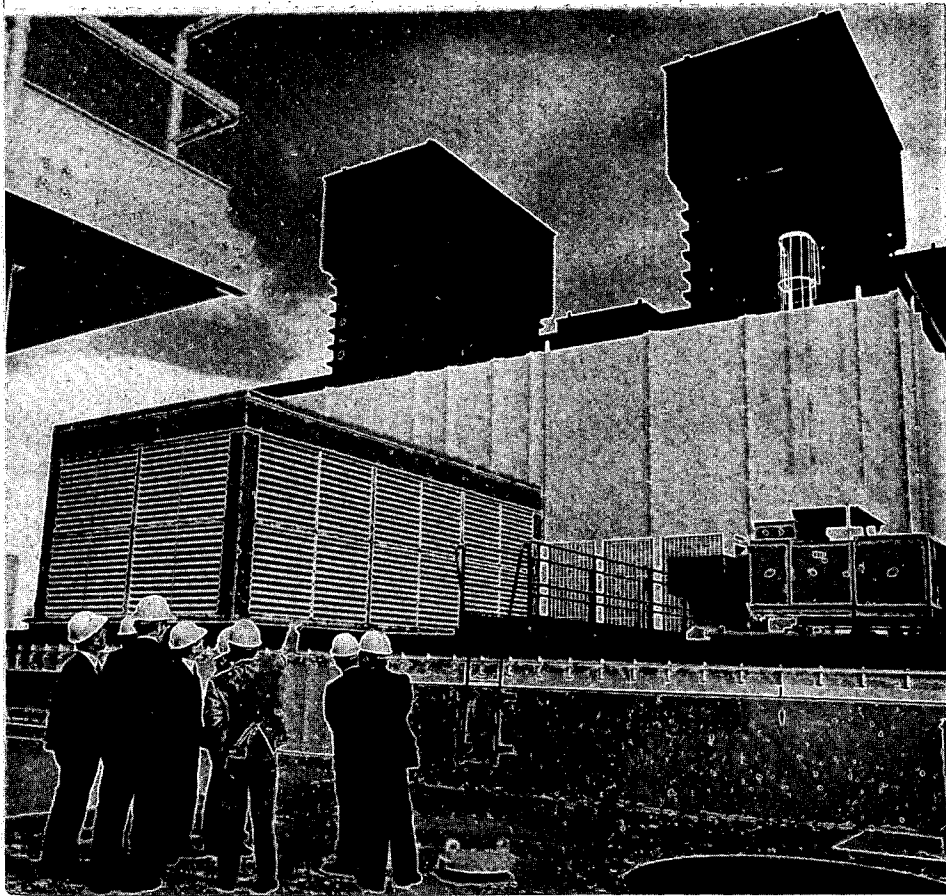
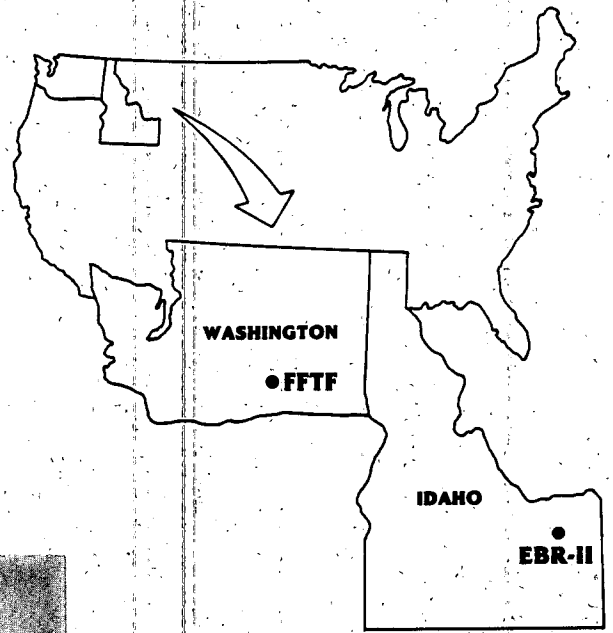
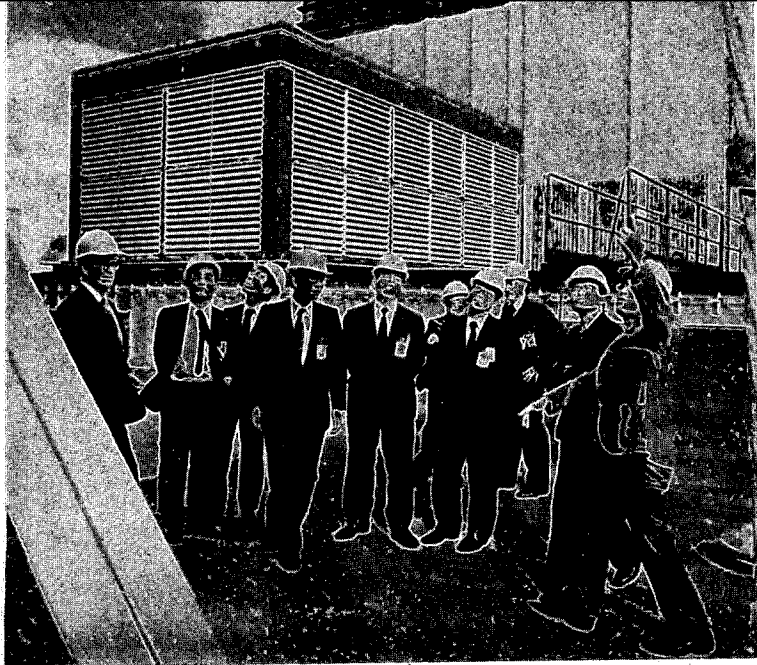
**Facility Description:** EBR-II is a sodium-cooled pool-type reactor with a nominal reactor output of 62.5 MWt. It also features a complete electrical power plant, generating up to 20 MWe. EBR-II offers training experience at a fast-breeder reactor producing electric power. In effect, it is an experimental power station since it also serves as an irradiation facility for breeder-related experiments.

EBR-II contains complete instrumentation and control systems that govern fast-reactor power operation. Operating variables are measured and controlled in conditions similar to those of a large commercial power plant. (Basic design characteristics are shown in Table 2.)

**Test Capability:** EBR-II operates primarily as an irradiation facility. The reactor core features seven rows of subassembly positions that can be used for experimental irradiations. The first six rows are designed for driver fuel use.

EBR-II is used as:

- An irradiation facility for fuels and materials.
- A test facility for in-reactor instrumentation.
- A reactor test environment for sodium components and systems.
- An operating facility to gain experience with LMFBRs.



**Course Title: GENERAL ORIENTATION**

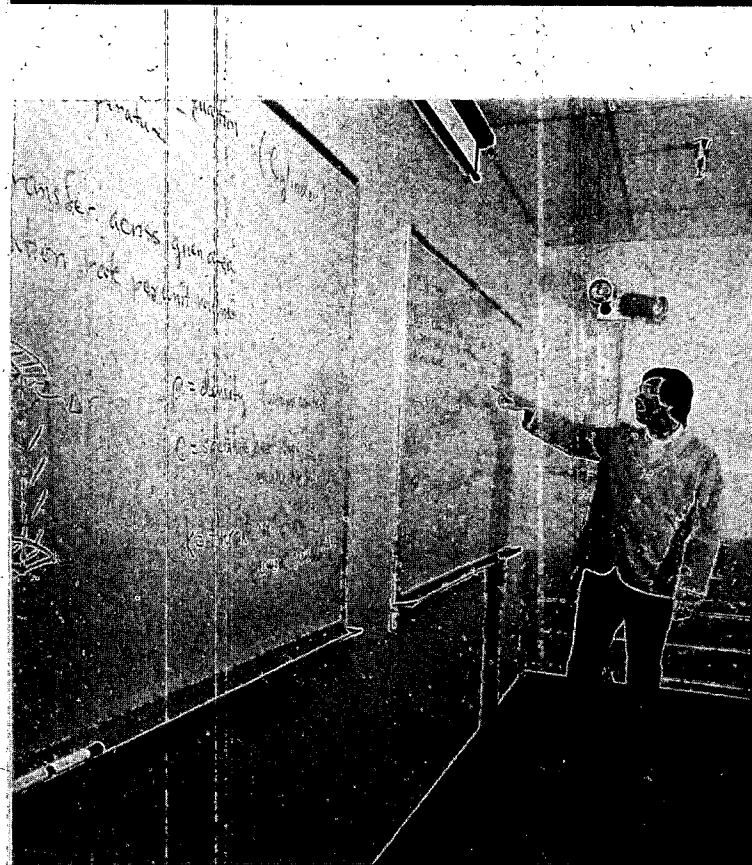
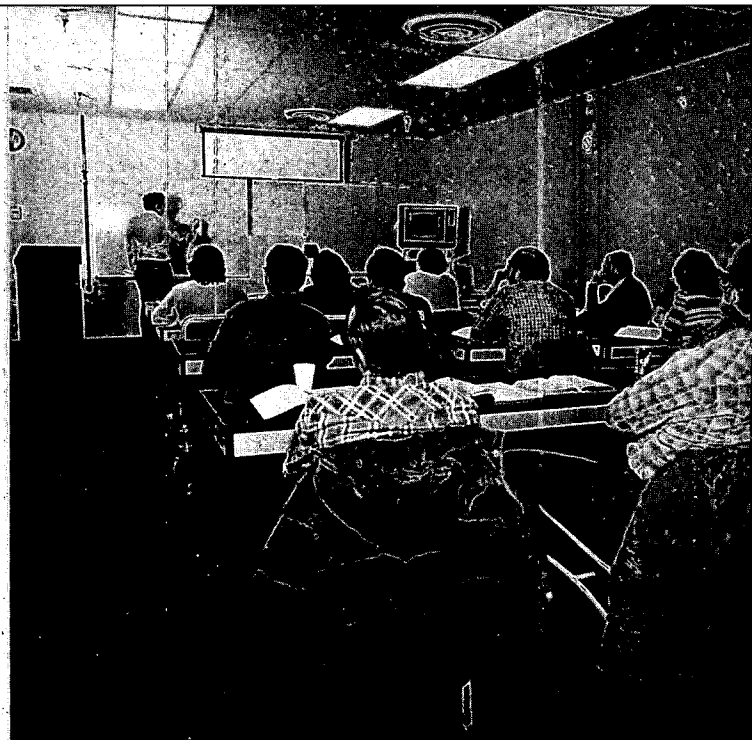
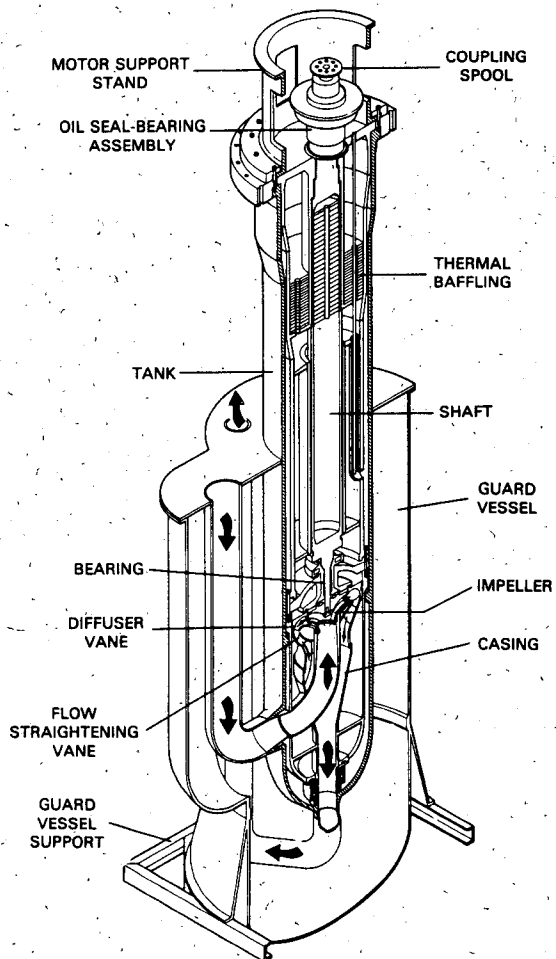
**Availability:** At both FFTF and EBR-II.

**Duration:** 1 to 2 weeks.

This course fulfills the necessary requirements so that the trainee can regularly enter the reactor facility area without special escort. The trainees at each site must attend the general orientation course for that particular plant.

Introductory information includes a descriptive review of major plant operating systems. Tours throughout the plant facilities are also offered. The trainees become acquainted with specialized concerns such as plant security, oxygen-deficient atmospheres, radiation worker safety, criticality safety and related work procedures in fast-reactor facilities.

Classes are conducted for up to two weeks. However, the information offered and the duration of instruction may vary, depending on requests of the users and the subsequent assignments planned for the trainees.



## **Course Title: BASIC KNOWLEDGE TRAINING**

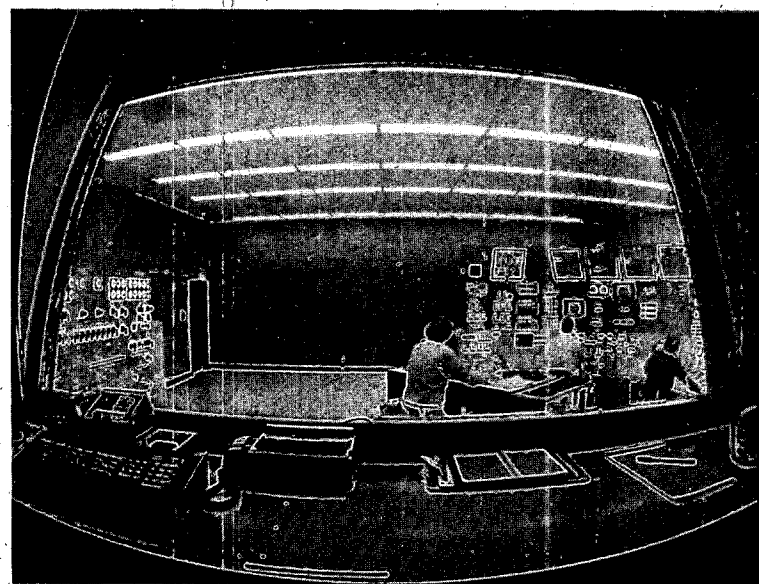
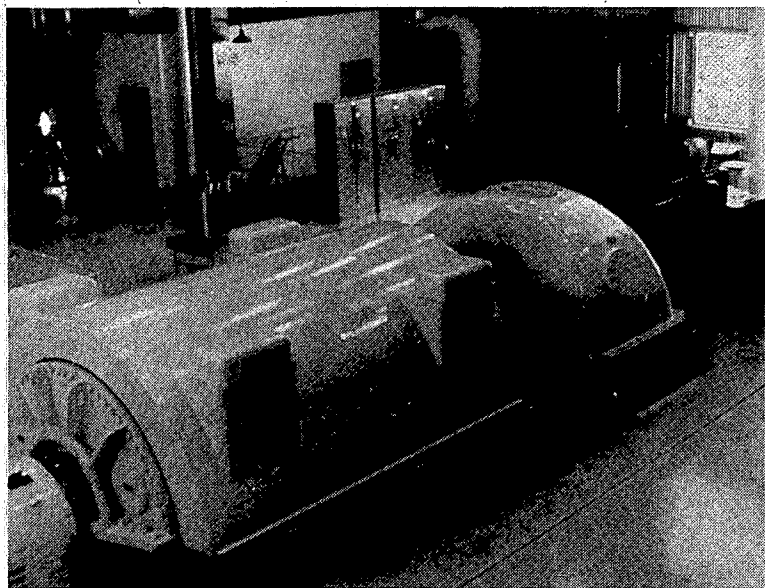
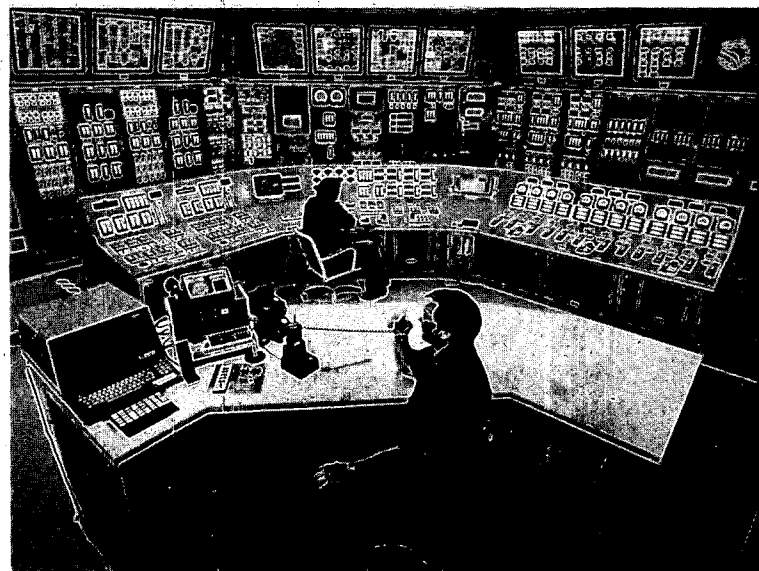
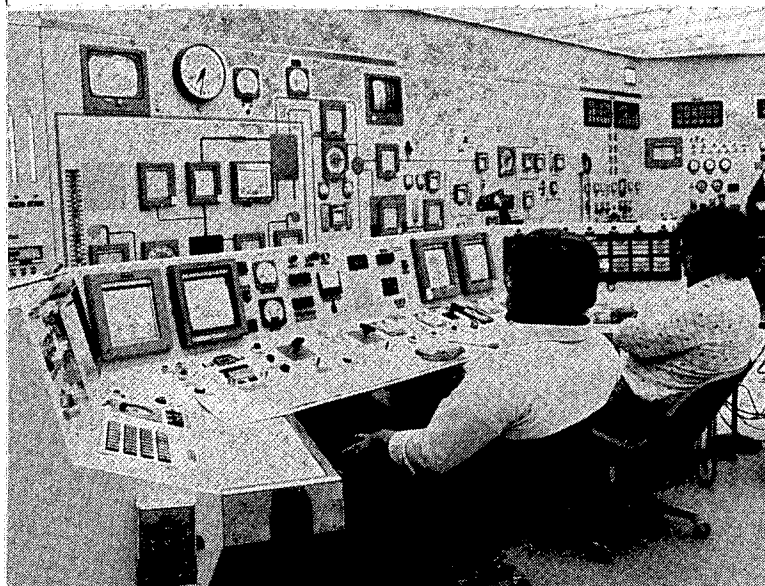
**Availability:** At FFTF.

**Duration:** 2 days to 2 weeks.

A basic knowledge of fundamental reactor principles is extremely important for successful completion of Breeder Reactor Staff Training courses.

Special provision has been made at the FFTF site to offer instruction in any of the following subjects, as needed. The course work is designed for personnel who do not have technical degrees, and is also helpful for degreed personnel who desire updated information or broad refresher training in these important topics.

<u>Course Topics</u>	<u>Duration</u>	<u>Recommended for</u>
BASIC SCIENCE Heat Transfer Fluid Flow General Physics	2 days	Plant Operator; Control Room Operator; and Refueling
MATHEMATICS	3 days	Control Room Operator
MECHANICAL THEORY Pumps Valves	2 days	Plant Operator, Control Room Operator, Refueling, and Examination and Decontamination Services
ELECTRICAL/INSTRUMENT THEORY Motors Generators Instrumentation	3 days	Plant Operator, Control Room Operator, Refueling, and Examination and Decontamination Services
RADIATION CONTROL PRINCIPLES Dose Rate Equations Radioactive Decay Principles	1 week	Radiation Control Engineering
FAST REACTOR PHYSICS	2 weeks	Control Room Operator





**Course Title: CONTROL ROOM OPERATOR**

**Availability:** At FFTF and EBR-II.

**Duration:** 3 months.

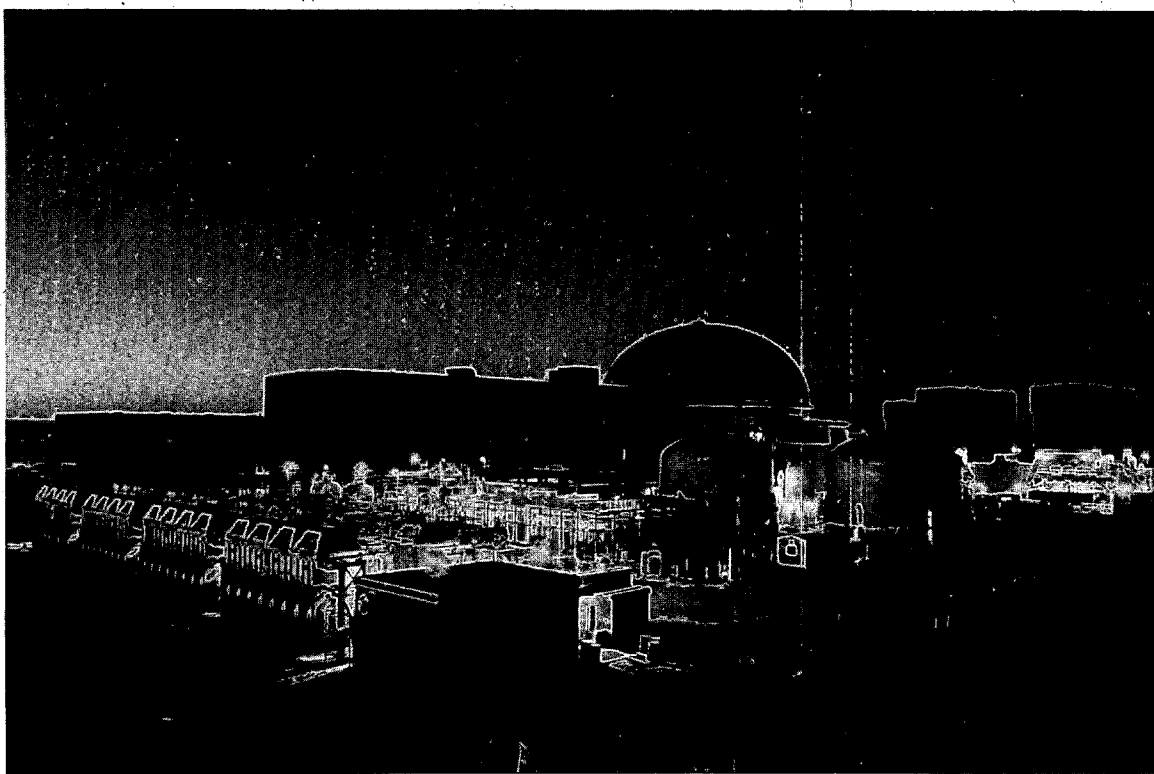
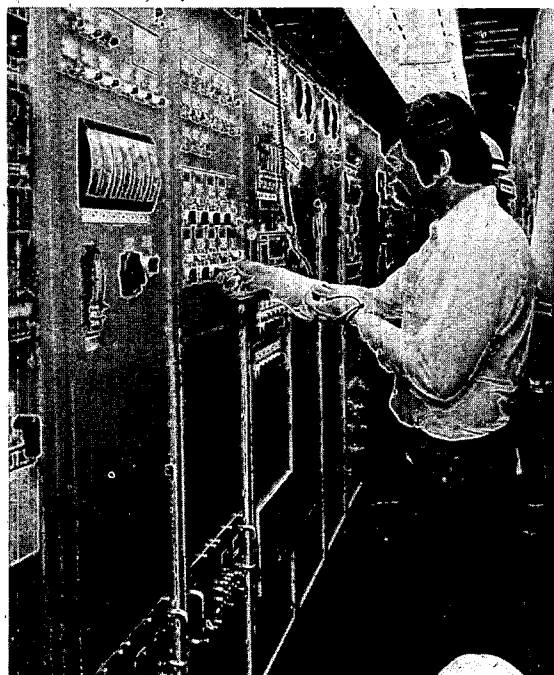
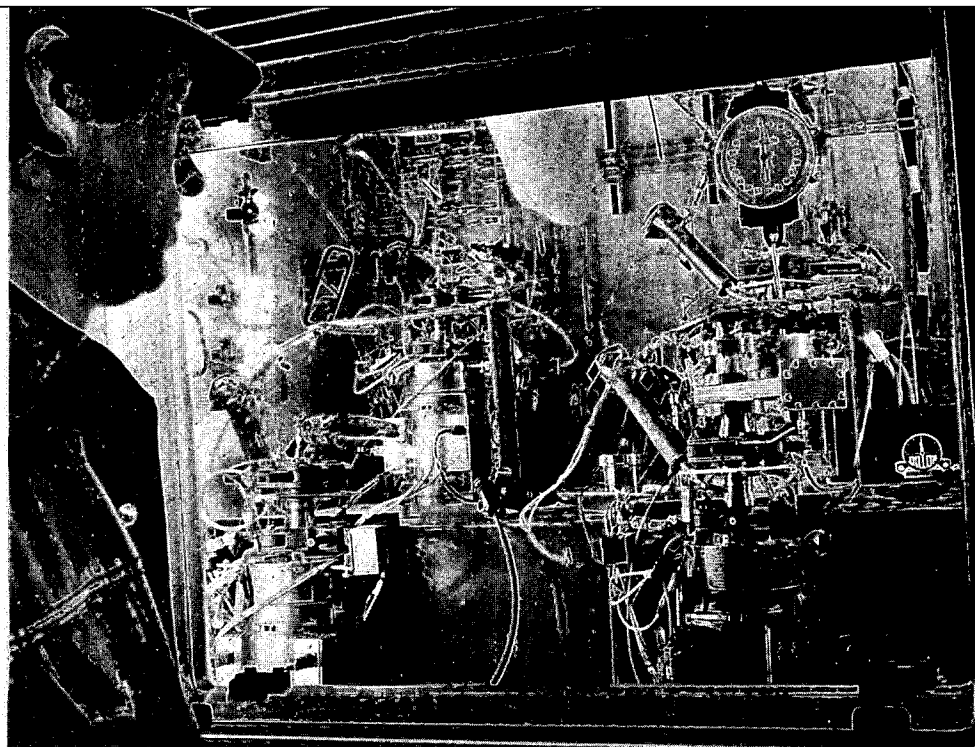
This course offers detailed training for prospective control room operators as well as for other personnel who would benefit from a solid understanding of breeder-reactor plant operations. Numerous informational topics describe the control room operation of a liquid-metal fast-breeder reactor.

Before taking this course, many trainees would benefit from prior completion of the Plant Operator course. This combination provides a more complete understanding of the overall plant operation of a breeder reactor.

The Control Room Operator course at each reactor site consists of both classroom instruction and in-plant training. Basic principles and practices applicable to any LMFBFR are emphasized. Therefore, specific details about each particular plant are included only as needed for understanding basic principles, and graduates are not certified as EBR-II or FFTF operators.

Classroom instruction includes a broad study of reactor equipment and systems, operating and administrative procedures, specific breeder-plant occurrences (i.e., natural circulation and decay heat), and related topics (i.e., technical specifications). During in-plant training by an operating crew, trainees receive systems training in the reactor plant environment and learn about the application of procedures.

Special training opportunities are provided at each reactor site as part of this course. At EBR-II only, training includes experience with the steam and electrical generating systems. At FFTF only, an Operator Training Simulator provides extensive training experience in manipulation of plant controls under normal and abnormal conditions, which could not be otherwise presented in-plant.



**Course Title: PLANT OPERATOR**

**Availability:** At FFTF.

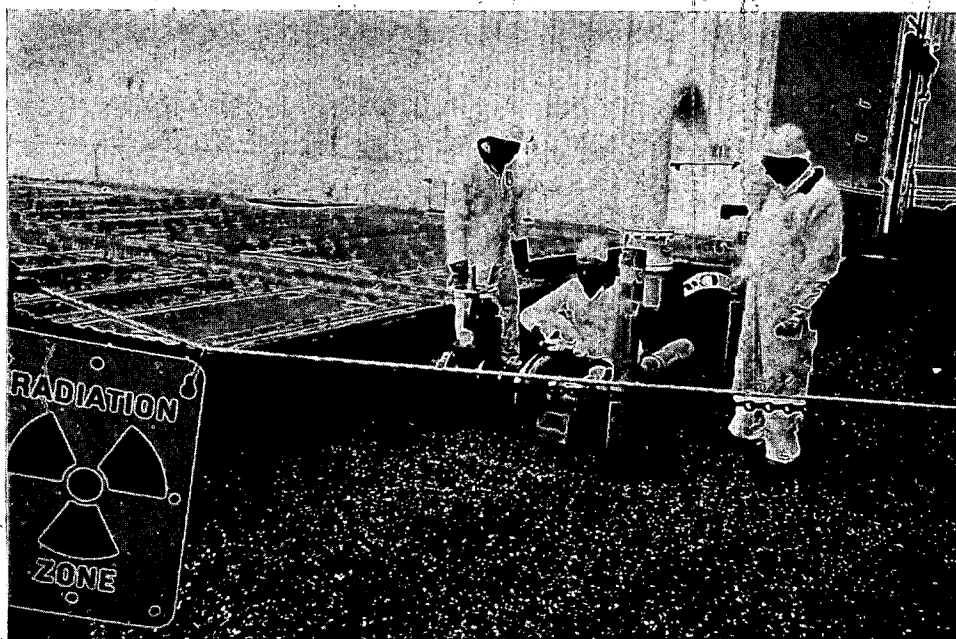
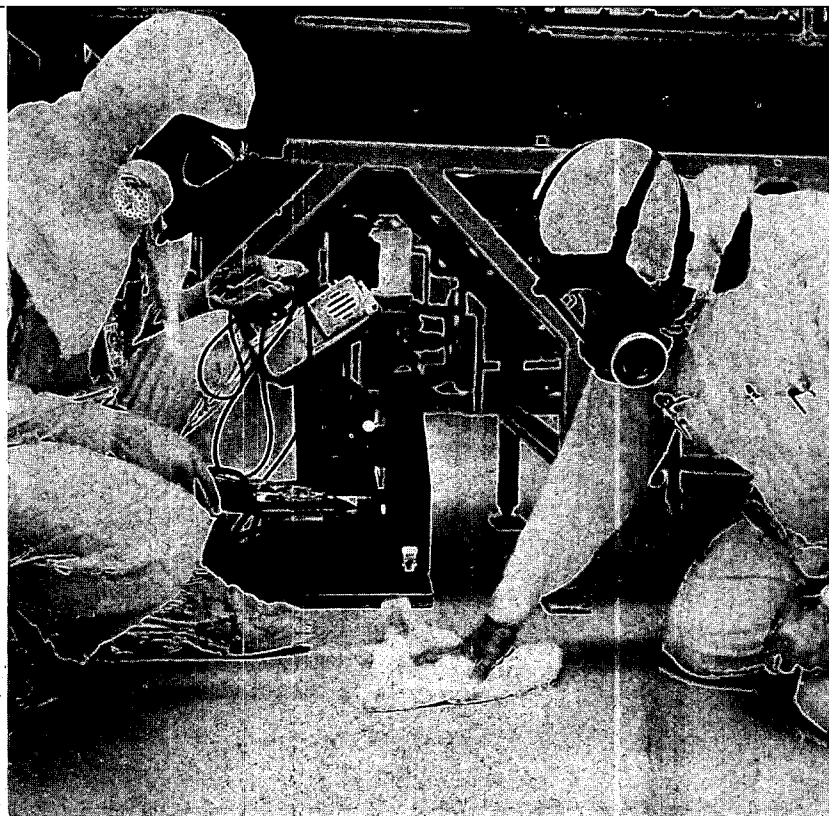
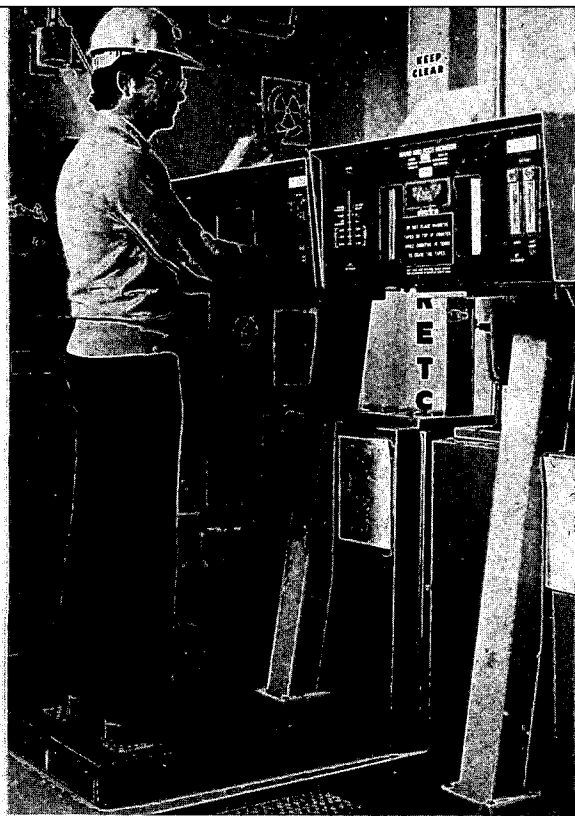
**Duration:** 3 months.

This course introduces trainees to the operation of a breeder reactor, including the sodium coolant system and other auxiliary systems. The scope of coursework would be valuable as a forerunner to the Control Room Operator training course, although it is not a prerequisite.

The topics focus on the basic principles and practices that are applicable to any LMFB. Classroom training will cover plant and reactor systems, sodium technology, operating and administrative procedures, and technical specifications.

The in-plant training portion of the course will be conducted by an FFTF operating crew, illustrating the application of procedures and providing additional system training. Trainees will be instructed in the operation of selected plant equipment and will perform under the guidance of designated qualified operators. Instruction will also be given concerning particularly sensitive equipment, and trainees will be able to closely observe qualified operators of such equipment.

FFTF plant equipment and operational methods are used primarily as examples to assist trainees in understanding basic breeder reactor principles. Thus graduates of this course are not certified as FFTF operators.



**Course Title: RADIATION CONTROL ENGINEERING**

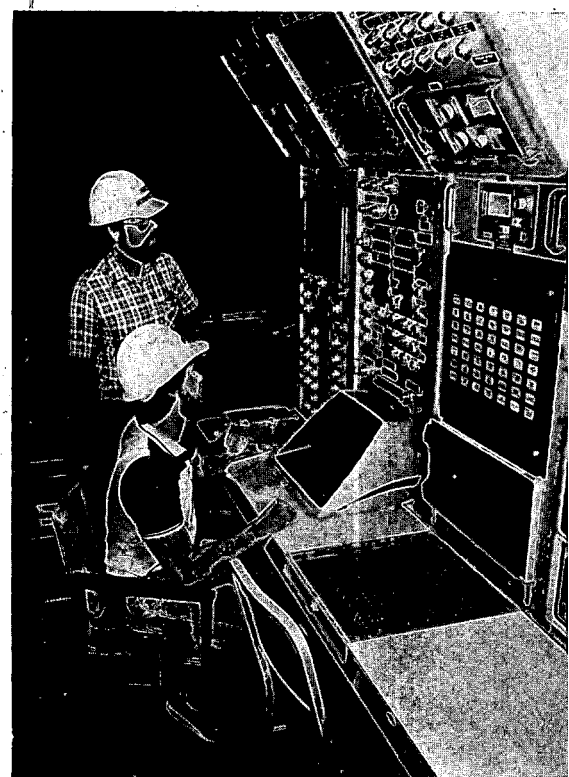
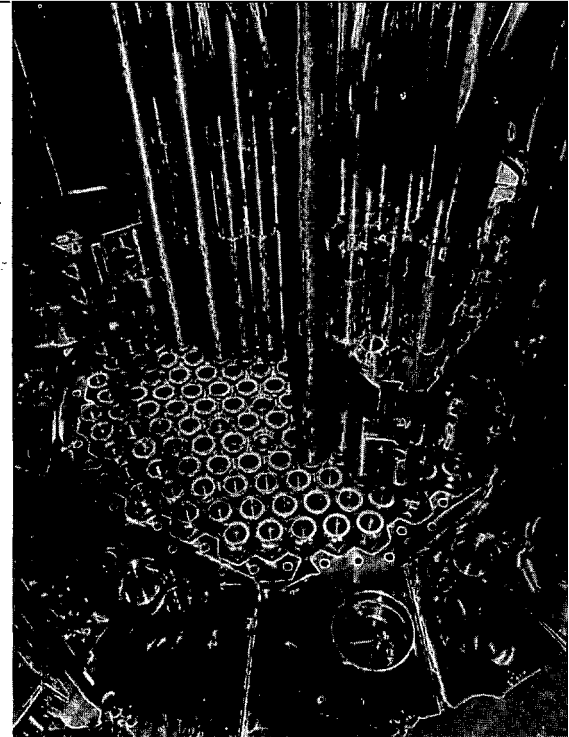
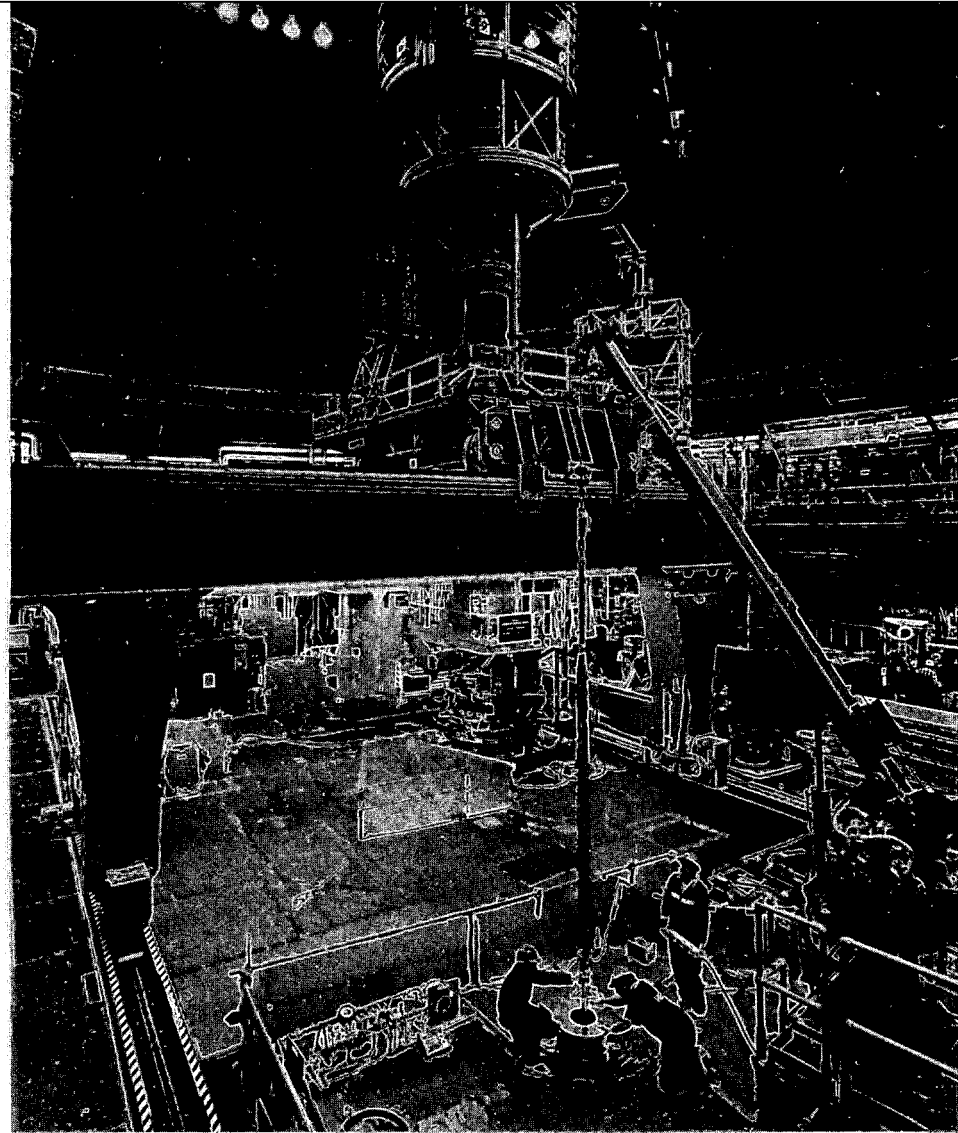
**Availability:** At FFTF.

**Duration:** 1 month.

Day-to-day work at the FFTF or any breeder reactor plant involves employee activities in radioactive areas, often involving radioactively contaminated equipment. To protect personnel who work in such radiation zones, major efforts at FFTF involve radiation protection technologists and operational health physicists.

The radiation control engineering course is designed to give on-the-job experience to trainees who are preparing to become radiation protection technologists or operational health physicists. Both classroom and in-plant training are provided.

Classroom instruction covers a wide range of topics such as radiation and radiation detection theory, dosimetry principles, health physics calculations, internal dose estimates, and radiological problems. Actual experience will be provided during a refueling or maintenance period at FFTF. This in-plant training will be conducted by operational health physicists or by qualified radiation protection technologists to provide practical experience in radiation control within a breeder reactor environment.





**Course Title: REFUELING**

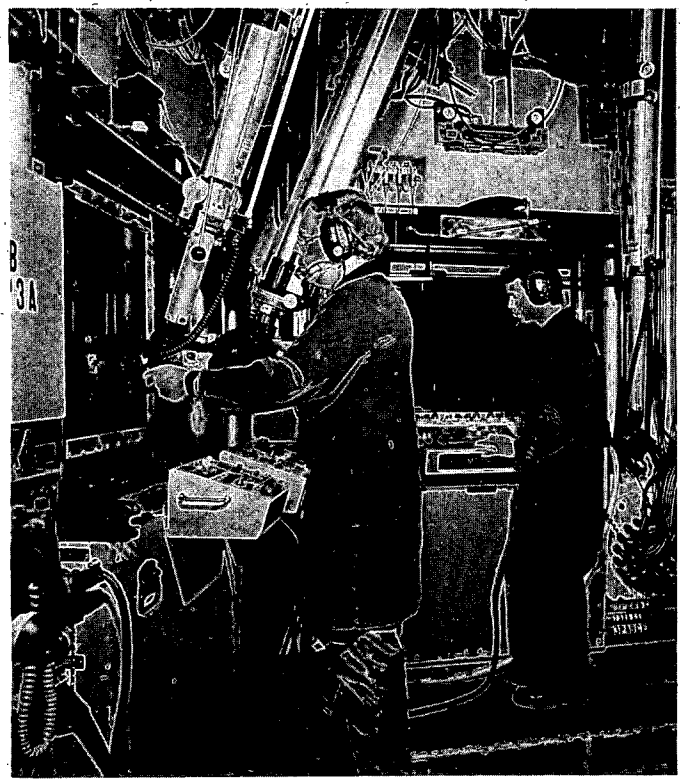
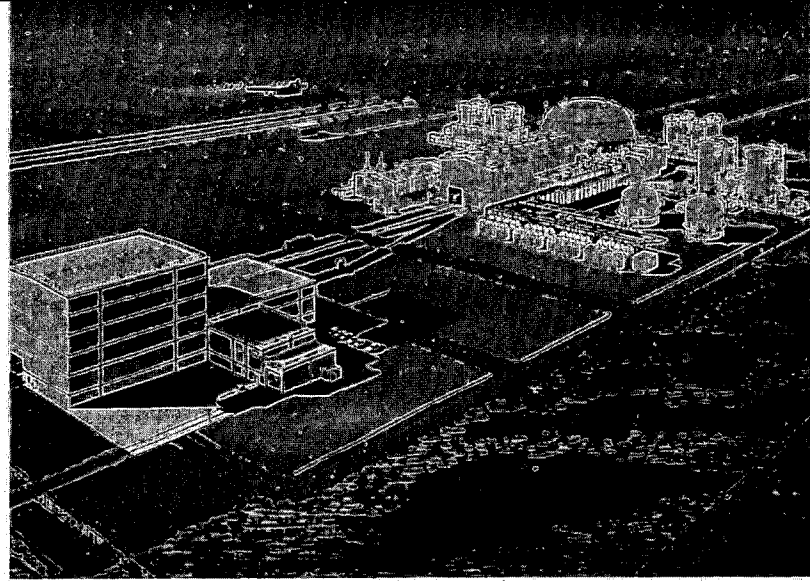
**Availability:** At FFTF.

**Duration:** 2 months.

At FFTF refueling techniques and procedures have been developed that are directly applicable to other breeder reactor plants. Therefore, this course offers valuable on-the-job experience in the refueling operations at a breeder reactor.

Both classroom instruction and in-plant training are provided for trainees. Classroom work would be conducted during the preparation for FFTF refueling. Topics would include refueling cycles, equipment, operating techniques, administrative and refueling procedures, material accountability and the technical specifications guiding the overall operation.

In-plant training would then be conducted during actual FFTF plant refueling. This provides an opportunity for trainees to closely observe the operation of refueling equipment and to gain possible hands-on experience in operating selected equipment under the close direction of a qualified refueling operator.



**Course Title: EXAMINATION AND DECONTAMINATION SERVICES**

**Availability:** At FFTF.

**Duration:** 2 months.

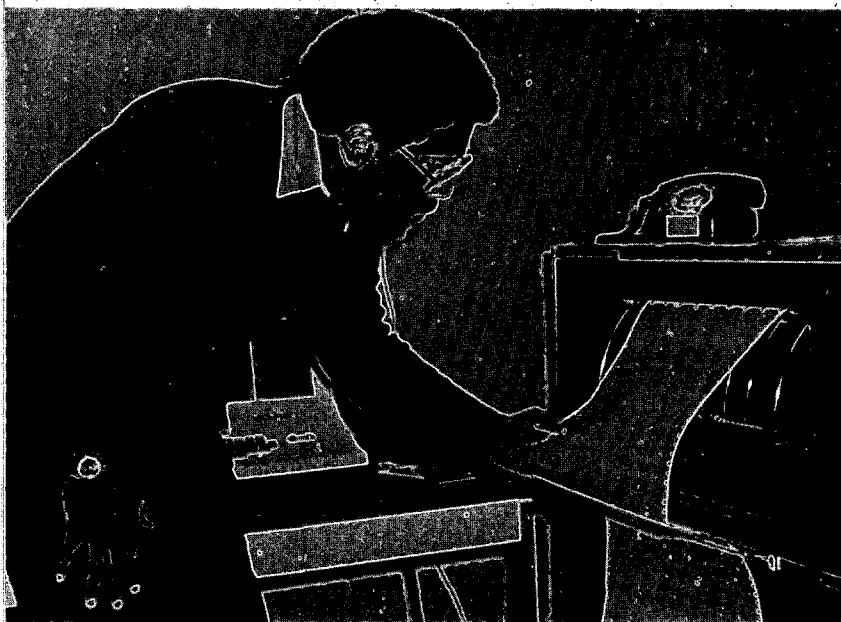
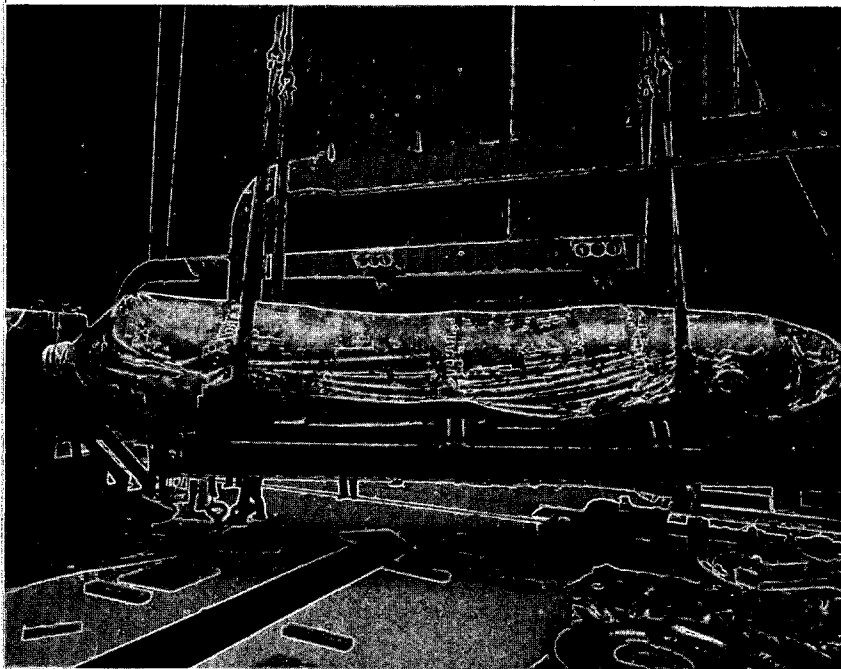
Two locations at the Fast Flux Test Facility plant will offer valuable hands-on experience in the examination and decontamination of breeder-type components. Both classroom instruction and in-plant training are offered in this course.

Instruction will cover hot cell systems, equipment and operation plus sodium technology, fissile material handling and decay heat removal from spent fuel. The course will introduce trainees to the operation of hot cell equipment and methods for removal of liquid sodium from components taken out of a breeder-reactor vessel.

In-plant training to complement the instruction would be offered in these FFTF locations:

- The Interim Examination and Maintenance Cell is a large hot cell within the FFTF containment vessel and is the largest vertical hot cell in the world. It is designed for use in the disassembly and initial examination of fuel and test assemblies following their irradiation in FFTF.
- The Maintenance and Storage Facility is a large structure adjacent to FFTF offering convenient maintenance capabilities for sodium-wetted and/or radioactive components. The building includes a large shielded area similar to a hot cell plus special facilities for removing residual sodium from large plant components, such as pumps.

Actual plant training locations would be determined according to trainee needs, avoiding any interference with plant work schedules during the training period.



**Course Title: SPECIAL EMPHASIS**

**Availability:** At FFTF

**Duration:** Variable

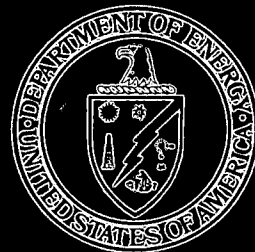
Because of the range of expertise and technical experience gained in developing, testing and operating the FFTF, the capability exists for other kinds of training courses relating to breeder reactor development.

Special programs can be developed to take advantage of this extensive knowledge at FFTF, depending upon the needs of users. Examples of possible areas of interest include:

- Work Control Process
- Startup and Operations Experience
- Engineering Overview of FFTF Operation and Support Functions
- Master Information and Data Acquisitions Systems (MIDAS)
- Maintenance
- Outage Planning
- Lessons Learned at FFTF
- Current FFTF Systems Problems
- Trend Analysis

Suggestions are welcomed on other potential training courses involving areas of interest based on FFTF experience.

DO NOT MICROFILM  
COVER



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, nor any of their contractors, subcontractors or their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use 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 or its contractor or subcontractors.

Prepared for the U.S. Department of Energy by the Westinghouse Hanford Company, a Subsidiary of Westinghouse Electric Corporation.

BOE-Richland, WA