BNWL-500
VOLUME 71

FAST FLUX TEST FACILITY

BNWL-500
VOLUME 71

BATTELLE NORTHWEST
BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
3000 STEVENS DRIVE, P. O. BOX 999, RICHLAND, WASHINGTON 99352

PACIFIC NORTHWEST LABORATORY
RICHLAND, WASHINGTON
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

BNWL-500
Volume 71

FAST FLUX TEST FACILITY

CONCEPTUAL FACILITY DESIGN DESCRIPTION
FOR THE
INERT GAS CELL EXAMINATION FACILITY
NO. 71

December 12, 1968

PACIFIC NORTHWEST LABORATORY
Richland, Washington 99352
Operated by
Battelle Memorial Institute
for the
U.S. Atomic Energy Commission under Contract No. AT(45-1)-1830

BNWL-500

Volume 71

Prepared by ______________________ Date 12/19/67

Recommended by ______________________ Date 2/28/68
Evaluation Board

Approved by ______________________ Date 3/14/68
Configuration Control Board

Approved by AEC Letter, J. M. Shivley, Project Administrator, FFTF Project Office, Richland Operations Office, to E. R. Astley, FFTF Project Manager; Subject, "FFTF CFDD No. 71, Inert Gas Cell Examination Facility" dated December 12, 1968.

TABLE OF CONTENTS

INERT GAS CELL EXAMINATION FACILITY

INTRODUCTION

The purpose of this Conceptual Facility Design Description (CFDD) is to provide a technical description of the Inert Gas Cell Examination Facility such that agreement with RDT on a Conceptual Design can be reached. The CFDD also serves to establish a common understanding of the facility concept among all responsible FFTF Project parties including the Architect Engineer and Reactor Designer.

Section 1.0 FUNCTIONS AND DESIGN REQUIREMENTS of this CFDD is Baseline information. The balance of the information is the present Reference Design Only.

Included are the basis for concept selection, process work load requirements, a list of interface areas, and a list of support information necessary to proceed with and complete Preliminary Design.

The contents of this document support and expand the requirements established in the Overall Conceptual Systems Design Description.[1]

1. Refer to References, Appendix A, Item 3.

SECTION 1.0 FUNCTIONS AND DESIGN REQUIREMENTS

1.1 FUNCTIONS

The basic functional objective of the Inert Gas Cell Examination Facility is to provide a reliable means, under controlled environmental conditions, to:

- Retrieve postirradiation data from fuels, materials, and components irradiated in the FTR
- Service defective core components irradiated in the FTR.

The capability to perform the following functions is provided:

A. Interim nondestructive examination during a single reactor outage of selected fuels, materials and components irradiated in FTR.

B. Interim disassembly, nondestructive examination and reassembly (during one or more operating cycles) of fuels, materials and components irradiated in the FTR.

C. Disassembly and nondestructive examination of fuels, materials and components irradiated in the FTR whose irradiation is complete.

D. Prepare fuels, materials, and components irradiated in the FTR for transfer to interface systems.

E. Collect and record data obtained during examination operations.

F. Replace individual test subassembly specimens prior to completion of subassembly irradiation.

G. Repair or replace defective instrumentation attached to fuels, materials, and components irradiated in FTR.

1.2 DESIGN REQUIREMENTS

The design requirements for performing the facility functions as well as assuring plant and personnel safety, plant availability and preservation of data are listed below:

1.2.1 Basic Design Requirements

1.2.1.1 General Requirements

A. The facility shall be designed to permit completely remote operation and to meet the examination processing load[1,2] and effectiveness goals[3] for examination of fuels, materials, and components discharged from the FTR.

B. The facility shall be capable of handling vented or failed fuels including those containing plutonium or materials which react with water or water vapor.[4,5]

C. Design, fabrication and construction of this facility shall conform to the most recent issue of codes and standards listed in "Hanford Standard Design Criteria," HWS-10006,[4] or standards which shall be prepared as necessary to meet special requirements.

D. Detailed criteria and responsibilities for determining and verifying the quality of the facility shall be defined for the following:
   1. Design adequacy
   2. Fabrication and construction quality
   3. Operations capability

1.2.1.2 Equipment Requirements

A. Provisions shall be made for storage[1,2,6] of fuels, materials and components undergoing examination in the cell bank. Storage locations shall be shielded to reduce total radiation dose[7] to in-cell materials.

---

1. Refer to Examination Process Load Requirements, Appendix F.
2. Refer to Support Information Requirements, Appendix B, Item1.
3. Refer to References, Appendix A, Item 30.
4. Refer to References, Appendix A, Item 23.
5. Refer to References, Appendix A, Item 5.
6. Refer to Interfaces, Appendix C, Item 15.
7. Refer to Support Information Requirements, Appendix B, Item 8.

B. Equipment or means[1] shall be provided to remotely prepare in-cell solid waste for disposal.[2]

C. Equipment or means[3] shall be provided for remote cleanup and decontamination of cell interiors and preliminary decontamination of equipment prior to removal from the cell.

D. Remotely controlled equipment[4,5] shall be provided for performing the interim and final examination operations shown in Table I on fuels, materials and components[6,7] irradiated in the FTR.

E. Insofar as practical, in-cell examination and support equipment shall be designed for remote removal, installation and maintenance. Simple flexible and modular equipment shall be stressed.

F. Wherever practical, examination equipment shall be designed for remote readout and recording of data.[8,9]

G. In-cell examination and support equipment shall be designed for ease of decontamination and contact maintenance. Where practical the materials used and the decontamination processes[3] selected shall be compatible. The designs shall provide for ease of removal and installation of equipment parts not compatible with decontamination processes.

---

1. Refer to Support Information Requirements, Appendix B, Item 9.
2. Refer to Interfaces, Appendix C, Item 7.
3. Refer to Support Information Requirements, Appendix B, Item 11.
4. Refer to Equipment List, Appendix E.
5. Refer to Support Information Requirements, Appendix B, Items 1 and 4.
6. Refer to Interfaces, Appendix C, Items 10-13, 17, 18 and 21.
7. Refer to Examination Process Load Requirements, Appendix F.
8. Refer to Interfaces, Appendix C, Item 21.
9. Refer to Support Information Requirements, Appendix B, Item 5.

TABLE I. Examination Operations

Operation[1]	Limited Interim Examination[2]	Extended Interim Examination[3]	Final Nondestructive Examination
Duct removal	X	X	X
Disassembly		X	X
Reassembly		X	
Visual inspection	X	X	X
Photography	X	X	X
Overall dimensional measurement	X	X	X
Interpin spacing measurement	X	X	X
Length, warp and cross-section measurement of pins, specimens and hardware		X	X
Fuel pin defecting		X	
Neutron radiography	X	X	X
Gamma scanning	X	X	X
Weighing of assemblies	X	X	X
Fuel pin balance point determination		X	X

1. Refer to References, Appendix A, Items 2 and 17 through 23.
2. Limited Interim Examination Operations are performed on those selected fuels materials and components irradiated in the FTR whose decay heat output, inspection requirements and design permit inspection and return to the reactor to be completed during a scheduled reactor outage.
3. Extended Interim Examination Operations are performed on those fuels, materials and components irradiated in the FTR whose decay heat output, inspection requirements and design require the additional processing time of one or more reactor operating cycles before return to the FTR. Replacement specimens can include the original specimens, nonirradiated specimens or specimens previously irradiated at the FTR or other sites.

TABLE I. (contd)

Operation[1]	Limited Interim Examination[2]	Extended Interim Examination[3]	Final Nondestructive Examination
Instrumentation tests	X	X	X
Instrumentation repair		X	
Replace duct	X	X	
Weighing of capsules, pins and specimens		X	X
Leak testing		X	X
Sodium bond and level testing		X	X
Fission gas collection and measurement		X	X
Backfill and seal after fission gas collection		X	
Milling and cutting of capsules, hardware and irradiated components			X
Preparation of specimens for shipment			X
Sodium drain and fill		X	X

1. Refer to References, Appendix A, Items 2 and 17 through 23.
2. Limited Interim Examination Operations are performed on those selected fuels materials and components irradiated in the FTR whose decay heat output, inspection requirements and design permit inspection and return to the reactor to be completed during a scheduled reactor outage.
3. Extended Interim Examination Operations are performed on those fuels, materials and components irradiated in the FTR whose decay heat output, inspection requirements and design require the additional processing time of one or more reactor operating cycles before return to the FTR. Replacement specimens can include the original specimens, nonirradiated specimens or specimens previously irradiated at the FTR or other sites.

H. Equipment or methods shall be provided to control the deposition of sodium vapor on in-cell surfaces and equipment to within acceptable limits.[1]

I. Equipment shall be provided to remove sodium[1,2,3] from irradiated fuel and materials test subassemblies and core components prior to examination and shall be adequate to permit reinsertion into the FTR when required (Refer to 1.2.1.1B).

1.2.1.3 Radiological Control Requirements

A. Confinement systems[4,5,6] shall be designed to control the environmental release of radionuclides to quantities within the requirements of AEC Manual, Chapter 0524, and RL Supplement RL-0524-01.

B. Respiratory protection such as masks for use with breathing air[7,8] from manifolds or portable fresh air cannisters shall be available in operating galleries and radiation zone support areas.

C. Air sampling heads[7,8] shall be available in operating galleries and radiation zone support areas.

D. Air balance[5] shall insure air flow from low radioactive zones to zones of higher radioactivity. Highest pressure in the facility shall be negative with respect to the outside atmosphere.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Support Information Requirements, Appendix B, Items 1 and 13.
3. Refer to Interfaces, Appendix C, Item 15.
4. A confinement system depends upon ventilation control and treatment of exhaust gas to remove airborne radionuclides other than noble gases before the gas is discharged through a stack.
5. Refer to Interfaces, Appendix C, Items 8 and 19.
6. Refer to References, Appendix A, Items 13 and 14.
7. Refer to Interfaces, Appendix C, Item 5.
8. Refer to References, Appendix A, Item 25.

E. Emergency systems,[1] alarms[2] and procedures shall be provided to insure maintenance of the proper air flow patterns between zones, rooms, cells and hoods.

F. Exhaust gas from a cell or hood shall be filtered by dual high efficiency (99.95% for 0.3 micron particles) fire retardent filters,[2] both readily and remotely changeable.

G. Chemical cleanup systems[1] or decay holdup tanks shall be available for volatile exhaust wastes such as iodine, cesium, antimony, ruthenium, tellurium.

H. Provisions shall be made for sampling downstream from filters or cleanup systems.[2]

I. Means shall be provided for identification of fuels, materials and components during handling, storage, examination and packaging for safety,[3,4] accountability[5,6,7] and data preservation purposes.

J. Equipment shall be provided for monitoring in-cell radiation levels.[3,7,8]

K. Radiation monitoring equipment, including critical radiation alarms, high gamma area alarms, continuous alpha and beta-gamma airborne monitors, and personnel monitoring instruments shall be provided throughout the facility consistent with FFTF Design Safety and Radiation Control Criteria.[3,7,8]

---

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to Interfaces, Appendix C, Items 8 and 19.
3. Refer to References, Appendix A, Item 14.
4. Refer to References, Appendix A, Item 9.
5. Refer to Support Information Requirements, Appendix B, Item 5.
6. Refer to Interfaces, Appendix C, Item 20.
7. Refer to Support Information Requirements, Appendix B, Item 8.
8. Refer to Interfaces, Appendix C, Item 23.

L. Emergency backup fuel cooling equipment[1,2] will be provided independent of the normal fuel temperature control systems as specified in the FFTF Design Safety Criteria 1.2.4E.

1.2.2 Concept-Related Design Requirements

1.2.2.1 Facility Arrangement Requirements

A. The cell bank[3] shall be sized and/or arranged[4] to permit:
   1. Transfer of fuels, materials, and components[5] to and from interface systems.[6]
   2. Cleaning[6,7] and storage[6] of fuels, materials, and components in a vertical position.[8]
   3. Remote handling,[9] disassembly, reassembly and interim examination of fuels, materials, and components in a vertical position.[8]
   4. Remote installation and removal of in-cell equipment.
   5. Simultaneous performance of independent handling and examination operations.
   6. Adequate in-cell shielding.[10]
   7. Preliminary decontamination of highly contaminated equipment.

B. The facility shall be designed to permit future linear expansion of the cell bank.[9,11]

---

1. Refer to Support Information Requirements, Appendix B, Item 3.
2. Refer to References, Appendix A, Item 11.
3. Refer to Interfaces, Appendix C, Item 4.
4. Refer to Design Evaluation, Appendix D, Item 2.
5. Refer to Interfaces, Appendix C, Items 10-12, 17, 18 and 21.
6. Refer to Interfaces, Appendix C, Item 15.
7. Refer to Support Information Requirements, Appendix B, Items 1 and 13.
8. Refer to References, Appendix A, Item 23.
9. Refer to References, Appendix A, Item 1.
10. Refer to Support Information Requirements, Appendix B, Item 8.
11. Refer to Interfaces, Appendix C, Item 5.

C. A decontamination cell shall be provided by interface systems[1] and equipped for cleaning[2] of contaminated equipment prior to contact decontamination and maintenance or storage. The cell shall be located adjacent to the equipment transfer lock in the cell bank.

D. Cell operating galleries[3] shall be sized to permit installation and removal of handling, control and recording equipment, and movement of equipment and personnel.

E. Adequate operational support areas[3] and equipment shall be provided adjacent to the cell bank for the following:

1. Contact decontamination, maintenance and storage of contaminated equipment.[1,2]
2. Processing and storage of film.
3. Data storage and reduction.[4,5]
4. Storage of consumable supplies, spare parts, and spare equipment.
5. Mockup and functional testing of new equipment and procedures.
6. Personnel change room.[3]
7. Clean laundry storage.[3]
8. Personnel decontamination.[3]
9. Health monitoring office[3] and counting equipment.[6,7]
10. Laboratory offices.[3]
11. Contaminated laundry storage.[3]
12. Movement of equipment and materials.

---

1. Refer to Interfaces, Appendix C, Item 16.
2. Refer to Support Information Requirements, Appendix B, Item 11.
3. Refer to Interfaces, Appendix C, Item 4.
4. Refer to Support Information Requirements, Appendix B, Item 5.
5. Refer to Interfaces, Appendix C, Item 20.
6. Refer to Interfaces, Appendix C, Item 23.
7. Refer to Support Information Requirements, Appendix B, Item 8.

F. Provisions[1] shall be made for infrequent personnel entry into the cells under controlled conditions. Design shall facilitate ease of personnel entry and provide for retrieval of personnel in an emergency. Suits with life support services[2] such as breathing and cooling air, and communications shall be provided for paired personnel entry during a major outage after penetrating radiation levels have been reduced to permissible levels.

1.2.2.2 Service Requirements

A. Automatic temperature and pressure recording and controlling equipment shall be provided by interface systems[4] to monitor and control the operation of the gas atmosphere[3] handling equipment.

B. Equipment shall be provided by interface systems[4] to record and monitor impurity levels in the inert gas cell atmosphere.[3]

C. Standby or redundant inert gas atmosphere cooling and circulating equipment[3,4] shall be automatically energized when required in the event a failure occurs in the units which are being operated.

D. Adequate in-cell illumination[5,6] (including color correction) and lighting control shall be provided for visual inspection and photography of fuel, materials, and components irradiated in the FTR; visual control of remote operations, television[7] and personnel entry into the cell.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Interfaces, Appendix C, Items 2 and 6.
3. Refer to Support Information Requirements, Appendix B, Item 2.
4. Refer to Interfaces, Appendix C, Items 19 and 22.
5. Refer to Interfaces, Appendix C, Item 3.
6. Refer to Support Information Requirements, Appendix B, Item 10.
7. Refer to Interfaces, Appendix C, Item 2.

Lights shall be protected against mechanical damage and located so as to reduce glare.

E. Lighting intensity[1] in each cell operating gallery shall be controllable to minimize reflections on windows during inspection and photography operations.

F. Provisions shall be made for remote replacement of in-cell lights.[1]

G. Communications equipment[2] such as telephones, intercom, public address shall be provided throughout the facility. Communications shall be provided between cell operating stations and for suited entry into cells. In-cell microphones connected to speakers at operating stations shall be provided to assist remote control of cutting or machining operations.[3]

H. Service panels shall be provided at each cell operating station and supplied with:

1. 110 V ac electrical outlets[4]
2. Intercom outlets[2]
3. TV outlets[2]
4. In-cell lighting intensity controls[1]
5. Electric manipulator key locked control outlets[4]
6. Bridge crane key locked control outlets[4]
7. High and low pressure inert gas outlets.[5]

---

1. Refer to Interfaces, Appendix C, Item 3.
2. Refer to Interfaces, Appendix C, Item 2.
3. Refer to References, Appendix A, Item 16.
4. Refer to Interfaces, Appendix C, Item 1.
5. Refer to Interfaces, Appendix C, Items 6 and 19.

I. Cell wall service[1] penetrations shall be sealed to preclude in-leakage of impurities into the inert atmosphere[2] and special services[3] shall be routed through replaceable service plugs.

J. Provisions shall be made to minimize air in-leakage and to confine contamination during replacement of service plugs.

K. Service panels shall be provided in each operating gallery area and supplied with:
   1. 110 V ac electrical outlets[4]
   2. Intercom outlets[5]
   3. Telephone outlets[5]
   4. Gallery lighting intensity control[6]
   5. Data control outlets.[7]

L. Support areas shall be provided with the services[8] required for the area. This includes heating and ventilation, lighting, electrical power, fire detection, sanitary and process sewer, water, steam, high pressure air, laboratory vacuum and communication.

---

1. Refer to Interfaces, Appendix C, Items 1, 2, 3, 4, 6, 7, 19 and 22.
2. Refer to Support Information Requirements, Appendix B, Item 2.
3. Refer to Support Information Requirements, Appendix B, Item 4.
4. Refer to Interfaces, Appendix C, Item 1.
5. Refer to Interfaces, Appendix C, Item 2.
6. Refer to Interfaces, Appendix C, Item 3.
7. Refer to Interfaces, Appendix C, Items 20 and 22.
8. Refer to Interfaces, Appendix C, Items 1-3, and 6-9.

1.2.2.3 Equipment Requirements

A. Equipment[1,2] shall be provided for forced gas cooling of fuel specimens to about 600 °F cladding temperature (higher cladding temperatures could be tolerated in specific tests) during handling, examination and storage. Total heat removal capability (heat removal capability depends upon fuel subassembly design, permissible cladding temperature, allowable drag or vibration forces and decay heat output per fuel pin) for a fuel subassembly will be:
   1. Up to 20 kW for forced gas cooling with axial flow.
   2. Up to 10 kW for forced gas cooling with transverse (suction) flow.

B. Equipment for forced gas cooling shall be instrumented to monitor:
   1. Flowrate
   2. Pressure drop
   3. Inlet gas temperature
   4. Outlet gas temperature.

C. Instrumentation[3] shall be provided to monitor cladding temperature of fuel test pins that are instrumented with surface thermocouples.

D. Fuel cladding temperatures shall be controlled by varying the cooling gas flowrate within limits determined by:
   1. Calculated flowrate and outlet temperature for specified cladding temperature.
   2. Signal from a surface thermocouple on an instrumented test pin.

---

1. Refer to Support Information Requirements, Appendix B, Items 1 and 3.
2. Refer to References, Appendix A, Item 11.
3. Refer to Interfaces, Appendix C, Item 22.

E. Remote controlled crane(s)[1] shall be provided and sized for handling and transfer of in-cell equipment and core component assemblies.[2]

F. Remote controlled electro-mechanical manipulator(s)[1] shall be provided and sized for manipulating tools, fixtures and parts of assemblies.

G. In-cell handling equipment shall be capable of servicing the cell bank and transferring fuel, materials and components irradiated in the FTR to and from interface systems.[3] Cell servicing includes removal and installation of equipment, parts or modules and transfer of irradiated fuels, materials and components within the cell bank.

H. Sealed transfer devices, ports or locks, designed to minimize in leakage of impurities into the inert atmosphere shall be installed in the cell wall[4] for:

1. Transfer of consumable supplies and small parts
2. Removal and introduction of equipment
3. Removal of solid waste[5]
4. Transfer of packaged specimens to shipping casks.

I. Visual access to all areas of the cell bank shall be provided through a combination of sealed windows,[6] binoculars, periscopes and television[7] systems.

---

1. Refer to References, Appendix A, Item 1.
2. Refer to Interfaces, Appendix C, Items 10-12, 17, 18 and 21.
3. Refer to Interfaces, Appendix C, Item 15.
4. Refer to Interfaces, Appendix C, Item 4.
5. Refer to Support Information Requirements, Appendix B, Item 9.
6. Refer to Support Information Requirements, Appendix B, Item 7.
7. Refer to Interfaces, Appendix C, Item 2.

J. Viewing windows shall be designed and provisions made so that heat, radiation or mechanical damage will not affect the shielding, sealing, or confinement qualities of the windows. Remotely replaceable alpha seal plates shall be provided to permit replacement of windows without loss of confinement.

K. Initial viewing window light transmission shall be about 25%.[1] Stabilized glass, replaceable glass sections, or shielded shutters shall be used for protection of the viewing windows from radiation darkening such that window light transmission remains above 10% after twenty years.

1.2.3 Firm Design Choices

A. Inert atmosphere cells shall be lined with stainless steel[2,3,4,5] to assist control of atmosphere purity and decontamination of the cell.

B. A filtered, cooled and purified inert gas atmosphere[6,7] shall be provided by interfacing systems[8] in cell areas where irradiated fuels and materials are handled and examined. The purification system shall maintain the oxygen and moisture levels at about 25 ppm each, while feed and bleed shall control nitrogen concentrations. The capability for changing the cells atmosphere to air during a major outage shall be provided.

---

1. Refer to Support Information Requirements, Appendix B, Item 7.
2. Refer to Interfaces, Appendix C, Item 4.
3. Refer to Support Information Requirements, Appendix B, Item 6.
4. Refer to Conceptual Design Evaluation, Appendix D, Item 3.
5. Refer to References, Appendix A, Item 24.
6. Refer to Support Information Requirements, Appendix B, Item 2.
7. Refer to Conceptual Design Evaluation, Appendix D, Item 4.
8. Refer to Interfaces, Appendix C, Item 19.

C. Two sealed master-slave manipulators[1] shall be provided (where required) at each cell operating station for increased handling dexterity.

1.2.4 Design Safety Criteria

The following Design Safety Criteria A through Q are identical with the italicized portions of Section 27, Design Safety Criteria for the Inert Gas Cell Examination Facility.[2]

A. Radiological shielding[3,4,5] for the inert gas examination cells will be designed to limit radiation dose rates, from core components being handled or stored inside the cells, to values below the following for normal operations: (DSC 1.1)[2]

- 0.2 mrem/hr in locations that are routinely occupied[6]
- 2.0 mrem/hr in locations that are not routinely occupied[6]

Positive physical barriers will be provided to control personnel access in areas where the dose rates exceed 10 rem/hr, or the concentration of radionuclides in air is greater than 1,000 times the control concentration.

B. The Inert Gas Cell Examination Facility will be provided with the capability to operate with an inert gas atmosphere.[7] The composition of the atmosphere will be controlled to levels required to prevent sodium combustion and corrosion damage to fuel subassemblies. Concentrations of deleterious gas contaminants in excess of predetermined safe levels will read out and alarm in the control room. (DSC 1.2)[2]

---

1. Refer to References, Appendix A, Items 1 and 12.
2. Refer to References, Appendix A, Item 14, Section 27.
3. Refer to Interfaces, Appendix C, Item 4.
4. Refer to References, Appendix A, Item 10.
5. Refer to Support Information Requirements, Appendix B, Item 8.
6. Refer to References, Appendix A, Item 25.
7. Refer to Interfaces, Appendix C, Items 19 and 22.

C. Confinement systems[1,2] will be provided for control and treatment of exhaust gases during transfer, examination, and processing of fuel and during decontamination and maintenance of contaminated equipment. (DSC 1.3)[3]

D. The design of the facility will include provisions for maintaining Cell Bank pressure at least 1/4 in. W.G. pressure[1,4] less than the surrounding operating galleries. (DSC 1.4)[3]

E. Redundant and/or backup features will be provided in the design such that cooling of the fuel subassemblies and experiments can be assured based on removal of the highest expected decay heat output. (DSC 1.5)[3]

F. Instrumentation will be provided to monitor and control fuel subassembly and experiment cooling systems at all times. (DSC 1.6)[3]

G. The fuel subassembly and experiment handling equipment will be designed with redundancy or backup features as appropriate, so that no single component failure will result in fuel damage which exceeds levels allowable under Criteria for Accident Severity Levels.[5] (DSC 1.7)[3]

H. Redundant and/or backup features will be employed in the design of the cell atmosphere cooling system[6] such that cooling of the cell can be accomplished if normal cooling is lost. (DSC 1.8)[3]

I. Fuel storage[7,8] facilities will be designed to prevent criticality. Safe geometry is the preferred means of designing for criticality safety and will be utilized wherever possible. (DSC 1.9)[3]

---

1. Refer to Interfaces, Appendix C, Items 8 and 19.
2. Refer to References, Appendix A, Item 13.
3. Refer to References, Appendix A, Item 14, Section 27.
4. Refer to References, Appendix A, Items 8 and 25.
5. Refer to References, Appendix A, Item 14, Section 1.
6. Refer to Interfaces, Appendix C, Item 19.
7. Refer to References, Appendix A, Item 9.
8. Refer to Interfaces, Appendix C, Item 15.

J. The Inert Gas Cell Examination Facility will be designed to prevent flooding. (DSC 1.10)[1]

K. In-cell materials,[2,3] components and equipment will be selected and designed for stable and reliable operation under environmental conditions such as high radiant heat loads, sodium vapor deposition, inert gas atmosphere, and high radiation levels. (DSC 1.11)[1]

L. Emergency power[4] will be provided for support systems and/or equipment to operate the Inert Gas Cell Examination Facility as follows: (DSC 1.12)[1]

- Fuel subassembly[5] and cell atmosphere cooling systems[6]
- Inert Gas Circulation System[6]
- Ventilation Exhaust System[7]
- Criticality monitors, continuous air monitors, and area radiation monitors[8]
- Equipment necessary to move a subassembly to a safe location
- Selected lighting.[9]

M. The Cell Bank will be provided with a pressure relief device[6] vented to the stack[7] via the filtration system. (DSC 1.13)[1]

N. Instrumentation[10] will be provided to monitor exhaust filters for pressure drop. (DSC 1.14)[1]

---

1. Refer to References, Appendix A, Item 14, Section 27.
2. Refer to Support Information Requirements, Appendix B, Item 6.
3. Refer to Conceptual Design Evaluation, Appendix D, Item 5.
4. Refer to Interfaces, Appendix C, Item 1.
5. Refer to Support Information Requirements, Appendix B, Item 3.
6. Refer to Interfaces, Appendix C, Item 19.
7. Refer to Interfaces, Appendix C, Item 8.
8. Refer to Interfaces, Appendix C, Item 23.
9. Refer to Interfaces, Appendix C, Item 3.
10. Refer to Interfaces, Appendix C, Item 22.

O. Neutron sensitive criticality detectors as described in BNWL-MA-29[2] will be provided for the Inert Gas Cell Examination Facility with alarms as designated by HWS-8210-S.[3,4] (DSC 1.15)[1]

P. Continuous air monitoring and sampling equipment sensitive to alpha and beta-gamma activity, will be provided for the Inert Gas Cell Examination Facility.[4,5] (DSC 1.16)[1]

Q. Radiation area monitors sensitive to gamma radiation will be provided for the Inert Gas Cell Examination Facility.[4,5] (DSC 1.17)[1]

---

1. Refer to References, Appendix A, Item 14, Section 27.
2. Refer to References, Appendix A, Item 33.
3. Refer to References, Appendix A, Item 34.
4. Refer to Interfaces, Appendix C, Item 23.
5. Refer to Support Information Requirements, Appendix B, Item 8.

SECTION 2.0 PHYSICAL DESCRIPTION OF THE FACILITY

The Inert Gas Cell Examination Facility Conceptual Design is based on the Functions (Section 1.1) and on the Design Requirements (Section 1.2) as applicable to the reference vertical core FFTF Reactor Concept.[1] This facility concept provides the operations staff and experimentors with a means for retrieving (under controlled environmental conditions) post-irradiation data on fuels, materials, and components irradiated in the FTR. The facility also provides the means for servicing fuel, material and component assemblies such as replacing test specimens and repairing or replacing defective instrumentation.

The facility arrangement, size and equipment described in this concept is dependent on other FFTF system concepts,[1,2] core components configuration[3] and Functional Testing Requirements.[4,5] Therefore, this concept is subject to review and revision as other interface FFTF systems concepts are finalized.

2.1 SUMMARY DESCRIPTION

Fuels, materials and components to be examined or serviced in the facility will be representative of those for use in liquid metal fast breeder reactors. These include vented and aqueous reactive fuels which may be tested to failure. Since a controlled environment is required for processing such materials, a facility containing a purified argon atmosphere, shielded confinement system (cell bank) and necessary operational

1. Refer to References, Appendix A, Items 3 and 31.
2. Refer to Interfaces, Appendix C, Items 4, 15 and 16.
3. Refer to Interfaces, Appendix C, Items 10, 11, 12, 17, 18 and 21.
4. Refer to Support Information Requirements, Appendix B, Item 1.
5. Refer to References, Appendix A, Item 23.

support areas is provided. The cell bank is equipped for completely remote operations and safe handling of highly radioactive materials. The facility is designed to ensure that reliable data is obtained from the post-irradiation examination of fuels, materials, and components irradiated in the FTR.

2.1.1 Arrangement

The Inert Gas Cell Examination Facility arrangement is based on the efficient in-line flow of fuel, materials, and components from the FTR to the examination cells. Location of the examination facility adjacent to, and in line with the Fuel Handling Cell as part of a common cell bank provides for maximum utilization of the Fuel Handling Cell as a common zone for the cleaning, storage and transfer of fuels, materials and components. The cell bank arrangement also takes into consideration the examination processing load of fuels, materials and components irradiated in the FTR and an efficient flow sequence from the reactor, into the examination cells and back to the reactor.

Space and handling and examination equipment or means are provided in the cell bank to meet all functions and examination processing requirements as follows:

A. Limited nondestructive interim examination of open test position and closed loop test assemblies irradiated in the FTR that can be removed from, and examined and returned to the reactor during a single reactor outage.

B. Extended nondestructive interim examination of open test position and closed loop test assemblies, driver fuel assemblies and other core components irradiated in the FTR that require one or more operating cycles for removal from, examination and return to the reactor. This equipment includes the capability for repair and replacement of defective instrumentation and for replacement of individual fuel pins or specimens.

C. Disassembly of assemblies, capsules and components irradiated in the FTR whose irradiation has been completed.
D. Final examination of driver fuel and test assemblies, capsules, fuel pins, specimens (fuel and materials) and components irradiated in the FTR whose irradiation has been completed.
E. Packaging of fuel pins, capsules, specimens (fuel or materials) and components irradiated in the FTR whose irradiation is complete, have been examined and are ready for shipment.
F. Critically-safe, cooled and shielded storage of capsules, fuel pins, specimens and components irradiated in the FTR and being examined.
G. Identification of assemblies, fuel pins, specimens and components irradiated in the FTR during handling, storage, examination and packaging.
H. Service the cell bank.
I. Transfer fuels, materials, and components irradiated in the FTR to and from the Fuel Handling Cell, and to and from stations within the cell bank.
J. Portable subassembly cooling and vapor control during transferring and processing of fuel assemblies.

The Examination Facility portion of the cell bank is arranged as a sealed shielded confinement system consisting of three (3) in-line cells surrounded by operating galleries and support areas. All three cells operate with a filtered, cooled and purified argon atmosphere, under slightly negative pressure, to prevent loss of experimental data or reaction with fuels and materials being examined. These three cells or cell areas are the Interim Examination and Disassembly Cell, the Equipment

Storage and Transfer Cell and the Detailed Examination Cell. The Interim Examination and Disassembly Cell is sized for handling and processing core component assemblies 40 to 45 feet long in a vertical orientation.

Space is allocated in the adjacent Fuel Handling Cell for special sodium removal equipment provided by the Inert Gas Cell Examination Facility. This equipment will be used to clean sodium from vented or failed test assemblies or from those assemblies that cannot be cleaned by the normal sodium removal equipment provided in the Fuel Handling Cell.

2.1.2 Interim Examination and Disassembly Area

The Interim Examination and Disassembly Cell, located adjacent to the Fuel Handling Cell, is sized and equipped to accommodate fuel, material and component assemblies designated for interim or final examination which must be transferred, handled, cooled (cooling of fuel subassemblies is required during processing), disassembled, examined and reassembled in a vertical position. The following equipment is provided for this area:

A. Assembly transfer and handling equipment
B. Disassembly and reassembly machine
C. Subassembly cooling equipment
D. Subassembly measuring equipment (overall length and inter-pin spacing dimensions)
E. Assembly weighing equipment
F. Instrumentation testing equipment
G. Camera systems
H. Viewing windows
I. Cell service plugs
J. Visual aids (binoculars, "Questar" telescope and television)

K. Periscopes
L. Neutron radiography equipment
M. Duct and hanger rod storage racks
N. Gamma scanning equipment
O. Master slave manipulators
P. Electro-mechanical manipulators (post mounted)
Q. Small equipment through wall transfer device
R. Work platforms
S. Protective cell entry equipment

2.1.3 Equipment Storage and Transfer Area

The Equipment Storage and Transfer Cell, next in line, provides a shielded storage and remote maintenance area for all remotely operated in-cell equipment. It also acts as a transfer area for equipment to be remotely installed in the cell bank and for equipment being transferred from the cell bank for decontamination, contact maintenance, repair or storage. The following equipment is provided for this area:

A. Bridge cranes (service entire cell bank)
B. Master slave manipulators
C. Portable shielded hoist
D. Electro-mechanical manipulators, bridge mounted (service entire cell bank)
E. Large equipment transfer device
F. Viewing windows
G. Decontamination equipment
H. Cell service plugs
I. Visual aids (binoculars, "Questar" telescope, and television)
J. Waste transfer device
K. Work platforms
L. Protective cell entry equipment

2.1.4 Detailed Examination Area

The Detailed Examination Cell, last in line, is sized to accommodate capsules to be disassembled and reassembled, and fuel pins, fuel and material specimens, and component parts to be examined, stored and packaged for shipment. The following equipment is provided for this area:

A. Milling machine and accessories
B. Camera systems
C. Viewing windows
D. Cell service plugs
E. Visual aids (binoculars, "Questar" telescope, and television)
F. Periscope
G. Borescope
H. Pin and specimen measuring equipment
I. Weighing equipment
J. Pin leak testing equipment
K. Bond test equipment
L. Fuel pin defecting
M. Fission gas collection equipment
N. Fuel, material and component packaging equipment
O. Waste preparation equipment
P. Fuel pin balance determination equipment
Q. Sodium drain and fill equipment
R. Fuel pin and specimen storage (critically-safe, shielded and cooled)
S. Fuel pin and specimen transfer and storage racks
T. Material and component storage
U. Master slave manipulators
V. Small equipment through-wall transfer device
W. Work platforms

2.1.5 Support Areas

The operating galleries surround the cell bank to provide visual and handling control of in-cell operations. Space is provided to accommodate installation and removal of manipulator master ends, for the movement of operational and FFTF experimenter personnel, and for the installation and movement of equipment and consoles.

Adequate operational support areas and equipment are provided for efficient operation of the facility. Space and equipment is provided for the following:

A. Decontamination cell
B. Equipment transfer tunnel
C. Contact decontamination, maintenance repair and storage of contaminated equipment
D. Radiographic processing
E. Processing and storage of film
F. Data storage and reduction
G. Storage of consumable supplies, spare parts, and spare equipment
H. Mockup and functional testing of new equipment and procedures
I. Personnel change room
J. Clean laundry storage
K. Personnel decontamination
L. Health monitoring office and counting equipment
M. Offices
N. Contaminated laundry storage
O. Janitorial closets (contaminated and noncontaminated)

2.2 DETAILED DESCRIPTION

The Inert Gas Cell Examination Facility (see facility arrangement drawings)[1] arrangement with adjacent facilities and systems within the FFTF is based on the efficient in-line flow of FFTF fuel and test assemblies from the FTR to the examination cells. The facility cells are designed to permit completely remote operation[2] under controlled environmental processing conditions and to meet the examination processing load[3,4,5] of fuels materials and components irradiated in the FTR.

2.2.1 Process Cells

Location of the examination facility as part of a common cell bank,[6] adjacent to and in-line with the Fuel Handling Cell[7] permits utilization of the Fuel Handling Cell as a common zone for efficient transfer of irradiated FTR fuels, materials, and components between the Inert Gas Cell Examination Facility and the Storage and Loadout Basin[7] and the Reactor Refueling System.[8] The examination facility is arranged as a sealed, shielded confinement system consisting of three in-line cells[9] surrounded by operating galleries and support areas.[6] The arrangement takes into consideration need for possible future linear expansion[2,10] of the cell bank because of changes in processing loads and examination requirements. It is arranged to provide flexibility for changing equipment to more advanced remote handling, examination or processing systems, in the future.

---

1. Refer to Drawings, Appendix G.
2. Refer to References, Appendix A, Item 1.
3. Refer to References, Appendix A, Item 23.
4. Refer to Support Information Requirements, Appendix B, Item 1.
5. Refer to Examination Process Load Requirements, Appendix F.
6. Refer to Interfaces, Appendix C, Item 4.
7. Refer to Interfaces, Appendix C, Item 15.
8. Refer to Interfaces, Appendix C, Item 13.
9. Refer to Conceptual Design Evaluation, Appendix D, Item 2.
10. Refer to Interfaces, Appendix C, Item 5.

Space is provided in each cell for installation of all equipment[1] needed to fulfill the cell functions and requirements and thereby insure maximum operating efficiency. Although in-cell equipment reliability will be stressed, space is allowed for remote removal and installation of equipment for maintenance or replacement[2] without affecting operations within the cell.[3] Arrangement and the location of operating stations is such as to permit flow of material into, out of and between operating stations without interfering with examination work.

2.2.1.1 Interim Examination and Disassembly Cell

The Interim Examination and Disassembly Cell, adjacent to and interfacing with the Fuel Handling Cell,[4] is sized to accommodate fuel, material or component assemblies[5] designated for interim or detailed examination. The cell is sized to permit complete core component assemblies[5] to be handled, cooled (fuel only), disassembled, examined and reassembled in a vertical position[6] to preserve data.

Inside cell dimensions are approximately 20 feet in depth (wall to wall), × 20 feet wide × 65 feet high. Twelve operating stations are provided, two on each of the cell operating walls at three different operating levels (0 feet, 15 feet and 30 feet).

A sealed door[7] is provided to isolate the Inert Gas Cell Examination Facility portion of the common cell bank from the Fuel Handling Cell when required to maintain environmental conditions and during a major outage in the examination facility or the

1. Refer to Equipment List, Appendix E.
2. Refer to References, Appendix A, Item 6.
3. Refer to References, Appendix A, Item 1.
4. Refer to Interfaces, Appendix C, Item 15.
5. Refer to Interfaces, Appendix C, Items 10, 11, 12, 17, 18 and 21.
6. Refer to References, Appendix A, Items 22 and 23.
7. Refer to Interfaces, Appendix C, Item 4.

Fuel Handling Cell. The need for this door will be evaluated during preliminary design. A sealed, shielded access plug and door[1] is provided at the cells lowest level to allow suited personnel entry during a major outage. A sealed shielded access plug[1] is provided in the cell ceiling to allow remote removal and installation of long (greater than 6 feet) equipment modules.

2.2.1.2 Equipment Storage and Transfer Cell

The Equipment Storage and Transfer Cell (the next cell in the line) provides a shielded storage and preliminary decontamination area for remotely operated in-cell equipment. It also acts as a transfer area for equipment to be remotely installed in the cell bank and for equipment being transferred from the cell bank for decontamination,[2] contact maintenance,[2] repair or storage. Solid waste[3] or packaged fuel pins and specimens may be transferred through the cell ceiling to casks for shipment off site or disposal.

Inside cell dimensions are approximately 20 feet in depth (wall to wall) × 16 feet wide × 20 feet high.

Two operating stations serve the cell, one on each operating wall at the 30 feet operating level. A third viewing window is located near the ceiling of the cell to provide visual control for crane and electro-mechanical manipulator maintenance, remote removal and installation.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Interfaces, Appendix C, Item 16.
3. Refer to Interfaces, Appendix C, Item 7.

Two shielding doors are supplied to provide shielding for equipment stored within the cell. The need for the shielding doors and space required for lowering of crane or electromechanical manipulator bridges will be evaluated during preliminary design. A sealed, shielded access plug[1] and door is provided in the side of the cell to permit paired suited personnel entry during a major outage. An equipment access port approximately 6 feet in diameter is located in the cell floor. It is covered with a sealed and shielded hatch.[1]

2.2.1.3 Detailed Examination Cell

The Detailed Examination Cell is sized to accommodate equipment for processing capsules, fuel pins, fuel and material specimens and components. Inside cell dimensions are approximately 20 feet in depth (wall to wall) × 42 feet long × 20 feet high. Twelve operating stations are provided, five on each long wall and two on the end wall of the cell at the 30 feet operating level. The final cell height and elevation of the cell floor will be determined during preliminary design after equipment concepts, and associated handling and viewing requirements have been defined.

2.2.2 Cell Structure

Radiological protection of operating personnel from exposure by penetrating radiation is achieved by providing adequate radiation shielding for routinely occupied areas and by limiting the time that personnel remain in nonroutinely occupied areas.[2,3] Sealed cells are provided to contain the argon atmosphere, reduce in-leakage of impurities, and provide positive contamination control

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to References, Appendix A, Item 1.
3. Refer to References, Appendix A, Item 14.

2.2.2.1 Shielding Walls

Shielding[1,2] is provided within the facility to limit personnel radiation exposures to levels consistent with FFTF Design Safety Criteria.[3] The cell walls at operating stations are about 5 feet thick[1,3,4] and constructed from high density (225 #/ft^3) concrete. Final selection of wall thickness and type of concrete will be done during preliminary design. Shielding at the floor, upper wall and ceiling locations is decreased where personnel occupancy is less frequent. High density shielding (steel or lead) is provided for offset service access penetrations. Neutron absorbing materials are also provided where high density shielding materials are used.[3]

The walls of the Equipment Transfer Tunnel located directly below the Equipment Storage and Transfer cell are constructed of regular concrete. Final selection of wall thickness[3] and type of concrete will be done during preliminary design. The floor of this tunnel directly beneath the transfer port to the cell above will be composed of high density material.

The walls of the In-Cell Service Room located directly below the Detailed Examination Cell are constructed of regular concrete. Final selection of wall thickness[3] and type of concrete will be done during preliminary design.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to References, Appendix A, Item 10.
3. Refer to References, Appendix A, Item 14.

2.2.2.2 Surface Protection

The internal surfaces[1,2] of the cells are covered with a gas tight stainless steel liner (not less than 1/8 in. thick walls and 1/4 in. thick floor pan) to facilitate control of atmosphere purity, decontamination of the cell and for confinement of airborne contaminants.[3] Final liner thickness will be determined during preliminary design.

All liner seams are welded and ground to eliminate potential traps for contamination. Penetrations for through wall transfer systems, access ports, viewing windows, manipulator through tubes and special service plugs are provided. The penetrations are carbon steel frames or sleeves with stainless steel faces. The stainless steel faces are seal welded to the stainless steel liner. Sealed cell penetrations are also provided for general cell services.[4]

The floor of the Equipment Transfer Tunnel is covered with a stainless steel floor pan with coved corners. The interior tunnel walls and ceiling concrete surfaces are covered with a thermoplastic resin based coating. All external concrete surfaces are covered with a thermoplastic resin based coating to facilitate decontamination.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Conceptual Design Evaluation, Appendix D, Item 3.
3. Refer to References, Appendix A, Items 1 and 24.
4. Refer to Interfaces, Appendix C, Items 1, 2, 3, 4, 6, 7, 19 and 21.

2.2.3 Support Areas

2.2.3.1 Equipment Transfer Tunnel

The Equipment Transfer Tunnel located directly below the Equipment Storage and Transfer Cell is sized and equipped for transfer of equipment and supplies to and from the cell above, which are too large for transfer into or out of the cellbank with the through wall transfer devices.

The area[1] directly below the access port to the Equipment Storage and Transfer Cell is approximately 8 feet wide × 10 feet long × 12 feet high. A tunnel area approximately 13 feet long × 8 feet wide × 8 feet high leads to the airlock. The airlock[1] is approximately 8 feet square × 16 feet high and contains three doors; one to the tunnel, one to the radiation zoned maintenance and storage area, and one to the Decontamination Cell.

2.2.3.2 Decontamination Cell

A Decontamination Cell,[2,3] provided by others, is sized and equipped for cleaning of highly contaminated equipment prior to contact decontamination and maintenance or storage. Its location adjacent to the equipment transfer lock below the Equipment Storage and Transfer Cell assists in controlling airborne contamination and reducing personnel exposure as the equipment is removed from the examination cells.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Interfaces, Appendix C, Item 16.
3. Refer to References, Appendix A, Item 6.

2.2.3.3 In-Cell Service Room

The In-Cell Service Room is sized[1] to accommodate special in-cell service equipment such as for welding or special vacuum for fission gas collection and is located directly below the Detailed Examination Cell. Special service access penetrations to the Detailed Examination Cell are provided through the ceiling of this room. Access penetrations to the Interim Examination and Disassembly Cell are provided in a recessed area in the wall between the Equipment Transfer Tunnel and the Equipment Storage and Transfer Cell. Inside dimensions of the room are approximately 24 feet wide × 46 feet long × 10 feet high. Personnel access to this area is from the radiation zoned maintenance and operations area.

2.2.3.4 Cell Personnel Entry Airlocks

An airlock located in the 30 foot operating gallery is sized[1] and equipped[2] to allow suited personnel entry into the Equipment Storage and Transfer Cell during a major outage. The top surface of the airlock also acts as an access platform for use of the viewing window near the ceiling of the Equipment Storage and Transfer Cell. An airlock located at the -15 foot level is sized[1] and equipped[2] to allow suited personnel entry into the Interim Examination and Disassembly Cell.

2.2.3.5 Operating Galleries

The Operating Galleries[1] surround the cell bank to provide full visual and handling control of in-cell operations. A space about 20 feet deep is provided to allow for installation and

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Interfaces, Appendix C, Items 2 and 6.

removal of manipulator master ends, for the movement of operational and FFTF experimenter personnel, and for the installation and movement of equipment and consoles. There are three levels of operating galleries. These galleries are controlled non-contaminated areas.

The upper level operating gallery (30 feet) surrounds the examination cell area on three sides. There are operating areas along two walls of the Interim Examination and Disassembly Cell and the Equipment Storage and Transfer Cell. There are operating areas along three walls of the Detailed Examination Cell. Suited personnel entry through an airlock into the cell bank (Equipment Storage and Transfer Cell) may be made from this level.

The second level (15 feet) operating galleries are located on two sides of the Interim Examination and Disassembly Cell with operating areas along each cell wall.

The lower level (0 feet) operating gallery surrounds three sides of the cells. Operating areas are located along two walls of the Interim Examination and Disassembly Cell. The third wall of the Interim Examination and Disassembly Cell has a neutron radiography cell and gamma scanning collimator port and operating areas. Access to the -15 foot level with its airlock for suited personnel entry to the Interim Examination and Disassembly Cell is provided from this level.

2.2.3.6 Operational Support Areas

Operational Support Areas and equipment are provided for efficient operation of the facility.[1] Two types of areas are provided; controlled, non-contaminated areas and radiation areas

1. Refer to References, Appendix A, Item 1.

or zones. The two types of areas are separated by airlocks and air flow is from controlled non-contaminated areas to areas of higher activity.

A. Controlled non-contaminated areas[1] adjacent to the 30 foot operating gallery level contain the following:

1. Office space near the examination cells for operations supervisors or engineers directing the examination work.
2. Consumable supply storage for operations.
3. Space for storage and processing of film under controlled temperature conditions. Photographs taken during examination must be processed before continuing the examination sequence to ensure that the quality of the negative meets experimenters' needs.
4. Space and equipment for storage of examination records, negatives, and background information on experiment.
5. Space and equipment for reduction of data[2] for input to the Control and Data Handling System.[3]
6. Facilities for personnel comfort and janitorial service.
7. Space and equipment for mockup[4,5] and testing of new equipment or techniques and training personnel to operate new equipment. This is a vital requirement for remote controlled equipment.
8. Space and equipment for storage and maintenance[5,6] of non-contaminated manipulator master ends, equipment consoles and examination equipment used in the operational galleries.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Support Information Requirements, Appendix B, Item 5.
3. Refer to Interfaces, Appendix C, Item 22.
4. Refer to Support Information Requirements, Appendix B, Items 6 and 8.
5. Refer to References, Appendix A, Item 6.
6. Refer to Interfaces, Appendix C, Item 16.

B. A controlled non-contaminated area[1] is provided adjacent to the operation gallery at the 0 foot level. This area contains space and equipment for offices, consumable supply storage, personnel comfort and a radiographic processing room.

C. The facility radiation zone is located at the 15 foot level and is adjacent to the In-Cell Service Room, the Equipment Transfer Tunnel, and the Decontamination Cell. This area[1] contains the following:

1. Space and equipment for contact decontamination[2,3,4] to permit radiation levels to be reduced so that repair or calibration can be done with a minimum of personnel exposure. This capability is needed for complicated pieces of equipment which are not easily decontaminated, require disassembly for decontamination or have parts which can be damaged by conventional decontamination methods.
2. Maintenance and operational space, and equipment[3] for contact maintenance, repair or calibration of low level contaminated equipment to minimize the need for packaging and transferring to other parts of the FFTF.
3. Storage space is provided for contaminated equipment that is for standby or for short term usage in the cells.
4. An established area equipped for personnel decontamination to be done quickly and efficiently.

---

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to References, Appendix A, Item 6.
3. Refer to Interfaces, Appendix C, Item 16.
4. Refer to Support Information Requirements, Appendix B, Item 1.

5. Office space and counting equipment for preparation of monitoring records, counting of air monitoring filters and storage of portable monitoring instruments.[1] Location of assigned monitors near the examination cells, contributes to efficient monitoring through better control of personnel exposure and radioactive contamination.
6. Facilities for personnel comfort, changing into protective clothing and storage of clean and contaminated laundry and clothing[1] as these are standard requirements for hot cells.

D. An equipment elevator[2] is provided between operating gallery levels. Hatches[2] are also provided between operating levels to assist in the transferring of large heavy items using the building overhead crane.[2]

2.2.4 Atmosphere

A purified argon atmosphere[3,4,5] is provided for handling and inspection of fuels since materials to be examined will include vented and aqueous reactive fuels which may be tested to failure.[6] There will also be sodium carry over[7] at some locations in the examination facility. The purified argon atmosphere assists in avoiding loss of experimental data.[8]

---

1. Refer to Interfaces, Appendix C, Item 23.
2. Refer to Interfaces, Appendix C, Item 4.
3. Refer to Interfaces, Appendix C, Item 19.
4. Refer to Support Information Requirements, Appendix B, Item 2.
5. Refer to Conceptual Design Evaluation, Appendix D, Item 4.
6. Refer to References, Appendix A, Item 20.
7. Refer to References, Appendix A, Item 4.
8. Refer to References, Appendix A, Item 2.

The Argon Processing System provided by the Inert Gas Receiving and Processing System circulates, filters, cools, and purifies the argon atmosphere.[1] Pressure controlled supply and exhaust valves meter the argon into the cells. An oil seal for relieving gas overpressure is provided in addition to pressure controlled exhaust valves. The argon purification system maintains the oxygen and moisture impurity levels at about 25 ppm each. Nitrogen concentrations are controlled by feed and bleed of argon. A compressor and receiver drawing from the recirculation system maintains a supply of compressed argon which is distributed to in-cell service outlets for operation of pneumatic equipment. The operating gas pressure of the cells will be less than -1 inch w.g.

To protect equipment operation and to allow personnel entry to the cells the average design temperature of the argon atmosphere is about 90 °F or similar to that at the EBR-II, Fuel Cycle Facility. The temperature of the gas is lowered or raised (between limits of about 70 °F - 100 °F) to take care of changes in barometric pressure and total gas inventory, and changes caused by gas lock transfer of materials, and other process equipment.

Transfer of equipment, waste and consumable supplies through the cell walls is through gas transfer locks with provisions for purging the locks with the same argon used for the cell atmosphere. The design in-leakage rate through the liner and seals will be determined after the cell atmosphere purity limits have been firmly established.

Exhaust gas from the cells will be filtered by dual high efficiency (99.5% for 0.3 micron particles) fire retardent filters,

---

1. Refer to Support Information Requirements, Appendix B, Item 2.

both readily and remotely changeable. Chemical cleanup systems or decay holdup tanks will be provided by the Inert Gas Receiving and Processing System[1] for exhaust wastes such as iodine, cesium, antimony, ruthenium, and tellurium. Means will be provided for sampling and monitoring downstream from filters or cleanup systems to assure that the highly radioactive gases have been routed to the decay holdup tanks and that safety requirements for release to the environs have been met.[2]

The supply of gas for initial fill, inventory makeup and airlock purging will be provided by the Inert Gas Receiving and Processing System.[1] The supply of gas for subassembly and fuel section cooling is also supplied by the Inert Gas Receiving and Processing System.[1]

2.2.5 Support Services

2.2.5.1 Electrical Power

Abundant electrical power is provided by Building Electrical Power System[3] to in-cell areas, operating galleries and support areas for the operating of tools and equipment. Where loss of power supply may jeopardize facility and personnel safety, and loss of experimental data, certain equipment is connected to the emergency power supply. Emergency power supply[4] is supplied to the inert gas circulation system, the subassembly cooling systems, the ventilation exhaust system, monitoring systems, selected lighting and for remote cranes and electrical manipulators.

---

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to References, Appendix A, Items 13 and 14.
3. Refer to Interfaces, Appendix C, Item 1.
4. Refer to References, Appendix A, Items 1 and 14.

2.2.5.2 Lighting

In-cell illumination (including color correction) and lighting control is provided by Lighting System[1] in the cell bank for visual inspection of fuel, photography, visual control of remote operations, television and personnel entry into the cells.

General in-cell illumination[2] intensities will not be less than 250 fc. Supplementary lights mounted on remote electro-mechanical manipulators and cranes, examination work tables, in-cell equipment, and television cameras are provided for use in operations requiring higher lighting levels. Auxiliary low surface brightness lights, will be provided in the cell bank for personnel entry.

All lights installed in the cell bank have controls at the operating stations to adjust in-cell lighting intensity to suit the needs of the operations being conducted. The lighting intensity in each cell operating gallery is also controllable to minimize reflections on windows during remote handling, inspection and photography operations.

2.2.5.3 Communications

The facility is provided with communications equipment[3] such as telephones, intercom, public address in all support areas. Transmittal of operational and safety information between support areas of the facility and with other FFTF System is required for efficient plant operation.

Communications is provided between all cells operating stations and for suited entry into the cells. Personnel performing simultaneous operations at different operating stations

---

1. Refer to Interfaces, Appendix C, Item 3.
2. Refer to Support Information Requirements, Appendix B, Item 10.
3. Refer to Interfaces, Appendix C, Item 2.

must transmit information and instructions during handling and examination operations. Television outlets are provided in each cell area of the cell bank. Portable television equipment is provided in cell to assist transfer, handling and examination operations.

2.2.5.4 Waste Disposal

Equipment and control for liquid waste disposal is provided by the Radioactive Waste System.[1] Expendable containers are provided for packaging solid waste. Casks[1] for transfer of solid waste containers to burial locations are also provided by Radioactive Waste System.

A chemical cleanup system for disposal of radioactive gases in the cell bank is provided by the Inert Gas Receiving and Processing System.[2]

2.2.5.5 Ventilation Control

Air balance provided by the Heating and Ventilation System[3] ensures air flow from nonradioactive zones to zones of higher radioactivity. Air pressure differentials between nonradioactive and radioactive zones (other than hoods and cells) is minus 1/10 to 1/4 inch of water. Highest pressure in the facility is negative with respect to the outside atmosphere.[4] The gas pressure differential[2,3] between rooms and hoods, or rooms and cells is at least minus 1/4 inch of water.

1. Refer to Interfaces, Appendix C, Item 7.
2. Refer to Interfaces, Appendix C, Item 19.
3. Refer to Interfaces, Appendix C, Item 8.
4. Refer to References, Appendix A, Item 13.

2.2.5.6 Standard Services[1]

A. All support areas are provided with the normal plant services such as heating and ventilation, lighting, electrical power, fire detection, drinking water, and communications. Standard services are also provided in certain areas in support of operations[2] as follows:

1. Change rooms and janitorial closets: hot and cold water, sanitary sewer, 100 V ac outlets and ventilation exhaust.
2. Film processing: hot and cold water, sanitary sewer, 100 V ac outlets, ventilation exhaust and dark room safety lights.
3. Data reduction: 110 V ac outlets, intercom outlets and data control outlets.
4. Mockup and repair: 110 V, 220 V, and 440 V ac electrical outlets, laboratory vacuum, steam, hot and cold water, process sewer, high and low pressure air and ventilation exhaust.

B. Service panels are provided in each operating gallery area and supplied with the following:

1. 110 V ac outlets
2. Intercom outlets
3. Telephone outlets
4. Gallery lighting intensity control
5. Data control outlets.

---

1. Refer to Interfaces, Appendix C, Items 1, 2, 3, 6, 7, 8 and 9.
2. Refer to References, Appendix A, Item 1.

2.2.6 Components

The selection[1,2] of materials, components and equipment[3] for use in the facility is guided by the fact that all of the in-cell equipment will operate under more severe environmental conditions than those normally encountered in other examination facilities. There will be high decay heat output from irradiated fuel with associated radiant heat problems.[4] An argon atmosphere will be highly ionized and can cause associated electrical and equipment operational problems.[5] High radiation levels ($>10^6$R/hr) will be encountered[6] and can cause appreciable damage to certain materials. Residual Sodium will be present during handling and examination operations.

2.2.6.1 Sodium Removal Equipment

Sodium Removal Equipment[7,8,9,10,11] is provided for cleaning failed or vented fuel assemblies and those assemblies not compatible with equipment (argon-steam cleaning) provided by the Irradiated Fuel Handling System in the Fuel Handling Cell. This special equipment is also located in the Fuel Handling Cell. It is sized to clean one assembly at a single positioning and is designed so that fuel decay heat is controlled during the cleaning.

---

1. Refer to Conceptual Design Evaluation, Appendix D, Item 5.
2. Refer to Support Information Requirements, Appendix B, Item 6.
3. Refer to Equipment List, Appendix E.
4. Refer to References, Appendix A, Item 11.
5. Refer to References, Appendix A, Item 12.
6. Refer to References, Appendix A, Item 10.
7. Refer to Support Information Requirements, Appendix B, Item 1.
8. Refer to Equipment List, Appendix E, Item 1.
9. Refer to Interfaces, Appendix C, Item 15.
10. Refer to Support Information Requirements, Appendix B, Item 13.
11. Refer to Support Information Requirements, Appendix B, Item 4.

2.2.6.2 Sodium Drain and Fill Equipment

Sodium Drain and Fill Equipment[1,2,3] is provided to collect sodium from capsules during their disassembly and to fill capsules with sodium during their reassembly. The equipment is located in the Detailed Examination Cell.

2.2.6.3 Cooling Equipment

Cooling equipment[4,5] is provided for removal of decay heat[6] to control irradiated fuel surface temperatures to levels necessary for preservation of experimental information (about 600 °F) during handling, disassembly, examination and storage. This equipment may also be used to flow test assemblies if required for reinsertion.

Portable cooling shrouds, capable of removing up to 20 Kw of decay heat from a fuel subassembly and compatible with handling, disassembly, and reassembly equipment are first attached to fuel assemblies in the Fuel Handling Cell. These units supply an axial argon gas flow through the subassembly duct or the shroud, depending upon subassembly design, during vertical transfer, and interim examination. The need for sodium vapor traps will be determined during the conceptual design of the cooling equipment.

1. Refer to Equipment List, Appendix E, Item 2.
2. Refer to Interfaces, Appendix C, Items 7, 19 and 24.
3. Refer to Support Information Requirements, Appendix B, Item 4.
4. Refer to Support Information Requirements, Appendix B, Items 3 and 4.
5. Refer to Equipment List, Appendix E, Item 3.
6. Refer to References, Appendix A, Items 11 and 22.

Cooling gas is supplied by the Inert Gas Receiving and Processing System[1] and routed through the cell wall and a flexible hose to the cooling shroud. Instrumentation is provided for monitoring gas flow, inlet and outlet gas temperature, and pressure drop. Thermocouples attached to fuel pin and specimen surfaces may be utilized to monitor fuel temperatures when available. Cladding temperatures will be controlled by varying the cooling gas flow rate as determined by calculated flow rate and outlet temperature and by signals from thermocouples installed in test specimens. A backup cooling method is provided to prevent fuel meltdown resulting from loss of primary cooling gas flow or during an emergency evacuation.

2.2.6.4 Assembly Transfer and Handling Equipment

Assembly Handling Equipment[2,3] is provided for transferring assemblies, using a bridge crane, in a vertical position to and from the Fuel Handling Cell as well as to and from storage[4] or work stations such as cleaning,[4] disassembly-reassembly, neutron radiography, and gamma scanning.

This equipment consists of grapples which can be handled with an electromechanical manipulator and be locked to an assembly.

Several grapples are provided for handling different types and sizes of assemblies. A positive lock feature is incorporated into the fixture to prevent dropping an assembly. This equipment is normally located in the Interim Examination and Disassembly Cell in appropriate equipment racks.

---

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to Support Information Requirements, Appendix B, Item 4.
3. Refer to Equipment List, Appendix E, Item 4.
4. Refer to Interfaces, Appendix C, Item 15.

2.2.6.5 Disassembly and Reassembly Machine

Two driver fuel and test assembly disassembly and reassembly machines[1,2] are provided in the Interim Examination and Disassembly Cell. The machines are located at separate work stations. Work platforms and equipment racks are provided at each station for accessory tooling, fixtures and equipment, and examination equipment used during the disassembly and reassembly of the assemblies.

A cooling baffle attached to the machine frame is provided for transverse cooling (removal of up to 10 Kw of decay heat by suction) of fuel sections after removal of the duct while maintaining cladding temperatures of about 600 °F. Cooling is by suction to minimize contamination spread and heat effects on in-cell equipment and controlled and monitored the same as the axial cooling shrouds. Equipment for moving, cooling and filtering the gas is provided by the Inert Gas Receiving and Processing System.[3] A backup cooling method is provided to prevent fuel meltdown resulting from loss of primary cooling gas flow or during an emergency evacuation.

The equipment provides the capability to completely disassemble all types of assemblies (fuel, test or component) allowing complete control of part identity. Special jigs, fixtures, welding and cutting equipment is provided for duct and specimen removal and replacement, instrument repair or replacement and hardware removal. Machines are of modular construction and designed for remote removal of modules and changing of tooling. Complete visual inspection can be performed and photographic records of the visual inspection and disassembly operations obtained.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Items 5, 30, 31 and 32.
3. Refer to Interfaces, Appendix C, Item 19.

2.2.6.6 Subassembly Measurement Equipment

Two sets of Subassembly Measuring Equipment[1,2] are provided and designed to mount on the Disassembly and Reassembly Machine work table in the Interim Examination and Disassembly Cell.

This equipment is capable of making overall fuel or test section width, length, bow, and interpin spacing measurements. Direct readout measuring devices such as air gages (with inert gas), differential transducers with standards and pressure sensers are utilized.

The equipment is designed to be compatible with the disassembly and reassembly machine and is located and mounted by the master slave manipulators or by the electromechanical manipulators. Recording instruments are located in the cell operating gallery.

2.2.6.7 Instrumentation Testing Equipment

Instrumentation Testing Equipment[1,3] is provided in the Interim Examination and Disassembly Cell for testing and checking the continuity and integrity of instrumentation. The equipment can be located in-cell or out of cell, depending upon radiation damage problems, equipment cost and sensitivity requirements.

Remote recording equipment is used where needed for monitoring specimen conditions. Equipment located in-cell is stored in the Equipment Transfer and Storage Cell if exposure to prolonged radiation is found to adversely affect operation.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 6.
3. Refer to Equipment List, Appendix E, Item 7.

2.2.6.8 Photography Systems

Three special sealed, shielded, through-wall camera systems[1,2] are provided for continuous photography of specific disassembly examination operations or to make a record of the appearance or condition of items being examined. The systems consist of mirrors, adjustable lens appatures, sealed through-wall tube, rolled 70 mm film package mechanism and shielding. This type of system allows detailed visual inspection of components and color photography to be done with minimum loss of resolution and eliminates color introduced by lead glass windows. A camera system is installed in the operating wall adjacent to each disassembly machine and a single unit with remote positioner is installed in the Detailed Examination Cell.

Two portable macrocameras with a special frame are furnished for mounting on the exterior cell wall and used for direct photography through the viewing windows.

2.2.6.9 Binoculars and Telescopes

Portable binoculars[3] are provided for use at each viewing station. Binocular Positioning-Holding Fixtures are provided at each viewing station. A set of binoculars may be easily attached or removed from the fixture. The fixtures allow the binoculars to be moved about the window to any position and then to be fixed rigidly in that position; so that an individual's hands are then free for manipulator or equipment operation.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 8.
3. Refer to Equipment List, Appendix E, Item 9.

"Questar Type" Telescopes[1] are provided for use at each viewing station. An attachment allows the binocular positioning fixture to be used for positioning and holding the telescopes in position at the viewing station.

The binoculars and telescopes are used as optical viewing aids for equipment control, direct viewing of long distance operations and for visual inspection of fuels, specimen and components when magnifications of greater than 1:1 are required.

2.2.6.10 Periscopes

"Kollmorgen Model 301 Through-Wall Type" Periscopes[2] with photographic attachments are provided in the Interim Examination and Disassembly Cell and also in the Detailed Examination Cell. This type of periscope has a hermetically sealed dome at the inner cell wall which remains in place during removal of the periscope for maintenance. These periscopes are provided as optical viewing aids for detailed visual inspection and photography of fuels, materials and components requiring magnifications up to 30X and up to 180° solid angle scanning.

2.2.6.11 Borescope

A Borescope[3,4] with photographic attachments is provided in the Detailed Examination Cell. The borescope is plug-mounted and sealed so that it can be easily withdrawn for replacement of lamps. The borescope is provided as an optical viewing aid for detailed inspection and photography of component internal surfaces and openings.

---

1. Refer to Equipment List, Appendix E, Item 10.
2. Refer to Equipment List, Appendix E, Item 11.
3. Refer to Support Information Requirements, Appendix B, Item 4.
4. Refer to Equipment List, Appendix E, Item 12.

2.2.6.12 Neutron Radiography Equipment

Neutron Radiography Equipment[1,2,3] is provided in the Interim Examination and Disassembly Cell. A wall beam opening sealed with thin aluminum plate is used to pass the beam from a critical source (reactor) similar to that used by General Electric at its Vallecitos Nuclear Center. The neutron reactor source and its control room are located at the 0 foot level operating area. A sealed shielded through-wall penetration device will be used to introduce and remove the transfer plates.

2.2.6.13 Gamma Scanning Equipment

Gamma Scanning Equipment[1,4] for use in inspecting fuel assemblies, fuel pins, and fuel specimens is provided in the Interim Examination Cell. A collimeter and detector are mounted in a sealed, shielded through-wall penetration and along with the recording equipment are located at the 0 foot operating area. A multichannel analyzer with features of background subtraction, spectrum storing and stripping, and final magnetic tape storage with local readout is used to study point-peak energy levels or selected energy ranges linearly in axial increments or with continuous scanning. A remotely controlled positioner is provided in-cell for movements of pins.

2.2.6.14 Milling and Cutting Equipment

A remote operated Milling Machine[1,5] is provided in the Detailed Examination Cell for special disassembly operations such as precision disassembly of materials test capsules and sampling

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 13.
3. Refer to References, Appendix A, Items 16 and 35.
4. Refer to Equipment List, Appendix E, Item 14.
5. Refer to Equipment List, Appendix E, Item 15.

of hardware. Modular design of the mill facilitates equipment maintenance in that removal of the complete unit is not required. Cutters, accessories and modules (i.e., gear head, drive motor, etc.) can be remotely removed and replaced.

Portable, single purpose Cutting Equipment[1,2] and accessories are also provided in the cell bank. This equipment consists of hack saws, shears and rotary cutting devices (such as saws, grinders, pipe cutters, etc.) that may be moved from cell to cell as required. This equipment is also utilized to reduce hardware to disposable lengths for packaging in waste disposal containers for burial.

2.2.6.15 Pin and Specimen Measuring Equipment

Pin and Specimen Measuring Equipment[1,3] is provided in the Detailed Examination Cell to measure length, warp, and cross-sectional dimensions of pins and specimens and pin clad thickness. Eddy current, air gages and differential transducer type measuring heads mounted on remotely operated position machines are utilized. Measuring sensors are replaceable with manipulators and readout is to recorders located in operating consoles in the cell galleries.

2.2.6.16 Weighing Equipment

Weighing Equipment[1,4] is provided in the Interim Examination and Disassembly Cell and the Detailed Examination Cell to obtain

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 16.
3. Refer to Equipment List, Appendix E, Item 17.
4. Refer to Equipment List, Appendix E, Items 18 and 19.

weight changes of assemblies, pins and specimens. This equipment consists of a load cell with remote readout and a balance with remote controls and readouts. Fuel pin balance point determination equipment is also provided to locate the center of gravity of fuel pins.

2.2.6.17 Pin and Specimen Test Equipment

Equipment[1,2] is provided in the Detailed Examination Cell for leak checking suspect nonvented fuel pins and fuel specimens, and, resealed fuel pins. A chamber pressure decay method will be used. This equipment may also be utilized to test sealed capsules or packaged pin and specimens. Equipment is also provided in the Detailed Examination Cell to defect pins. Pin and specimen sodium bonding and level will be inspected using electromagnetic techniques such as pulsed eddy current.

2.2.6.18 Fission Gas Collection Equipment

Fission Gas Collection Equipment[1,3] is provided in the Detailed Examination Cell to collect fission gas from fuel pins. This equipment will utilize a vacuum pump, toepler pump and drilling, collection and welding devices (for resealing). The volume of fission gas is measured and samples collected for spectrographic analysis. Gas samples are stored in-cell until radiation levels permit transfer for analysis. Location of part of this equipment in the under-cell service area will be evaluated during conceptual design of the equipment.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Items 20, 21 and 22.
3. Refer to Equipment List, Appendix E, Item 23.

2.2.6.19 Packaging Equipment and Waste Preparation

Packaging Equipment[1,2] is provided in the Detailed Examination Cell to prepare fuels, materials and components for shipment or storage. This equipment includes mechanical sealing devices and welding equipment, as well as accessory jigs and fixtures. Leak testing equipment is provided to test containers when necessary to meet shipping requirements.

2.2.6.20 Fuel Storage

Facilities and equipment are provided for critically-safe cooled and shielded storage[1,3,4,5] of fuel pins and fuel specimens being examined. The fuel and material assemblies are stored in the adjacent Fuel Handling Cell.[6]

Fuel pins and fuel specimens are stored in the Detailed Examination Cell. Critically-safe, shielded and cooled storage is provided for 20 pin and specimen transfer and storage racks. These racks are nuclear safe, and capable of holding 40 pins or specimens each for transfer or storage. The racks are also used to transport pins and specimens to work stations and maintain sample identification. Each storage location is identified[7] for accountability and sample identification purposes.

---

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 24.
3. Refer to Support Information Requirements, Appendix B, Item 8.
4. Refer to References, Appendix A, Item 9.
5. Refer to Equipment List, Appendix E, Items 26 and 27.
6. Refer to Support Information Requirements, Appendix B, Item 5.
7. Refer to Interfaces, Appendix C, Item 15.

2.2.6.21 Material and Component Storage

Storage racks[1,2] for a maximum of six (6) ducts or hanger rods are provided in the Interim Examination and Disassembly Cell. Shielded storage racks for disassembled material specimens or components waiting for inspection, packaging, final storage or disposal are provided in the Detailed Examination Cell.

2.2.6.22 Cell Service Plugs

Special cell service plugs[1,3] are provided at each operating station and the floor of the Detailed Examination Cell to route services through the cell wall for operation of examination equipment and readout of data. These plugs are sealed, shielded and replaceable. They are designed so that during replacement air in-leakage and confinement of contamination is controlled.

2.2.6.23 Master Slave Manipulators

Two sealed master-slave manipulators[4] of the "CRL Model J Type" are provided at each cell operating station viewing window where increased handling dexterity is required. The dexterity of this conventional[5] piece of equipment permits them to do the complex light duty handling and equipment control that is necessary, to process fuels, materials and components through the various cleaning, cooling, disassembly, reassembly and examination operations. This type of (gas tight) manipulator[6] is sealed at the wall penetration through-tube so that the gas atmosphere purity is maintained during operation and during

1. Refer to Support Information Requirements, Appendix B, Item 4.
2. Refer to Equipment List, Appendix E, Item 25.
3. Refer to Equipment List, Appendix E, Item 29.
4. Refer to Equipment List, Appendix E, Items 33 and 34.
5. Refer to References, Appendix A, Item 1.
6. Refer to References, Appendix A, Item 12.

removal of the arms for maintenance. The motorized extended reach feature of the slave facilitates greater coverage of the in-cell work area. Maximum load capacity is approximately 20 pounds. Various tong ends, fingers, hands and power tools are furnished as accessories.

A remote decontamination cell and repair area equipped with confinement hoods are provided for maintenance of the master-slave manipulator slave arms and through-tubes since high radiation and radiant heat levels prohibit the use of booting on the in-cell slave arms. The master slave arm is designed for remote removal by an in-cell crane or electromechanical manipulator. Because of their complexity master-slave manipulators cannot be maintained remotely. Spare manipulator components are provided to replace units removed for decontamination or repair.

2.2.6.24 Electromechanical Manipulators

Two bridge mounted "PAR" type electromechanical manipulators[1] are provided and sized for the medium-heavy duty handling such as manipulating tools, fixtures and parts of subassemblies. Each manipulator is mounted on a bridge which travels on rails which extend from the Fuel Handling Cell to the end of the Detailed Examination Cell. These manipulators are shared with the Fuel Handling Cell.[2] Installation of both manipulators on the same track permits one to be used to pull or push a failed unit to the Equipment Storage and Transfer Cell for maintenance. Load capacity is approximately 400 lbs with the hand in any position and 2000 lbs for direct lifting (from sholder). Remote

1. Refer to Equipment List, Appendix E, Items 35, 37 and 38.
2. Refer to Interfaces, Appendix C, Item 15.

maintenance is performed in the Equipment Storage and Transfer Cell whenever possible. Shielded storage from high level radiation is provided during idle periods in the Equipment Storage and Transfer Cell. Manipulator controls which are portable can be plugged into key locked control outlets to permit direct visual control of handling, examination and transfer operations at any cell operating station. Control systems will be evaluated during preliminary design to prevent interference between electromechanical manipulators and other equipment on operations within specific cell areas.

Two side wall post mounted "PAR" type electromechanical manipulators[1] provided and sized for the medium duty handling are located in the Interim Examination and Disassembly Cell. Portable consoles are also used. Load capacity is approximately 150 lbs with the hand in any position.

Various tong ends, hands, hooks and power tools are supplied as accessories. Racks will be provided for holding and transferring these accessories. The manipulators are designed for remote removal, decontamination, and maintenance. At a minimum, this will include carriages, tube and hoist assemblies, manipulator arms, bridge drives and electrical conductors. Remote removal at these modules will permit the major maintenance activities for the manipulators to be performed by contact means. The remaining maintenance on the bridges will be infrequent and will be performed remotely after lowering the bridge near the floor in the Equipment Storage and Transfer Cell.

2.2.6.25 Bridge Cranes

Two remote controlled bridge cranes[2] are provided and sized for heavy-duty handling and transfer of in-cell equipment and

1. Refer to Equipment List, Appendix E, Item 36.
2. Refer to Equipment List, Appendix E, Item 39.

assemblies. Rails near the cell ceiling (above the electromechanical manipulators) extend from the Fuel Transfer Cell to the end of the Detailed Examination Cell. These bridge cranes are shared with the Fuel Handling Cell.[1] The cranes perform rudimentary handling and transfer and assist examination process operations. Portable control consoles can be plugged into key locked control outlets to permit visual control at any operating station during handling or transfer operations. Crane control systems will be evaluated during preliminary design to prevent interference between cranes and other equipment or operations within specific cell areas. Load capacity of each bridge crane is approximately 10,000 lbs.

Installation of two cranes on the same track allows one to pull or push a failed unit to the Equipment Storage and Transfer Cell for maintenance. The cranes are designed for remote removal, decontamination and maintenance. At a minimum this will include carriages, hoists, bridge drive and electrical conductors. Maintenance of the bridges will be infrequent and will be performed in the Equipment Storage and Transfer Cell as discussed under electromechanical manipulators.

2.2.6.26 Small Equipment Transfer Devices

Small equipment and consumable supplies[2] are transferred into the sealed cells with a through-wall transfer device. Two such devices are provided in the cell bank for redundancy and to

1. Refer to Interfaces, Appendix C, Item 15.
2. Refer to Equipment List, Appendix E, Item 40.

minimize in-cell handling and transfer of small items. One in the Interim Examination Cell and one in the Detailed Examination Cell.

An air tight glove box (on the operating gallery wall) and a shielded cylindrical carriage make up the device. At the intermediate position (carriage within the cell wall) the carriage is sealed at inner and outer walls and purged with clean argon gas[1] prior to transfer into the cell. The size of the carriage cavity is approximately 10 in. diam × 30 in. long.

2.2.6.27 Large Equipment Transfer Device

A large equipment transfer device[2] is provided below the Equipment Storage and Transfer Cell. Equipment is transferred into or from the cell bank through the cell floor of the Equipment Storage and Transfer Cell via the Equipment Transfer Tunnel and an air lock.

A portable carriage (stainless steel bucket) approximately 6 feet diam and 6 ft deep, an elevating mechanism and a trolley are used to transfer the items. The portable carriage in its up/most position is sealed against the bottom of the liner in the cell floor. The bucket is purged with argon gas[1] prior to opening the sealed, shielded floor hatch for access to the bucket on the elevating mechanism.

2.2.6.28 Solid Waste Transfer Device

A waste transfer device[3] is provided in the ceiling of the Equipment Storage and Transfer Cell. Solid waste[4] packaged in proper containers or packaged pins and specimens for offsite shipment may be transferred to casks without a loss of confinement.

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to Equipment List, Appendix E, Item 42.
3. Refer to Equipment List, Appendix E, Item 43.
4. Refer to Interfaces, Appendix C, Item 7.

A sealed, shielding plug containing an eccentric, confinement, valve mechanism allows packages up to 10 in. diameter to be transferred to inert gas purged[1] casks using the cask lifting fixture to facilitate the transfer. The transfer device is installed in a sleeved cell roof penetration.

2.2.6.29 Viewing Windows

Sealed, lead glass windows[2] are provided at cell wall operating stations for visual control of remote in-cell operations. The windows are designed so that heat, radiation or mechanical damage will not affect the shielding, sealing or confinement qualities of the windows. If a failure of an in-cell window section occurs, the viewing window will not allow in-leakage of impurities or a loss of shielding for personnel.[3] Means are provided to protect viewing windows against heat, radiation or mechanical damage. Remotely replaceable alpha seal plates are used to permit replacement of the windows without loss of confinement or in-leakage of impurities.

For improved viewing purposes the initial lead glass viewing window light transmission is about 25%. With correct window design this light transmission quality can be provided by existing technology. It is important to have the highest initial light transmission possible to aid viewing of remote operations. Proven techniques such as stabilized glass, replaceable sections of glass and shielded shutters are used for protection of the lead glass windows from radiation darkening so that the window light transmission will remain above 10% after twenty years. Viewing window angles (maximum off-axis) are approximately:

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to Equipment List, Appendix E, Items 44, 45 and 46.
3. Refer to References, Appendix A, Item 1.

- 50° upward,
- 68° downward,
- 75° to the sides.

Optimum window[1] viewing angles and in cell light levels for the sealed, lead glass windows will be determined through the use of a mockup. Window design (oil filled or plastic bonded) will be evaluated during preliminary design and final selection made.

2.2.6.30 Protective Cell Entry Equipment

Personnel entry to the Equipment Storage and Transfer Cell and the Interim Examination and Disassembly Cell is provided through the use of plastic life support suits[2,3] (similar to SEFOR suits) located in the air lock at each access plug and door. A special panel with double helmeted and collapsible suits will be used. Each panel will provide a minimum of two suits for entry of personnel in pairs. Breathing and cooling air is provided[4] to and from the suits during use by supply and exhaust hoses. Voice communication[5] is also provided between the various operators inside and outside the cells. Breathing air is routed to a full face mask so that the wearer's breathing air is not contaminated should the suit be punctured during use. Temperature controlled and dried cooling air is routed to all extremities.

2.2.6.31 Portable Shielded Hoist

A hoist mounted in a portable, shielded and sealed container[6] is provided for remote removal and installation of the electromechanical manipulator and bridge crane carriages. The container

---

1. Refer to Support Information Requirements, Appendix B, Item 7.
2. Refer to Equipment List, Appendix E, Item 47.
3. Refer to References, Appendix A, Item 26.
4. Refer to Interfaces, Appendix C, Item 6.
5. Refer to Interfaces, Appendix C, Item 2.
6. Refer to Equipment List, Appendix E, Item 48.

is mounted and sealed to the top of the Waste Transfer Device on the roof of the Equipment Storage and Transfer Cell (55 foot level) when in use. Hoist capacity is approximately 4000 lbs. Argon gas[1] supply lines are located near the transfer port for purging the container as well as waste and specimen shipping casks.

Controls for remote operation of the hoist are installed at the viewing window located near the ceiling of the Equipment Storage and Transfer Cell. When not in use the portable hoist is stored in the Inert Gas Cell Examination Facility shielded storage area.

2.2.6.32 Decontamination Equipment

Portable decontamination equipment[2] is provided for preliminary decontamination of examination and handling equipment prior to its transfer from the Equipment Storage and Transfer Cell. The equipment consists of vacuum cleaners, scrapers, wipers and brushes. This equipment will also be used for cleanup of chips from cutting operations, particulates from failed fuels and general in-cell housekeeping. When not in use the equipment is stored in the Equipment Storage and Transfer Cell. The need for ultrasonic cleaning equipment will be evaluated during preliminary design (see Section 4.2.1).

2.2.6.33 Support Equipment

Equipment is provided in the support areas[3] of the facility to assure that efficient and economical performance of operations is maintained.

---

1. Refer to Interfaces, Appendix C, Item 19.
2. Refer to Equipment List, Appendix E, Item 41.
3. Refer to Equipment List, Appendix E, Items 49 to 66.

Area	Equipment
Operating Galleries: (Controlled non-contaminated)	• Mobile Manipulator racks (Master ends) • Laboratory carts • Lift truck (walk along) • Mobile positioning work platforms • Work tables
Locker Room: (Controlled non-contaminated)	• Standard locker room equipment[1] • Personnel monitoring equipment[2]
Mockup and Repair: (Controlled non-contaminated)	• Monorail hoist (4000 lb capacity) • Manipulator repair racks • Manipulator checkout rack • Lift truck (high lift walk-a-long) • Hand carts • Positioning tables • Work benches • Vises • Bench grinders • Hand tools - tool chests • Power hand tools • Electrical testing equipment • Mockup equipment
Storage Areas: (Controlled non-contaminated)	• Manipulator racks • Console and recorder racks • Consumable supply racks and cabinets • Spare parts racks and bins
Dark Room: (Controlled non-contaminated)	• Film developing equipment • Film viewers

1. Refer to Interfaces, Appendix C, Item 4.
2. Refer to Interfaces, Appendix C, Item 23.

Area	Equipment
	• Storage racks and cabinet • Refrigerator • Work benches • Film dryer
Data Reduction Area: (Controlled non-contaminated)	• Data storage and reduction equipment[1] • Work tables • Film viewing equipment • Negative files
Equipment Transfer Tunnel Airlock: (Radiation Zone)	• Monorail hoist (4000 lb capacity) • Glove box attachments • Sealed shield door[2]
Decontamination Cell:[3] (Radiation Zone)	• Through wall manipulators with discharge nozzles) • Viewing windows • Filters • Condenser • Differential pressure controller • Centrifugal pump • Solution tanks
Contact Decontamination Area: (Radiation Zone)	• Manipulator - through tube handling container[3] • Hoods - sinks[3] • Glove boxes[3] • Bagging and sealing equipment[3]
Repair and Checkout Area: (Radiation Zone)	• Mobile manipulator racks • Manipulator repair racks[3]

1. Refer to Interfaces, Appendix C, Item 20.
2. Refer to Interfaces, Appendix C, Item 4.
3. Refer to Interfaces, Appendix C, Item 16.

Area	Equipment
	• Manipulator checkout rack[3]
	• Monorail hoist (4000 lb capacity)
	• Hoods
	• Work benches with hoods
	• Vises
	• Hand tools - tool chests
	• Hand power tools
	• Lift truck - (walk along)
	• Laboratory carts
	• Hand carts
	• Electrical Testing Equipment
Storage Areas: (Radiation Zone)	• Consumable supply racks and cabinets
	• Spare parts racks and bins
	• Small equipment storage
Shielded Storage Room: (Radiation Zone	• Manipulator racks
	• Small equipment racks
	• Large equipment racks
	• Monorail hoist (4000 lb capacity)
Radiation Monitoring: (Radiation Zone)	• Portable monitoring equipment[1] and storage
	• Air sample counters[1]

2.2.7 Instruments, Controls, Alarms, and Protective Devices

2.2.7.1 In-Cell Equipment Control

Service panels at the operating stations provide special services[2] for operation and control of in-cell equipment such as:

- 110 V ac electrical outlets

1. Refer to Interfaces, Appendix C, Item 23.
2. Refer to Interfaces, Appendix C, Items 1, 2, 3, 6 and 19.

- Intercom outlets
- TV outlets
- In-cell lighting intensity controls
- Electric manipulator key locked control outlets
- Bridge crane control key locked outlets
- High and low pressure inert gas outlets

Equipment operating consoles, direct visual control, remote readout and TV provide the primary means of monitoring and controlling in-cell conditions and operations. In-cell microphones connected to speakers at the operating stations provide control of remote machining operations.[1]

2.2.7.2 Atmosphere Control

Redundant cooling and circulating equipment[2] is provided to prevent excessive temperature, pressure or purity levels. Interlocks are provided so that standby equipment is automatically turned on should a malfunction occur in an operating cooler or fan. The control system for the atmosphere handling equipment also actuates a building alarm and an alarm at a central emergency control center to warn of malfunction of the system. Automatic cell temperature, pressure and atmosphere purity monitoring and controlling equipment is part of the Inert Gas Receiving and Processing System.[2]

2.2.7.3 Radiation Monitoring

The early detection of radiation hazards or radioactive contamination is important in a facility designed to handle plutonium.[3]

1. Refer to References, Appendix A, Item 15.
2. Refer to Interfaces, Appendix C, Item 19.
3. Refer to References, Appendix A, Item 1.

Radiation Monitoring equipment[1] is provided by Radiation Monitoring System[2] for all areas of the facility as required to meet Design Safety and Radiological Control requirements.[3] Typical radiation control equipment and instrumentation will include critical radiation alarms, continuous alpha-beta air monitors, beta-gamma monitoring and high gamma alarms, portable monitoring instruments, personnel monitoring instruments, air sampling devices, and air sample counters. In-cell gamma monitors with remote readout are also provided for each major cell area.

2.2.7.4 Protective Devices

Emergency systems,[4] alarms[4,5] and procedures are provided to insure maintenance of the proper air flow patterns between zones, rooms, cells, and hoods so that personnel are warned that loss of confinement has occurred or that equipment has failed and emergency procedures are required.

Respiratory protection,[6] such as masks for use with fresh air cannisters and breathing air outlets,[7] and air sampling heads[7] are provided in the operating galleries and radiation zoned support areas.

Suits with life support[7] and communications[8] are provided for personnel entry into the cells (under controlled conditions) during a major outage for decontamination of the cells.[9]

---

1. Refer to Support Information Requirements, Appendix B, Item 8.
2. Refer to Interfaces, Appendix C, Item 23.
3. Refer to References, Appendix A, Items 8, 13 and 14.
4. Refer to Interfaces, Appendix C, Item 19.
5. Refer to Interfaces, Appendix C, Item 8.
6. Refer to References, Appendix A, Item 25.
7. Refer to Interfaces, Appendix C, Item 6.
8. Refer to Interfaces, Appendix C, Item 2.
9. Refer to References, Appendix A, Item 1.

2.2.7.5 Data Indication and Storage

Data indication and storage equipment such as a typewriter with papertape reader/punch is provided in the data reduction area of the examination facility by the Control and Data Handling System.[1] This equipment may be used for local integration of examination data for the experimenter, entering examination data to the core component history file retained in the Digital Data Handling System, or for recalling preirradiation test data or previous inspection data on experiments and/or components from the core component history file. Examination data to be integrated, sorted or stored is normally inserted manually into the acquisition system located in the data reduction area. When desired, applicable examination, data of a routine nature may be automatically stored in the data indication and storage equipment.

---

1. Refer to Interfaces, Appendix C, Item 20.

SECTION 3.0 SAFETY CONSIDERATIONS

3.1 HAZARDS

3.1.1 Fire

Fire could be a significant hazard in the examination cell bank, particularly when liquid metal or metallic and carbide fuels are handled, and the hazard is increased by gamma heating of the fuel material. During remote handling operations fuel pins with surface temperatures at ∿600 °F may come in contact with exposed materials, and components. Loss of cooling and melt down of fuel will increase the temperature significantly. There will also be sodium carry-over on subassemblies which can vaporize and deposit within the cells or in the gas purification system. Sodium under the proper conditions can be combustible.

Fire can be a hazard in the support areas of the facility where electric motors and control consoles are in constant use. The use of various solvents for decontamination of examination equipment constitute a fire hazard.

3.1.2 Criticality

Criticality constitutes a hazard. Loss of experimental data and damage to in-cell materials and equipment could be expected. Increased radiation and possible contamination spread would be a danger to operating personnel.

3.1.3 Penetrating Radiation

Penetrating radiation constitutes a significant hazard. Improper removal of fuel, samples and radioactive equipment outside the confinement of the cells can result in high radiation exposures of operating personnel.

3.1.4 Airborne Contamination

Airborne contaminates are a significant hazard. Failure of a confinement system such as loss of air balance could result in a spread of airborne contaminants from areas of higher radioactivity to areas or zones of little or no radioactivity. Improper removal of fuels, samples or highly contaminated equipment outside the confinement of the cells can also result in an uncontrolled spread of airborne contaminants with subsequent danger to operating personnel.

3.2 PRECAUTIONS

3.2.1 Fire

A purified argon atmosphere is provided and maintained in the examination cell bank with purity limits (oxygen and moisture) established such that combustion cannot be supported. Emergency power, redundant or backup equipment (atmosphere cooling, recirculating and purity control, and subassembly cooling) and automatic recording, and warning equipment with provisions for correcting the malfunction or starting up emergency system are provided to prevent the loss of atmosphere control with its possible fire and contamination hazards.

Flammable in-cell construction and equipment materials which can be damaged by heat will be used only when protected by insulation.

Normal fire protection equipment[1] such as overhead sprinklers, wall mounted emergency fire fighting equipment, and warning devices will be provided for the operating galleries and support areas. Good administrative control and strict adherence to established procedures will also be required. Products of combustion detectors are provided in the neutron reactor cell area.

---

1. Refer to Interfaces, Appendix C, Item 9.

3.2.2 Criticality

Stringent mechanical as well as administrative criticality controls[1,2] and procedures are established for operation of the facility.

Examination and storage facilities[3] will be designed to preclude criticality. Only one driver fuel assembly will be transferred in each cell area at a time when fuel assemblies are located at work stations. The spacing between work locations for each assembly will be a minimum of six feet. Accidental meltdown of driver or test fuel subassemblies is possible (loss of cooling capability) and has been taken into consideration in establishing safe limits. Water or similar liquid neutron moderating materials will be excluded from the cell bank or limited in quantity to preclude criticality.

Studies[2] will continue to update the established criticality criteria for assemblies and will also establish safe limits and methods for handling, examining, and processing fuel pins, capsules and test fuel specimens. Geometrical and/or mechanical critically-safe fuel pin storage arrangements and facilities will be determined and provided.

Criticality detection and alarm equipment as well as a warning system are provided to alert operating personnel in the event that criticality accidently occurs.

3.2.3. Penetrating Radiation

Protection of personnel from penetrating radiation exposure is achieved by providing adequate radiation shielding and by limiting the time that personnel remain in radiation fields.

---

1. Refer to References, Appendix A, Items 9 and 14.
2. Refer to Support Information Requirements, Appendix B, Item 8.
3. Refer to Interfaces, Appendix C, Item 15.

Shielding[1] will be provided within the facility to limit personnel radiation exposures to levels consistent with FFTF Design Safety Critera.[2] (See 2.2.2 Cell Structure.)

Monitoring equipment[3,4] and warning systems as well as administrative radiation controls and procedures[5] will be provided for operation of the facility. Pocket dosimeters are supplied to operating personnel for self monitoring of penetrating radiation exposure. Continuous health physics monitoring is provided during removal of radioactive material and equipment from confinement systems and during decontamination operations. High gamma area monitors are provided to warn of off-standard conditions and set to alarm at ∿250 mr/hr at the probe. Change areas and personnel decontamination areas will be established to serve the under cell radiation zones so that contaminated clothing and plastic suits can be removed and personnel decontaminated as soon as possible.

3.2.4 Airborne Contamination

The control of internal exposure resulting from airborne contamination[2,4,5,6] is achieved by providing suitable facilities, handling and monitoring techniques, and by strict adherence to administrative procedures. Confinement systems are provided for transfer, examination and processing fuel, material and components irradiated in the FTR, and for decontamination and contact maintenance of contaminated equipment. These confinement systems depend upon ventilation control, and treatment of

---

1. Refer to References, Appendix A, Item 10.
2. Refer to References, Appendix A, Item 14.
3. Refer to Interfaces, Appendix A, Item 23.
4. Refer to Support Information Requirements, Appendix B, Item 8.
5. Refer to References, Appendix A, Item 13.
6. Refer to References, Appendix A, Item 8.

exhaust gas to remove airborne radionuclides other than noble gases before the gas is discharged through a stack. The confinement systems are designed to control the environmental release of radionuclides in an accident situation to quantities within the requirements established in AEC Manual Chapter 0524 and RL supplement RL0524-01.[1]

Radioactive airborne contamination spread from cells is prevented by sealed cells, negative in cell differential pressure, off-gas filtration and monitoring. Primary HEPA filters are installed in-cell with secondary back up HEPA filters located in a radiation control area.

Emergency systems,[2] alarms[2,3] and procedures are provided to insure maintenance of the proper air flow patterns between zones, rooms, cells and hoods so that personnel are warned that loss of confinement has occurred or that equipment has failed and emergency procedures are required.

Respiratory protection, including breathing air outlets and air sampling equipment, is provided throughout the facility. Continuous alpha and beta-gamma airborne monitoring equipment is provided for all areas of the facility to meet Design Safety and Radiological Control Criteria.[4] Strict adherence to established procedures and administrative control will be provided during transfer of samples and contaminated equipment from the confinement systems.

---

1. Refer to References, Appendix A, Item 13.
2. Refer to Interfaces, Appendix C, Item 19.
3. Refer to Interfaces, Appendix C, Item 8.
4. Refer to References, Appendix A, Items 8, 13, 14 and 25.

SECTION 4.0 PRINCIPLES OF OPERATION

The Inert Gas Cell Examination Facility is operated independent of the FTR in the remote handling and examination of fuels, materials and components irradiated in the FTR. However, reactor outages can result from improper performance of core components returned to the reactor after processing through interim examination. The examination processing load[1,2] of fuels, components and materials irradiated in the FTR is dependent upon the FTR operating cycles and performance. The facility is designed for efficient and economical performance of operations without jeopardizing the following:

- Plant and personnel safety
- Radiological contamination control
- Quality
- Preservation of data
- Plant availability

The material flow charts shown on Drawings SK-3-12569 and SK-3-12992 in Appendix F illustrate the transfer and examination processes which take place in the Inert Gas Cell Examination Facility.

4.1 START UP

4.1.1 Equipment Checkout

Special attention is required for a final functional testing and checkout of all in-cell service, transfer, handling, processing and examination equipment to assure reliable operation. Operator training for correct equipment operation and the operational procedures to be followed during its use will be instituted

1. Refer to Examination Processing Load Requirements, Appendix F.
2. Refer to Support Information Requirements, Appendix B, Item 1.

during this period. Check out and practice of remote removal and replacement techniques is a necessary requirement for each item of equipment. Maintenance personnel should also receive training in the maintenance techniques to be used during operations.

4.1.2 Radiological Support

The facility confinement systems must be checked out and tested to assure that all cell penetrations are sealed, negative in-cell differential pressure can be maintained, primary and secondary off-gas filtration is operational, air balance has been established and can be controlled, all confinement system equipment including redundant and backup equipment is operational, and all warning systems have been tested, calibrated and are operational.

A comprehensive radiation survey of the cell walls, viewing windows, through wall equipment, access and service penetrations as well as in-cell radiation barriers will be conducted with a gamma source to assure that the cell shielding is adequate and continuous.

Radiation monitoring control systems such as critical radiation alarms, continuous alpha and beta-gamma air monitors, gamma monitoring and alarms, portable monitoring instruments, personnel monitoring instruments, and air sample counters will be tested and calibrated. All equipment will be operable.

Respiratory protection (including breathing air) and cell personnel entry life support services will be functionally tested and will be operable.

4.1.3 Support Services

The electrical power system will be checked out with particular attention paid to the emergency power supply and its availability to such items of equipment as the inert gas purification and circulation system, the subassembly cooling systems, the ventilation exhaust systems, selected lighting, monitoring systems and important items of remote handling equipment.

The facility lighting system will receive a complete check out with particular attention paid to in-cell illumination levels, characteristics and their control to assure good visual control of in-cell operations, visual inspection and photography.

Special attention will be paid to communication between each cell operating station and to in-cell communication systems such as that provided to assist control of cutting and machining operations, and for voice contact with personnel during suited cell entry.

4.2 NORMAL OPERATION

Efficient and economical operation of the facility is dependent upon a scheduled flow (see flow charts) of fuels, material and components irradiated in the FTR through the facility. During a scheduled FTR outage scheduling for the majority of the work to be performed will be focused on assemblies requiring interim examination during that outage. While the FTR is operating, the majority of the work load schedule will consist of processing assemblies requiring extended interim examination and final detailed examination.

4.2.1 Transfer, Cleaning and Storage

Assemblies designated for limited interim examination, extended interim examination or final examination in the Inert Gas Cell

Examination Facility are transferred from the Fuel Transfer Cell Cask[1] to the Fuel Handling Cell[2] using a cell bank overhead bridge crane. A portable cooling unit with combined sodium vapor control equipment is attached to each fuel assembly to be transferred. When it is assured that adequate cooling has been established the assembly is transferred in a vertical position to Storage,[2] or Cleaning Stations[2] or to the Interim Examination and Disassembly Cell. The removal or cleaning of sodium is performed on those assemblies requiring detailed visual examination or photography, repair or replacement of components and instrumentation, or disassembly for detailed examination.

Fuel assemblies are stored[2,3] in critically-safe, cooled, shielded storage locations in the Fuel Handling Cell. Cooling of the fuel subassemblies is maintained during storage. Shielded storage for material assemblies[2,3] is also provided in the Fuel Handling Cell. Space is available for 6 hanger rods on assembly ducts in shielded storage racks in the Interim Examination and Disassembly Cell.

Assemblies scheduled to return to the FTR after examination are transferred to the Fuel Transfer Cell Cask using the overhead bridge crane. Following examination fuel, material or components packaged in suitable containers[2] are transferred to the Fuel Handling Cell or through the ceiling of the Equipment Storage and Transfer Cell utilizing the waste transfer device and bottom loading casks.

During examination operations and prior to transfer particulate material and/or radioactive contamination on assembly surfaces is minimized by one or more of the following methods:

---

1. Refer to Interfaces, Appendix C, Item 13.
2. Refer to Interfaces, Appendix C, Item 15.
3. Refer to Support Information Requirements, Appendix B, Item 1.

- Good housekeeping practice (routine cleanup of cutting chips, particulate from failed fuel, sodium oxide, etc.).
- Wipe individual pins prior to reassembly.
- Wipe exterior assembly surfaces prior to transfer.
- Reprocess non-failed and non-vented assemblies through the sodium removal station (this assumes the sodium removal process utilizes a wash step).

Specimens are normally packaged in containers prior to shipment to protect the specimens from damage during water storage and/or shipments, and to minimize spread of contamination. Methods used to minimize surface contamination on containers prior to transfer to a cask or the water storage basin include ultrasonic cleaning (see 2.2.6 AF), and wiping.

4.2.2 Limited Interim Examination

Assemblies which have not been cleaned are transferred from the Fuel Handling Cell to the Interim Examination and Disassembly Cell by the over head bridge crane for a limited examination. A new cooling gas supply hose is connected to the portable cooling unit before the supply hose from the Fuel Handling Cell is disconnected. Limited visual inspection, photography, neutron radiography and gamma scanning may be performed before return to the F.T.R. during the outage. If data obtained indicates more extensive interim examination is required the assembly is transferred back to the Fuel Handling Cell for sodium removal. Assemblies which have had the sodium removed and are to be returned to the FTR during the outage are transferred to the Interim Examination and Disassembly Cell by the overhead bridge crane for a limited interim examination. Operations performed during limited interim examination may include removal and replacement of ducts, (depends upon decay heat level) visual inspection and photography of areas of interest, over all dimensional and interpin spacing measurements, neutron radiography, gamma scanning and testing of instrumentation. Cooling of fuel subassemblies is maintained during all operations.

As preparation of the assemblies for reinsertion in the FTR required instrument integrity tests, overall dimensional and straightness measurements, cleaning and gas flow tests are performed.[1] Written quality control procedures will be prepared and followed during the reassembly operations.

4.2.3 Extended Interim Examination

Assemblies which have had the sodium removed in the Fuel Handling Cell and are to be returned to the FTR are transferred to the Interim Examination and Disassembly Cell by the overhead bridge crane for an extended interim examination. Cooling of fuel subassemblies is maintained during all operations. Assembly reinsertion preparation and tests will be similar to those for limited interim examination.

For an extended interim examination; equipment is provided in the Interim Examination Cell for duct removal and replacement, disassembly and reassembly or replacement of pins, specimens and instrumentation, visual inspection, photography, overall dimensional and interpin spacing measurement, neutron radiography, gamma scanning and instrumentation testing and repair.

Replacement specimens may include, the original specimens, nonirradiated specimens or specimens previously irradiated at the FTR or other sites.[2] Specimens removed during interim examination may be processed through detailed examination and then reassembled.

---

1. Refer to Support Information Requirements, Appendix B, Item 1.
2. Refer to Interfaces, Appendix C, Items 14 and 15.

4.2.4 Final Disassembly and Detailed Examination

Cleaned assemblies designated for disassembly and final detailed examination are transferred into the Interim Examination and Disassembly Cell.

Assembly processing is similar to that for extended interim examination except that reassembly is not required. Hardware components will be processed according to schedule, reactor operations and experimentor interest. Assembly hardware no longer required, is transferred to the Detailed Examination Cell and prepared for disposal.

Material capsules may be transferred to the Detailed Examination Cell for disassembly, detailed examination and preparation for shipment.

Individual fuel pins, fuel or material specimens, and hardware requiring further inspection or processing are transferred to the Detailed Examination Cell for length, warp and cross-sectional measurements, weighing fuel pin balance point determination, leak testing, fission gas collection and measurement, or packaging.

Attention will be focused on the collection of good usable data and in maintaining the identity of all assemblies capsules, pins, specimens or components during disassembly, examination, transfers, packaging and storage. Pins and specimens are placed in transfer and storage racks to maintain identity and facilitate handling. Those items awaiting examination are placed in shielded storage. Items completing examination are packaged for disposal or shipment to fuel reprocessing.

Critically safe, shielded and cooled storage is available for 800 fuel pins or fuel specimens in the Detailed Examination Cell. Material specimen and component storage racks are also available.

Hardware components transferred to the Detailed Examination Cell will be processed according to schedule, reactor operations and experimenter interest. Those components completing their examination and no longer of interest and those components of no interest will be prepared for disposal.

Photographs or radiographs taken during examination operations are processed immediately to ensure that the quality of data meets the experimenter needs. Negatives are forwarded to outside facilities for reproduction.

Recording of data either automatically or through the use of personnel is a continuing operation. Data must be reduced, negatives analyzed and calculations performed to convert data for input to the Central Control and Data Handling System.[1,2]

4.2.5 Short Term Test Examination

Short term irradiated test assemblies[3,4,5] are received in the Inert Gas Cell Examination Facility from the Fuel Handling Cell for short term interim examination or for final examination during FTR operation. The short term test assemblies scheduled for an interim examination which are received with sodium removed must be disassembled, specimens examined and/or replaced, reassembled, and returned to the FTR for reinsertion. Examination operations will be similar to those performed during a regular limited interim examination with the exception that

1. Refer to Interfaces, Appendix C, Item 20.
2. Refer to Support Information Requirements, Appendix B, Item 5.
3. Refer to Interfaces, Appendix C, Item 18.
4. Refer to Examination Processing Load Requirements, Appendix F.
5. Refer to Support Information Requirements, Appendix B, Item 12.

the capsules containing multiple specimens may be disassembled and selected specimens replaced. Capsules may be replaced to assist in the reassembly

4.3 SHUTDOWN

No special shutdown operations are foreseen for this facility at the conceptual design stage. These operations will be reviewed and finalized during preliminary design.

4.4 SPECIAL OR INFREQUENT OPERATION

One spare operating station in the Detailed Examination Cell is provided to meet presently unforeseen requirements. It may be used for installation of special examination equipment because the FTR will be utilized for specialized tests[1] to resolve basic research problems. This special equipment and the procedures for its operation will be provided by the experimenters concerned. During normal operations a number of special (nonscheduled) tasks will be performed as the examination operations progress in order to achieve maximum retrieval of data. For instance it may be necessary to handle a closed loop tube containing sodium and a stuck closed loop assembly. During preliminary design the handling requirements and procedures[2] for such an occurrence will be defined to assure that basic handling capabilities are adequate. Special equipment needed to handle a stuck fuel assembly and closed loop tube will not be provided initially.

4.5 EMERGENCY

Emergency systems, alarms and procedures are provided to insure detection of nonstandard radiation or contamination

---

1. Refer to References, Appendix A, Item 7.
2. Refer to Support Information Requirements, Appendix B, Item 4.

conditions. Personnel are warned and emergency procedures followed in the event, contaminated material has spread, a loss of confinement has occurred or certain equipment has failed.

Criticality detection and alarm equipment as well as a warning system are provided in the facility. In the event an unintentional criticality occurs personnel are warned and evacuated, and appropriate procedures initiated.

Emergency power is provided to the inert gas purification and circulation system, the subassembly cooling equipment, the ventilation exhaust system, in-cell cranes and electric manipulators, monitoring equipment and some lights both in-cell and in the support area.

Redundant or backup equipment for the in-cell atmosphere cooling, recirculation and purity control is provided with automatic recording, warning and startup systems. Loss of atmosphere control with its possible contamination and fire hazards is prevented by provisions for automatic correction of the malfunction on startup of the emergency systems as well as warning of the incident.

Fire protection equipment such as overhead sprinklers, wall mounted emergency fire fighting equipment and warning devices as well as appropriate procedures are provided in the event a fire occurs in the operating galleries or support areas. Personnel are warned or evacuated and appropriate action taken to eliminate the emergency.

A backup cooling method and procedures are provided to prevent fuel meltdown resulting from loss of primary cooling. The cooling equipment will be designed to assure that evacuation can be accomplished without loss of subassembly cooling with subsequent meltdown. A study[1] will determine an optimal design-procedural arrangement for the Facility and equipment.

1. Refer to Support Informational Requirements, Appendix B, Item 3.

SECTION 5.0 MAINTENANCE PRINCIPLES

The Radioactive Maintenance System[1] will provide the support facilities, equipment and procedures for out-of-cell decontamination and maintenance of the Inert Gas Cell Examination Facility equipment.

5.1 PREVENTATIVE MAINTENANCE

A. Continuous operator training in the principles of operation and control and the proper procedures to be followed when using in-cell equipment is good assurance against possible costly downtime for major maintenance or repair of the equipment.

B. Periodic lubrication, adjustment and inspection of all in-cell equipment is scheduled on a routine basis and is performed remotely when possible. Where remote preventative maintenance is not feasible the equipment or component is transferred from the cell to the Decontamination Cell.[1] Minimum decontamination may be required for lubrication, adjustment, inspection and minor replacement of parts prior to return of equipment to the cell. Equipment or components which have a high use factor and require complex or extensive decontamination prior to routine maintenance are replaced with spare or redundant equipment or components.

C. Load testing of all handling and transfer equipment is performed on a scheduled routine basis.

D. In-cell equipment, instrumentation, and equipment controls are inspected, adjusted, and calibrated on a scheduled routine basis.

---

1. Refer to Interfaces, Appendix C, Item 16.

E. Alarms and detection devices are inspected, tested, and calibrated in accordance with Design Safety and Radiological Control Requirements.[1]

5.2 GENERAL MAINTENANCE

A. Insofar as practical in-cell equipment will be designed for remote removal, decontamination and maintenance.

B. Master slave manipular slave ends, electromechanical manipular components, crane components, special equipment components, and examination equipment are all transferred through the Equipment Storage and Transfer Cell to the Decontamination Cell for contact maintenance. Master slave manipulator through tubes are removed or installed from the operating gallery side of the cell walls utilizing portable sealed handling containers.

C. Equipment modules greater than 6 feet in length or diameter are transferred through the equipment access part in the ceiling of the Interim Examination and Disassembly Cell to portable sealed equipment handling containers for transport of the modules to decontamination and contact maintenance facilities.

D. Entry into the cell bank in life support suits will be necessary on occasion particularly during a major outage or to complete a decontamination of the cell bank. The cell bank atmosphere may be changed to air for a major equipment changeout. Personnel entry is made by a pair of individuals both in life support suits.

E. Lights and filtering equipment are remotely replaced on a routine basis but they may require more frequent changing if illumination levels decrease or if filter pressure drop is excessive.

---

1. Refer to References, Appendix A, Items 8 and 14.

F. Viewing window sections are replaced as required to maintain clarity for visual control.

G. Complex contact maintenance of contaminated manipulators and examination equipment is performed in a repair shop adjacent to the Decontamination Cell. Glove boxes and hoods are provided to assist in maintenance and repair of this equipment.

H. Shielded equipment storage is provided for equipment waiting for maintenance or repair, or for return to the cell bank.

I. Spare components and replacement part storage is also provided.

J. A manipulator master end repair shop and parts storage area is also provided in the support area adjacent to the cell bank.

5.3 DECONTAMINATION[1]

A. Equipment or means will be provided for remote cleanup and decontamination of cell interiors and preliminary decontamination of equipment.

B. Decontamination of the cells and equipment is required periodically to prevent radiation levels from becoming unmanageably high.

C. Only preliminary decontamination of equipment will be carried out in the cells particularly for equipment being removed, with complete decontamination of the equipment being done in the support area.

---

1. Refer to Support Information Requirements, Appendix B, Item 13.

D. A Decontamination Cell[1] is provided, sized, and equipped for cleaning of highly contaminated equipment prior to contact decontamination, maintenance, repair or storage. Its location adjacent to the Equipment Transfer Tunnel below the Equipment Storage and Transfer Cell will assist in minimizing airborne contamination spread and reducing personnel exposure.

E. Glove boxes and hoods are provided for contact decontamination of hard to decontaminate equipment components or parts.

F. Surface finishes and corrosion resistant materials are specified for in-cell equipment to facilitate decontamination.

G. The advantages of parts replacement over decontamination will be determined on the basis of cost, down time and personnel dose rates.

H. Decontamination of the cells is required for an outage involving a change in mission or a major change of equipment. The procedure for decontamination of the cell bank during a major outage includes the following steps:
   1. Remove all irradiated fuel and material.
   2. Partially decontaminate equipment and remove from cell.
   3. Remotely decontaminate cell interior by vacuuming and washing or wiping with detergents and solvents.
   4. Remotely survey cell interiors and mop both fixed and smearable radiation levels.

---

1. Refer to Interfaces, Appendix C, Item 16.

5. Remotely decontaminate hot spots with acids on cover with shielding until penetrating radiation levels have been reduced to levels which permit reasonable personnel working times.
6. Enter cell in plastic life support suits.
7. Complete cell decontamination by contact until radiation levels have been reduced to levels which permit reasonable personnel working times for all modifications.

APPENDIX A

REFERENCES

APPENDIX A

REFERENCES

1. K. R. Ferguson, W. B. Doe, and R. C. Goertz, "Remote Handling of Radioactive Materials," Reactor Handbook, Second Edition, Vol. IV, Engineering, Chapter 14, -- Edited by S. McLain and J. H. Martens. Interscience Publishers, New York, 1964.

2. Functional Test Requirements Study, GA-8061, Page 23, General Atomics, June, 1967.

3. C. C. Steele, Overall Conceptual Systems Design Description, BNWL-500, Vol. 1, pp 3-25 & 3-26, Battelle-Northwest, Richland, Washington, July 7, 1967.

4. Technical Review of BNWL-CC-400, NAA-SR-MEMO-11926, pp 3.13-1, Atomics International, April, 1966.

5. Hanford Standards Design Criteria, HWS-10006, Revision 2, Chapter SDC-1.2, GE-HAPO, May 3, 1963.

6. A. L. Coogler, G. J. Deily and R. J. Hale, "Evaluation of the High Level Cores at the Savannah River Laboratory," Proceedings of the Thirteenth Conference on Remote Systems Technology, 1965, pp 113 & 114.

7. O. K. Harling, Basic Research Capability of Fast Flux Test Facility, BNWL-496, Battelle-Northwest, Richland, Washington, July, 1967.

8. A. J. Stevens, F. Swanburg, and E. C. Watson, Preliminary Radiological Considerations Involved with Examination of Irradiated FTR Elements, BNWL-566, Battelle-Northwest, Richland, Washington, November, 1967.

9. C. L. Brown, "FFTF Criticality Safety - System 71 - Inert Gas Examination Cell," Conceptual Design Evaluation, BNWL-587, Battelle-Northwest, Richland, Washington, September, 1967.

10. W. L. Bunch, Shielding Calculations for Irradiated FFTF Fuel, BNWL-342, pp 9-12, Battelle-Northwest, Richland, Washington, December, 1967.

11. D. R. Dickinson, Gas Cooling of FFTF During Examination and Disassembly Preliminary Feasibility Study, BNWL-524, pp 1, Battelle-Northwest, Richland, Washington, July, 1967.

12. C. E. Stevenson, D. M. Paige, W. F. Holcomb and J. O. Kleffner, "Startup Experience for the EBR-II Fuel Cycle Facility, L. Manipulators and Process Auxiliaries," Proceedings of the Thirteenth Conference on Remote Systems Technology, pp 3-7, November 15-18, 1965.

13. Standards for Radiation Protection, AEC Manual Chapter 0524 and RL Supplement RL-0524-01.

14. D. E. Simpson, Design Safety Criteria For the Fast Flux Test Facility, BNWL-823, Section 1, Battelle-Northwest, Richland, Washington, 1968

15. C. L. Boyd, E. C. Watts, E. M. King and S. E. Dismuke, "Disassembly and Sampling of Irradiated Materials in the United States," International Symposium on Working Methods in High Activity Hot Laboratories, Grenable, France, p. 375, 1965.

16. J. L. Hoyt, C. E. Porter and C. D. Wilkinson, "Nuetron Radiography Applications at General Electric," 15th Conference on Remote Systems Technology, p. 109, 1967.

17. J. Ballif and J. Buck, Functional Test Requirements for Fast Flux Test Facility, Atomics International, NAA-SR-MEMO-12172, pp. 8, 13, and 23, November, 1966.

18. Members of K-Division Staff, A Study of Selected LMFBR Program Needs to Establish Functional Testing Requirements for the Fast Flux Test Facility, K-1578, pp. 10, 20, 23, and 27, Los Alamos Scientific Laboratory, December, 1966.

19. C. N. Spalaris, FFTF Functional Requirements, GEAP-5290, pp. 2-7, 2-17, 2-19, and 6-6, APO, General Electric Company, October, 1966.

20. W. E. McHugh, Functional Testing Requirements, pp. 601, 602, 617, 621, 628, and 630, Atomic Power Development Associates, Inc., October, 1966.

21. Functional Testing Requirements for Fast Flux Test Facility, pp. 4, 6, 8, 12, 27, and 30, ARD Westinghouse Electric Company, January, 1967.

22. FFTF Functional Test Requirements, Attachment to DRdeB-27-67, pp. 3, 4, 10, 14, 27 and 75, Idaho Nuclear Corporation.

23. R. J. Hennig, Unpublished Data, Functional Testing Requirements for the FFTF, A-0030-R, Battelle-Northwest, Richland, Washington, (Preliminary Report.)

24. H. M. Glen, "A Survey of Structural Materials for Use in Remote Handling Facilities," 10th Hot Laboratory Proceedings, ANS, p. 51, November, 1962.

25. Radiological Design Criteria, Sections II & IV, BNMA-3, Battelle-Northwest, Richland, Washington, March 22, 1965.

26. R. Franckx, "Refueling Cell Man Access Procedure," SEFOR Plant, General Electric, Advanced Product Operations, April, 1965.

27. R. C. Alexander and S. A. Cottrell, "Dounreay Experimental Reactor Establishment Highly Active Plutonium Examination and Processing Causes," Journal, British Nuclear Energy Society, July, 1964, pp. 215.

28. W. E. Berry, "Some Facts About Stress Corrosion of Austenitic Stainless Steels in Reactor Systems," Reactor Materials, Vol. 7, No. 1, Spring 1964.

29. E. L. Long, Jr., and C. Michelson, "Some Observations of Intergranular Corrosion of Irradiated Type 304 Stainless Steel," ORNL-3684, Nov., 1964.

30. R. A. Harvey, Unpublished Data, FFTF System Effectiveness Goals; Battelle-Northwest, Richland, Washington (Preliminary Report: A-0082)

31. R. C. Walker, FFTF Reference Concept Summary Description, BNWL-955, Battelle-Northwest, Richland, Washington, January, 1969.

32. D. P. O'Keefe, FFTF Examination Facility Atmosphere Impurity Control Requirements (A Review of Existing Information), BNWL-948, Battelle-Northwest, Richland, Washington, January, 1969.

33. P. C. Friend, Technical Manual for Neutron Sensitive Criticality Detector, BNWL-MA-29, Battelle-Northwest, Richland, Washington, May 1966.

34. Hanford Standard Specification for Emergency Audible Signals, HWS-8210-S, January, 1966.

35. D. G. Albertson, T. A. Fredericks, and W. T. Mine. FFTF Neutron Radiography Study: Phase I, GEIC-1101, General Electric, IPO, Vallecitos Nuclear Center, September, 1968.

36. G. A. West and C. D. Watson, Gamma Radiation Damage and Decontamination Evaluation of Protective Coatings and Other Materials For Hot Laboratory and Fuel Processing Facilities, ORNL-3589, Oak Ridge National Laboratory, Oak Ridge, Tennessee, February, 1945.

37. Integration Study of Fuel Handling and Radioactive Maintenance Systems Fast Flux Test Facility, Contract BSA-418. Task Order 2, Aerojet General Corporation, N.D., October, 1968.

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS

Item	Information Required	Type of Effort	Information Source	When Required
1.	Functional Testing Requirements	Design Study	BNW 189a Task DSA7	Start preliminary design to mid-preliminary design
	A. Number of fuel and material test assemblies for limited interim, extended interim and final examination.			
	B. Number of driver fuel assemblies to be examined.			
	C. The types of inspection and testing operations required for interim and final examination.			
	D. Special examination requirements for environmental control and preservation of data during examination operation such as: (1) Subassembly surface temperature control (2) Sodium removal criteria (to include vented and failed fuels) (3) Inert gas atmosphere purity criteria (4) Criteria for test reinsertion (5) Handling requirements (verticality)			

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS (contd)

Item	Information Required	Type of Effort	Information Source	When Required
	(6) Shipping requirements (7) Process rate studies (8) Storage requirements.			
	E. Reactor structural material and component examination requirements.			
	F. Typical test subassembly designs		DSA-7 & FE-4	
2.	Inert Gas Atmosphere	Design Study	BNW 189 Task FE-2 & AE	Start preliminary design
	A. Definition of basic requirements for the inert gas handling system.			
	B. Define pressure and temperature control requirements			
3.	Gas Cooling of FFTF Fuel	Engineering Study & Equipment Development.	BNW 189 Task FE-7	Late preliminary design
	A. Establish preliminary design criteria for forced gas cooling of fuel subassemblies and fuel storage locations.			
	B. Design data and criteria for backup fuel subassembly cooling equipment. Determine design procedural optimization for continued cooling during emergency evacuation.			

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS (contd)

Item	Information Required	Type of Effort	Information Source	When Required
	C. Fuel Subassembly and pin decay output.		BNW 189a Task DSA-4	
	D. Determine radiant heat levels from gas cooled subassemblies.		DSA-4	
4.	Examination Equipment (Refer to Appendix D & E)	Design and Development Study	BNW 189a Task FE-4	Start preliminary design to late preliminary design
	A. Determine special examination equipment development requirements.			
	B. Establish equipment concepts and input on cell space, viewing, handling and services for preliminary design descriptions.			
	C. Establish special or engineered examination equipment specifications.			
5.	Data Storage and Reduction	Engineering Study	AE	Mid-preliminary design
	A. Requirements for experimental tests.			
	B. Requirements for driver fuel surveillance program.			
	C. Requirements for accountability and location of fuel, material and components.			

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS (contd)

Item	Information Required	Type of Effort	Information Source	When Required
	D. Determine equipment requirements for data storage and reductions.			
6.	Materials and Component Selection	Design and Development Study		
	A. Establish in-cell structural material.		AE	Preliminary design
	B. Establish design criteria and candidate materials for in-cell equipment design.		AE	Mid-preliminary
	C. Establish design data or functional performance of materials, components and equipment in examination cell environs.		BNW 189a Task TF-4	Late preliminary design to final design
7.	Viewing Window Criteria	Development Study	AE	Late preliminary design
	Determine optimum window viewing angles and light transmission.			
8.	Radiological Control	Engineering Study	BNW 189a Task DSA-3	Start preliminary design to mid-preliminary design.
	A. Criteria for airborne contamination confinement requirements.			

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS (contd)

Item	Information Required	Type of Effort	Information Source	When Required
	B. Radiation shielding requirements		DSA-4	
	C. Radiation level studies.		DSA-4	
	D. Determine radiation monitoring equipment requirements		AE	
	E. Criteria for criticality control.		CP-1	
9.	Waste Disposal Waste packaging requirements.	Engineering Study	BNW 189a, AE & System 24	Start to mid-preliminary design
10.	In-Cell Lighting In-cell lighting requirements for viewing, photography remote operations and T.V.	Engineering Study	AE	Mid-preliminary design
11.	Decontamination Determine decontamination requirements & methods for examination equipment. Decontamination processes shall be compatible with equipment materials selected and the safety limits for personnel exposure during contact maintenance.	Engineering Study	BNW 189a Task FH-5, CSDD System 44	Mid-preliminary design

APPENDIX B

SUPPORT INFORMATION REQUIREMENTS (contd)

Item	Information Required	Type of Effort	Information Source	When Required
12.	Short Term Irradiation Tests Determine impact of short term Irradiation Facility Tests on the Inert Gas Cell Examination Facility Concept.	Engineering Study	AE	Mid-preliminary design
13.	Sodium Removal Equipment A. Determine design criteria for a proven method or equipment for removal of sodium from failed or vented fuel assemblies, and components. B. Establish characteristics of wastes from cleaning operations. C. Establish Sodium Removal equipment concept.	Design and Development Study	BNW 189a Task FE-4 & Rm-11	Late preliminary design

APPENDIX C

INTERFACES

APPENDIX C

INTERFACES

INTERFACING SYSTEM

Item	Service	No.	Title	Interfacing Area
1.	Electrical Power	12	Building Electrical Power System	Normal and emergency facility and equipment electrical supply.
2.	Communications Equipment	15	Communications System	Normal facility communications. Operational communications such as operating stations network, in-cell microphones, and portable in-cell cameras with closed circuit TV systems.
3.	Lighting	16	Lighting System	In-cell, operating gallery and support area lighting.
4.	Facility Arrangement and Support Equipment	21	Structures	High bay bridge crane. Personnel and equipment access. Facility structure and arrangement. Cell doors, locker room and equipment. Cell penetrations, sleeves and frames. Office equipment.
5.	Site Arrangement	22	Site Facilities	Space for future linear expansion of examination facility.
6.	Service Piping and Respiratory Protection	23	Service Piping System	Air sampling heads, breathing air, high pressure air, process sewer, steam and water supply, sanitary sewer & Laboratory vacuum supply.

APPENDIX C (contd)

INTERFACES

INTERFACING SYSTEM

Item	Service	No.	Title	Interfacing Area
7.	Radioactive Waste Disposal	24	Radioactive Waste System	Liquid and solid radioactive waste disposal. Waste packaging requirements & solid waste cask.
8.	Confinement Systems Heating and Ventilation	25	Heating and Ventilation System	Confinement systems for operating galleries, support areas and hoods including air balance control, filtered exhaust, and sampling. Normal facility heating and ventilation requirements.
9.	Fire Protection	26	Plant Fire Protection System	Normal facility fire detection, warning and protection for operating galleries and support areas.
10.	Component Examination	31	Reactor Core	Reflector Assembly examination
11.	Component Examination	33	Reactor Nuclear Control Components	Control Rod Assembly examination
12.	Component Examination	35	First Core Fuel Assembly Component	Driver Fuel Assembly examination.
13.	Reactor Refueling	41	Reactor Refueling System	Decay storage of Test Assemblies. Reinsertion of Assemblies.

APPENDIX C (contd)

INTERFACES

INTERFACING SYSTEM

Item	Service	No.	Title	Interfacing Area
14.	Nonirradiated Fuel Handling	42	Nonirradiated Fuel Handling System	Storage of Neutron Radiography Reactor nonirradiated fuel. Handling nonirradiated replacement specimens. Radiography requirements for nonirradiated components.
15.	Fuel Handling cell	43	Irradiated Fuel Handling System	Transfer of irradiated fuels materials and core components between the Inert Gas Cell Examination Facility and the Reactor Refueling System, and the Underwater Storage and Loadout Basin. Storage and normal sodium cleaning of irradiated fuels materials and core components designed for examination. Provide space for special sodium removal equipment (failed or vented fuels) supplied by the Inert Gas Cell Examination Facility. Packaging requirements for shipment of pins and specimens. Transfer replacement specimens to Examination Facility as received from off-site.

APPENDIX C (contd)

INTERFACES

INTERFACING SYSTEM

Item	Service	No.	Title	Interfacing Area
				Transfer of packaged pins and specimens for shipment offsite.
				Share cell bank bridge cranes and electromechanical manipulators.
16.	Decontamination and Maintenance	44	Radioactive Maintenance System	Decontamination cell and hoods equipped for cleaning of highly contaminated equipment adjacent to cell bank. Equipment handling containers
				Support area for contact decontamination maintenance and storage of contaminated equipment.
17.	Closed Loop Assemblies	61	Closed Loop System	Overall dimensions for closed loop tubes examination requirements.
18.	Short-Term Assemblies	68	Short-Term Irradiation Facility	Component Configuration & examination requirements.
19	Inert Gas Atmosphere	82	Inert Gas Receiving and Processing System	Provision and maintenance of a filtered, cooled and purified argon atmosphere in the cell bank, forced gas cooling of fuel subassemblies and cooling in-cell fuel storage locations.

APPENDIX C (contd)

INTERFACES

INTERFACING SYSTEM

Item	Service	No.	Title	Interfacing Area
				Supply high and low pressure inert gas for equipment operation.
				Confinement systems for the cell bank including gas balance and its control, filtered exhaust and its sampling, chemical clean-up systems, and emergency systems and alarms.
20.	Data Storage and Reduction	91	Central Control and Data Handling System	Recording, storage and reduction of information obtained during disassembly, reassembly, examination, storage and packaging operations.
21.	Component Examination	92	Reactor & Vessel Instrumentation System	Component configuration examination requirements.
22.	Instruments	93	Plant Instrumentation System	General cell operating instruments.
23.	Radiation Safety	96	Radiation Monitoring System	Radiation monitoring equipment.
24.	Sodium Analysis	85	Chemical Analysis Facility	Analyze sodium from experiments.

APPENDIX D

CONCEPTUAL DESIGN EVALUATION

APPENDIX D

CONCEPTUAL DESIGN EVALUATIONS

D.1 FUEL EXAMINATION FACILITY ALTERNATES

Alternate types of facilities to supplement and backup the Inert Gas Cell Examination Facility were considered during development of the concept described in this CFDD.

D.1.1 Underwater Cell Examination Facility

A. An Underwater Cell Examination Facility would provide an economical means for examination of those fuel, materials and components irradiated in the FTR which are compatible with water.

   1. This type of facility construction and operating costs are generally lower than either an inert gas facility or an air environment cell.

   2. An underwater cell would provide a facility where heat removal from high decay power FTR components or experiments need not be a major concern. This capability is a major advantage when it is realized that decay power for experiments may approach 10 kilowatts after one to two months of cooling.

   3. The facility would be very convenient for use with the Underwater Storage and Loadout Basin.[1]

B. Evaluation of preliminary studies, Functional Test Requirements and Examination Work Load Estimates indicates that a major portion of the expected FFTF experimental load and potential future driver fuels should not be examined under water. An Underwater Cell Examination Facility is not recommended for the following reasons:

---

1. Refer to Interfaces, Appendix C, Item 15.

1. It is difficult to assure that sensitized stainless steels will not react with water and effect data obtained during subsequent radiometallurgy examination.[1]
2. Materials and components that can be examined underwater without concern over loss of data have relatively low heat removal requirements.
3. Components which should not be examined underwater include:
   a. Failed and vented fuels
   b. Singly encapsulated carbide, sodium bonded and possibly nitride fuels
   c. Unencapsulated corrosion and mechanical test specimens.
4. Because inert gas cells are provided in FFTF, expansion of these cells and elimination of underwater examination has cost advantages.

D.1.2 Air Atmosphere Cell Examination Facility

An Air Atmosphere Cell Examination Facility would be slightly more economical than an inert gas facility for examination of those fuels, materials and components irradiated in the FTR that do not require strict environmental control.

Evaluation of preliminary studies, Functional Test Requirements and Examination Work Load Estimates indicate that the fraction of fuels and materials that do not require strict environmental control for preservation of data during examination is relatively small, particularly if the fuels or materials are to be returned to the reactor after examination. The option of possibly

1. Refer to References, Appendix A, Items 28 and 29.

returning an experiment to the reactor even though it had been thought the irradiation had been complete at the time it was removed from the reactor is not as practical as from an inert gas cell. Moreover, it would be necessary to provide a purge chamber during transfer between the air atmosphere cell and the Inert Gas Fuel Transfer Cell.[1]

An Air Atmosphere Cell Examination Facility is not recommended as there appears to be no real advantages.

D.1.3 Parallel Cell Arrangement

Aerojet-General Corporation performed a Systems Integration Study[2] to identify and develop alternate equipment and system arrangement concepts and operational flow patterns that would fulfill the combined functions and requirements of the FFTF Systems Group 40, Fuel Handling and Radioactive Maintenance including Fuel Examination. As part of this study, the advantages and disadvantages of a parallel cell arrangement in which the fuel examination facility and fuel transfer cell are arranged in parallel with a common fuel transfer area from reactor containment was examined. The arrangement permitted diverting a specimen to those portions of FFTF equipped for loadout and shipping without necessitating passage through previously traversed examination spaces as well as inappropriate portions of the irradiated fuel handling space. Interconnecting transfer cells or transfer tunnels between the two parallel cell banks and multiple loadout ports were considered as alternate methods for transferring specimens from one cell bank to the other. The advantages and disadvantages as determined by AGC in the course of the System 40 Integration Study are listed in their report.

1. Refer to Interfaces, Appendix C, Item 15.
2. Refer to References, Appendix A, Item 37.

Alternate cell arrangements which utilized interconnecting transfer cells or tunnels, or multiple loadout ports for transfer of fuel pin, specimen and hardware items between cell areas were examined and evaluated during the period leading to the selection of the reference cell arrangement in the CFDD.

Selection of an in-line cell arrangement permits equipment such as overhead cranes and manipulators to be shared, reduces costs of concrete for cell walls and transfer tunnels, and eliminate costs of casks. The reference cell as selected meets all the major functions of the Inert Gas Cell Examination Facility for less cost than the other arrangements considered. It also has a higher operating efficiency than either alternate and provides better contamination control than the multiple port-cask arrangement.

D.2 CELL BANK ARRANGEMENT

The location of the examination facility in line with and adjacent to the Fuel Handling Cell[1] within a common cell bank provides for maximum utilization of the Fuel Handling Cell as a common zone for transfer of fuels, materials and components irradiated in the FTR specified for examination, storage or shipment. This location minimizes the number of complex material transfers (cooling must be maintained for fuel subassemblies) between facilities handling equipment. It also allows greater flexibility for future operations in that certain facilities are shared such as over head bridge cranes and electromechanical manipulators while other facilities may be shared should the need arise such as disassembly (processing) of driver assemblies in the Interim Examination and Disassembly Cell of the cell bank and limited visual inspection and photography of assemblies in the Fuel Handling Cell.

1. Refer to Interfaces, Appendix C, Item 15.

The in-line cell bank arrangement relative to single unit cells has the advantages of: (1) greater flexibility of operations, and (2) lower cost. Flexibility is enhanced because the cell space given process operations can be adjusted as needed. Equipment can be moved directly and easily from cell to cell. Additional cells may be added to the cell bank without disrupting the material flows within the cell. The cost of the cells is less because a number of items can be shared. A single fuel, material and component transfer station, and a single large equipment transfer device can serve the whole cell bank. The overhead handling system (bridge cranes and manipulators) service the entire cell bank as well as transfer items to and from the Fuel Handling Cell. The length of the shielding wall is less since there is an outside wall on only two or three sides of the cells rather than on all four walls.

The disadvantages of the in-line cell arrangement are: (1) the operating gallery floor area surrounding the cell is somewhat limited for control or access, and (2) the operation of an individual cell is not completely independent of its neighbor. With proper utilization of space and shielding these disadvantages should not present any problems.

Overall size of the facility is based on engineering judgment dependent upon assembly length, handling requirements and the examination processing load. The depth of 65 feet for the Interim Examination and Disassembly Cell allows full length test assemblies to be disassembled, examined and reassembled in a vertical position.

D.3 STAINLESS STEEL LINER

A stainless steel liner[1] was chosen for the cell bank internal surfaces over a carbon steel liner with a thermoplastic resin

1. Refer to References, Appendix A, Item 24.

based coating on the basis of lower long term costs and the many operational advantages of stainless steel:

A. Maintenance of the in-cell surfaces is eliminated.

B. Decreased vulnerability of the cell walls to inadvertent physical damage during handling operations.

C. Decontamination of the cells is easier and more efficient.

D. Based upon expected in-cell radiation levels and life expectancy,[1] an epoxy coated steel liner would require cell entry about once every two years for replacement of the epoxy coating in the Interim Examination and Disassembly Cell area.

The disadvantages of the stainless steel liner are its higher initial capital cost compared to a carbon steel liner with a thermoplastic resin coating and the decreased light reflectivity from the walls for visual control of examination operations.

D.4 INERT GAS ATMOSPHERE

Three candidate gases are being considered for the Inert Gas Cell Examination Facility; Nitrogen, Argon and Helium. A study is presently being performed for evaluation of the candidate gases.[2] An inert gas will be selected and a definition of the basic requirements for the inert gas handling system[3] prepared on the basis of the study.

The evaluation of the candidate gases will be based on (but not limited by the following criteria):

A. Compatibility with driver fuel and test assemblies during examination and after reinsertion into the reactor.

---

1. Refer to References, Appendix A, Item 36
2. Refer to Support Information Requirements, Appendix B, Item 2.
3. Refer to Interfaces, Appendix C, Item 19.

B. Existence of proven operation.

C. Compatibility with other FFTF systems.

D. Electrical properties such as dielectric constant, ionization and reliability.

E. Heat removal capacity.

F. Economic considerations including relative cost of purification refrigeration and recirculation systems.

Argon was selected for the reference design primarily on the basis of experience gained through operation of the EBR-II Fuel Cycle Facility[1] and the Dounreay examination cells.[2] This selection permits existing technology to be used for equipment design.

Nitrogen was eliminated as a candidate cell gas because of the possible need for control of nitrogen impurity in the gas when fuel surface temperatures during gas cooling are more firmly established. For the present nitrogen impurity control to 4-6% by feed and bleed was selected. Nitrogen impurity in argon or helium can be controlled by chemical purification equipment to less than 3 ppm, but would be expensive.

The Inert Gas Cell Examination Facility and Irradiated Fuel Handling System have a common gas atmosphere in the reference concept. Inert Gas selection for the Reactor Refueling System and the reactor cover gas may be dictated by the gas-cooled fuel handling machine heat removal requirements. Helium has greater conductivity than argon, but both helium and argon have nearly equal heat capacity per unit volume.

---

1. Refer to References, Appendix A, Item 12.
2. Refer to References, Appendix A, Item 27.

If helium is selected for the gas-cooled fuel handling machine and reactor cover gas, some intermixing of argon and helium will occur during fuel transfers. Removal of argon from the helium cover gas can be easily accomplished by cryogenic methods. Because of cost of equipment for removal of helium from argon and cost of operation with helium it would be more advantageous to operate the cells with argon and some helium impurity. This will require design of examination equipment for operation in helium.

Electrical connectors can be operated in helium if minimum pin spacing is 1/8 inch or more.[1] Information on operation of electric motors in helium is not available. Based on operating experience in argon[1] with 220 volt electric motors and the differences in dielectric constant of the two gases, 115 volt motor operation in helium appears feasible. Programmed and Remote Systems Corporation (PAR) can furnish remote electric cranes and electromechanical manipulators with maximum voltages of 115 DC. PAR is currently planning tests of 115 volt motors in helium. Results are expected to be available in about 6 months.

Oxygen and moisture impurities of about 25 ppm in the argon atmosphere was selected for the reference design based upon operating experience at the EBR-II Fuel Cycle Facility[1] where excessive bearing and electric motor brush wear has occurred at lower levels.

D.5 MATERIAL AND COMPONENT SELECTION[2]

The selection of materials, components and equipment for use in the facility will be guided by the fact that all of the

1. Refer to References, Appendix A, Item 12.
2. Refer to Support Information Requirements, Appendix B, Items 4 and 6.

in-cell equipment will operate under more severe environmental conditions than those normally encountered in other examination facilities.

A. Usually the types of radiation and the radiation levels encountered in hot cells are such that radiation damage to metals, ceramics and materials of similar stability are not a problem. The principal radiation damage effect will be a decrease in physical properties of organic materials such as plastics, rubber and lubricants.

B. Atmosphere purity limits and the type of atmosphere also have considerable effect upon the operation and reliability of in-cell materials and components. Problems arise in the operation of electric motors, switches and other electrical components in a highly ionized atmosphere.[1] Particularly if the atmosphere is argon or helium. High purity dry atmospheres also have an adverse effect on lubricants and electric motor brushes.

C. Electric motors specified for in-cell use will be the induction type without slip-rings, commutators, thermal overload contacts or the like. Two phase, servo motors are recommended for all variable speed and positioning type drives, as in the electromechanical manipulators and cranes. Should the use of brush type motors be required, the brushes will be made from molydisulphide impregnated carbon such as those for "high altitude applications."

D. Fire is a significant hazard in the examination cells. Particularly when liquid metal or metallic and carbide fuels are handled. Metallic and carbide fuels are combustible, and the hazard is increased by gamma heating

1. Refer to References, Appendix A, Item 12.

of the fuel material. The purity limit of the argon atmosphere will be set to eliminate these fire hazards. Considerable damage to in-cell materials may occur because of radiant heat from high decay heat output subassemblies. During remote handling operations fuel pins with surface temperatures up to 600 °F may come in contact with exposed materials and components. Flammable construction materials or those which are damaged by heat will be used only when protected by insulation.

E. Although very little information is available on the optimum design life for hot cell materials and components, a reasonable design life appears to be about three years or more. When materials or components must be used under conditions where they will not function for three years, then steps will be taken to provide for remote replacement or shielding will be provided to reduce radiation exposure or heat damage. In any event complex components which are susceptible to wear, damage or failure within a short period of time must be replaceable or repairable with a minimum of effort and without removal of the complete equipment item.

APPENDIX E

EQUIPMENT LIST

APPENDIX E

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-1	Sodium Removal Equipment	1	SPECIAL[1,2]		Fuel Handling
71-2	Sodium Drain and Fill Equipment	1	SPECIAL	Drain sodium from disassembled capsules. Fill and prepare capsules for reassembly.	Detailed Examination Cell
71-3	Subassembly and Fuel Element Cooling Equipment	3	SPECIAL	Control irradiated fuel surface temperatures to levels necessary for preservation of experimental data. Control required during transfer, handling, disassembly examination, and reassembly operations. Portable units must be capable of removing 20 Kw decay heat.	In-Cell: Gas connections in Fuel Handling Cell, and Interim Examination and Disassembly Cell. Will first be connected to assembly in the Fuel Handling Cell.

---

1 Special examination equipment: Dependent upon concept, may be either BNW developed prototypes or AE engineered items.

2 Refer to Support Information Requirements, Appendix B, Item 4.

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-4	Assembly Transfer Grapples	3	SPECIAL	Handle assemblies in vertical position during transfer or positioning at cleaning or work stations. Use with overhead bridge crane. Must be compatible with cooling, cleaning, and disassembly and reassembly equipment.	In-cell: Used in Fuel Handling Cell, and Interim Examination and Disassembly Cell.
71-5	Disassembly and Reassembly Machine	2	SPECIAL	Disassemble assemblies. Remove and replace subassembly ducts. Replace or repair instrumentation. Replace specimens and reassemble assemblies. Will provide primary transverse cooling for fuel surfaces. Operate with master slave and electromechanical manipulators.	Interim Examination and Disassembly Cell.
71-6	Subassembly Measuring Equipment	2	SPECIAL	Measure overall fuel element and interpin spacing dimensions. Compatible with disassembly and reassembly machine. Use with master slave and electromechanical manipulators.	Interim Examination and Disassembly Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-7	Instrumentation Testing Equipment	1	SPECIAL	Test and check out integrity of assembly instrumentation. May also be used for examination of test instrumentation specimens. Transported by electro-mechanical manipulators and operated by master slave manipulators.	Interim Examination and Disassembly Cell.
71-8	Camera Equipment	5		Photographic collection of data for recording, examination and operational purposes. Macro-camera cameras are provided for through window photography. Special sealed through wall systems will be provided.	Sidewall Operating Galleries
	(A) Portable Macro-cameras	(2)	ENGINEERED[1,2]		
	(B) Wall Mounted Camera Systems	(3)	SPECIAL		

---

1 Engineered: BNW supplies requirements; AE prepares specifications and performs procurement.

2 Refer to Support Information Requirements, Appendix B, Item 4.

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-9	Binoculars with Positioning Fixtures	15	Standard[1]	Optical viewing for visual inspection of fuels, materials and components. Visual aid for equipment control and direct viewing of long distance operations requiring magnifications greater than 1:1. Positioning fixture allows binoculars to be moved to best viewing position on fact of window and clamped in place.	Viewing Window Operating Gallery Stations.
71-10	Telescopes	4	"Questar Type" Standard	Optical viewing for visual inspection of fuels, materials and components at magnifications greater than that available with binoculars and when periscope viewing is not available or compatible with object to be viewed. May be moved from station to station as required.	Viewing Window Operating Gallery Stations.

1 Standard: AE specified and procured equipment.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-11	Periscopes	4	"Kollmorgen Model-301 wall type" Standard	Optical viewing with photographic attachments for detailed inspection of fuels, materials and components requiring magnification up to 30 X and up to 180° solid angle scanning. Has a hermetically sealed dome at the inner cell wall which is maintained during removal of the periscope for maintenance.	Operating Gallery Through-Wall Sealed Penetrations in the Interim Examination and Disassembly Cell Walls and the Detailed Examination Cell Walls.
71-12	Borescope	1	SPECIAL	Optical viewing with photographic attachments for detailed inspection of component internal surfaces and openings. Equipment will be plug mounted and sealed such that it can be withdrawn from high radiation fields during idle periods.	Through Wall Sealed Penetration in the Detailed Examination Cell Wall.
71-13	Neutron Radiography Equipment	1		Radiographic inspection of subassemblies, capsules, pins and specimens. Thin wall beam openings of aluminum plate will be used with critical source (reactor).	Interim Examination and Disassembly Cell and 3rd Level Operating Gallery.
	(A) Reactor		ENGINEERED		
	(B) Foil Positioner		SPECIAL		
	(C) Speciman Positioner		SPECIAL		

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-14	Gamma Scanning	1		Axial incremental gamma scanning of fuel subassemblies, fuel capsules, fuel pins and fuel specimens. Peak multichannel analyzing will be available.	Interim Examination and Disassembly Cell and 3rd Level Operating Gallery.
	(A) Analyzing & Recording		ENGINEERED		
	(B) Collimators		ENGINEERED		
	(C) Speciman Positioner		SPECIAL		
71-15	Milling Machine and Accessories	1	SPECIAL	Remote operated Milling Machine utilized for precision disassembly of material capsules. Cutters, accessories and modules (gear head, drive motor, etc.) can be remotely removed and replaced.	Detailed Examination Cell.
71-16	Cutting Equipment and Accessories	1	SPECIAL	Remote cutting of material test sections, capsules and components utilizing saws and rotary cutting equipment. May be portable and taken to work station required.	Interim Examination and Disassembly Cell, and Detailed Examination Cell.
71-17	Pin and Specimen Measuring Equipment	2	SPECIAL	Measure length, warp and cross-sectional dimensions of pins and specimens.	Detailed Examination Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-18	Weighing Equipment	2		Weigh pins and specimens. Balance is to be remotely operated with remote read-out compatible with automatic data collection and storage. Load Cell used for assemblies.	Detailed Examination Cell and Interim Examination and Disassembly Cell.
	(A) Load Cell	1	ENGINEERED		
	(B) Remote Balance	1	SPECIAL		
71-19	Fuel Pin Balance Point Determination	1	ENGINEERED	Determine fuel pin C. G.	Detailed Examination Cell.
71-20	Pin Leak Test Equipment	1	SPECIAL	Leak check nonvented sealed pins and fuel specimens. May also be used to test sealed capsules.	Detailed Examination Cell.
71-21	Sodium Bond and Level Test Equipment	1	SPECIAL	Inspect and check pin and specimen bond.	Detailed Examination Cell.
71-22	Pin Defecting Equipment	1	SPECIAL	Defect pins and specimens for reinsertion.	Detailed Examination Cell.
71-23	Fission Gas Collection Equipment	1	SPECIAL	Collect for analysis fission gas samples. Equipment will include vacuum, drilling, collection and welding devices.	Detailed Examination Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-24	Fuel, Material and Component and Waste Packaging Equipment	1	ENGINEERED	Prepare fuels, materials and components for shipment or storage. Will include mechanical sealing, and welding equipment.	Detailed Examination Cell.
71-25	Hanger Rod and Duct Storage	1	AE DESIGN	Shielded storage for 6 hanger rods or ducts.	Interim Examination and Disassembly Cell.
71-26	Fuel Pin and Specimen Storage	2	AE DESIGN	Critically safe, shielded cooled storage for 10 each pin and specimen transfer and storage racks.	Detailed Examination Cell.
71-27	Pin and Specimen Transfer and Storage Racks	20	AE DESIGN	Critically safe racks for transferring and storing 40 pins or specimens. To be compatible with pin and specimen storage equipment.	Interim Examination and Disassembly Cell, and Detailed Examination Cell.
71-28	Material and Component Storage Racks	2	AE DESIGN	Temporary storage for materials or components disassembled and waiting for inspection, shipment, final storage or disposal.	Detailed Examination Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-29	Cell Service Plugs	200	ENGINEERED	Used to route services through the cell walls or floor for operation of examination equipment or for readout data. Sealed, shielded, and replaceable.	All operating station walls and floor of the Detailed Examination Cell.
71-30	Miscellaneous Tools Jigs and Fixtures	As Req'd	SPECIAL	Small items required to assist handling, transfer and examination operations.	Cell Bank.
71-31	Miscellaneous Tools Jigs and Fixtures Storage Racks	12	AE DESIGN	Store miscellaneous tools jigs and fixtures.	Cell Bank.
71-32	Work Platforms	16	AE DESIGN	Working surfaces at each operating or examination station to hold small equipment, tool jigs and fixtures, racks, transfer containers, and components.	In-cell Operating and Examination Stations.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-33	Sealed Master Slave Manipulators Spares	52 6	"CRL-Model J Type" Standard	For complex light duty handling and equipment control during processing of subassemblies and capsules through various disassembly, cleaning, cooling, reassembly and examination operations. This type of gas tight manipulator is sealed at the wall penetration through-tube such that the gas atmosphere purity is maintained during operation and during removal of the arms for maintenance. Maximum load capacity is approximately 20 lbs. Has motorized extended reach capability.	Through-Cell Walls at Viewing Station.
71-34	Master Slave Accessory and Tool Racks	20	Standard	Racks for holding master slave manipulator accessories such as hands, fingers, power tools, etc.	Cell Bank.
71-35	Electromechanical Manipulator, Bridge Mounted Spare Arm	2 1	"PAR-Model 6000 Type" Standard	For medium heavy duty handling such as manipulating tools, fixtures and parts of assemblies. Capacity approximately 400 lbs with hand at any position and 2000 lbs at shoulder hook.	Full Cell Bank Length including Fuel Handling Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-36	Electromechanical Manipulators, Side Wall Post Mounted	2	"PAR Type" Standard	For medium-duty handling in the Cleaning and Storage Cell and the Interim Examination Cell. Capacity approximately 150 lbs at any hand position.	Interim Examination and Disassembly Cell.
	Spare Arm	1			
71-37	Electromechanical Manipulator Accessory and Tool Racks	3	Standard	Racks for holding electromechanical accessories such as hands, hooks, impact wrenches, power tools, etc.	Cell Bank.
71-38	Manipulator Impact and Special Power Tools	3	Standard	Impact and Power tools used with the manipulators to assist handling, disassembly and reassembly operations.	Cell Bank.
71-39	Bridge Cranes	2	Standard	Provided and sized for heavy-duty handling and transfer of in-cell equipment and assemblies. Mounted on full length rails near the ceiling (above the electromechanical manipulators). Capacity approximately 10,000 lbs.	Cell Bank and Fuel Handling Cell.

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-40	Small Equipment Through Wall Transfer Device	2	AE DESIGN	Small equipment or consumable supplies may be transferred into the cells through a wall transfer device. The size of the carriage cavity is approximately 10" dia. x 30" long.	Detailed Examination Cell Wall and Interim Examination and Disassembly Cell Wall.
71-41	In-Cell Decontamination Equipment	1	Standard	Preliminary decontamination of equipment prior to transfer from cell and for remote cleanup of cells.	Equipment Storage and Transfer Cell
71-42	Large Equipment Transfer Device	1	AE DESIGN	Large equipment is transferred into or removed from the cells using a large equipment transfer device through the floor of the Equipment Storage and Transfer Cell in a 6 ft. dia. x 6 ft. deep stainless steel bucket.	Equipment Transfer Tunnel
71-43	Solid Waste Transfer Device	1	AE DESIGN	Transfer solid waste in containers or packaged pins and specimens through the Equipment Storage and Transfer Cell ceiling to casks without loss of confinement.	Equipment Storage and Transfer Cell Ceiling.

EQUIPMENT LISTS

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-44	Viewing Windows	27	Standard	Sealed lead glass windows are provided at cell wall operating station for visual control of remote in-cell operations. Design is such that heat, radiation or mechanical damage will not effect shielding, sealing or confinement qualities of the windows. Initial lead glass window light transmission is about 25%.	Cell Bank Walls.
71-45	Viewing Window Alpha Seal Plates	27	Standard	Remotely replaceable alpha seal plates are to be used with provisions for replacement of windows without loss of confinement.	Viewing Windows.
71-46	Viewing Window Shielding Shutters	26	Standard	Remotely installable viewing window shielding shutters along with stabilized glass and replaceable sections of glass will be used for protection of the lead glass windows from radiation darkening so that the window light transmission will remain above 10% after 20 years.	

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function Capacity or Remarks	Location
71-47	Protective Cell Entry Suits	8	AE DESIGN	Protected personnel entry with life support system.	Personnel entry air locks.
71-48	Portable Shielded Hoist	1	AE DESIGN	Remotely remove and install electromechanical manipulators, crane hoists and carriages in Equipment Storage and Transfer Cell. Used in conjunction with and sealed to the Waste Transfer Device. Unit is portable. Capacity approximately 4000 lbs.	On top of Equipment Storage and Transfer Cell.
71-49	Monorail Hoists	3	Standard	4000 lb. capacity. Used in Equipment Transfer Tunnel Airlock, controlled noncontaminated mock-up and repair area, and in the radiation zoned repair and checkout area.	Support Areas.
71-50	Mock-up Equipment	1	ENGINEERED	Used in controlled noncontaminated mock-up and repair area.	Support Area.
71-51	Lift Truck (HighLift Walk Along)	1	Standard	Used in controlled noncontaminated mock-up and repair area.	Support Area.

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-52	Lift Truck (Walk Along)	2	Standard	Used in operational galleries, mock-up and repair area and in radiation zoned rapair and check-out area.	Support Area.
71-53	Mobile Positioning Work Platforms	2	Standard	Used in operating galleries.	Support Area.
71-54	Positioning Tables	2	Standard	Used in mock-up and repair area, and in the radiation zoned repair and check-out area.	Support Area.
71-55	Work Benches Vises Bench Grinders	4 8 2	Standard	Used in mock-up and repair areas, and in radiation zoned repair and check-out area.	Support Area.
71-56	Hand Tools with Chests	6	Standard	Used in controlled noncontaminated areas and radiation zones as required. 3 sets in each general area.	Support Area.
56A	Power Tools-Sets	6			
71-57	Electrical Testing Equipment	2	Standard	One set in each general area; controlled noncontaminated and radiation zoned.	Support Area.
71-58	Mobile Manipulator Racks	12	Standard	Master end racks used in controlled noncontaminated area. Slave end racks used in radiation zone.	Support Area.
58A	Master Ends	(6)			
58B	Slave Ends	(6)			

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-59	Manipulator Repair Racks	4	Standard	Master end rack used in mock-up and repair area. Slave end rack used in repair and check out area.	Support Area.
59A	Master Ends	(2)			
59B	Slave Ends	(2)			
71-60	Manipulator Check-Out Rack	2	Standard	One each located in mock-up and repair area, and in repair and check out area.	Support Area.
71-61	Laboratory Carts	2	Standard	Used as required in controlled noncontaminated areas and in radiation zone.	Support Area.
61A	Hand Carts	4			
71-62	Storage Racks, Bins and Cabinets	8	Standard	Consumable supplies, consoles, spare parts storage.	Support Area.
71-63	Work Tables	20	Standard	Recording data at operating stations and for data reduction.	Support Area.
71-64	Film Processing Equipment		Standard	Used for processing photographs and radiographic data.	Dark Room & Radiographic Processing Room.
64A	Developing	2			
64B	Storage	2			
64C	Work Benches	2			
64D	Film Dryer	1			
64E	Refrigerator	2			
71-65	Film Viewing Equipment	1	Standard	Used to analyze and store negatives.	Data Reduction Room.
65A	Negative Files	1			

APPENDIX E (contd)

EQUIPMENT LIST

System Piece No.	Item	Qty.	Manufacturer	Function, Capacity or Remarks	Location
71-66	Hoods - Confinement	2	Standard	Operations Support.	Repair and Check out Area Radiation Zone.

APPENDIX F

EXAMINATION PROCESS LOAD REQUIREMENTS

APPENDIX F

EXAMINATION PROCESS LOAD REQUIREMENTS

F.1 BASIS FOR WORKLOAD ESTIMATES

Preliminary estimate of FFTF examination facilities probable workload was developed to serve as a basis for facility sizing and selection of conceptual features.

The estimate was prepared under the fundamental ground rule that FFTF examination facilities should be designed to serve the needs for reactor operation support and experimental programs beyond the initial FTR operational period. It is expected that during the first two to three years of operation, the primary examination requirements will be associated with confirmation of FTR core component design adequacy. However, it does not appear appropriate to design the examination facility capabilities for that operational mode, but rather for "equilibrium" operation. As a result, a one-year period was selected, approximately three to four years after FFTF startup, as the base for the workload estimate.

The estimate is based on subjective opinion for the most part. Available sources of information on probable FFTF experimental workload were consulted, including the user surveys of 1966, available LMFBR Program Plans, and current EBR-II experience. These sources were of value primarily in identification of major categories of testing requirements and not of test design characteristics or number. The testing capacity of the vertical core concept was also used as a basis for preparation of workload estimates.

---

1. Refer to References, Appendix A, Item 31.

F.2 FFTF PLANT SURVEILLANCE EXAMINATION WORKLOAD

Estimates of Plant Surveillance examination requirements were developed from information supplied by several members of the FFTF Project Organization. A summary of the several types of Plant Surveillance examinations is presented in Table F.I. This same support information indicated the examination atmosphere to be provided in the inert gas examination facility[1,2,3] should suffice for those instrumentation examinations which are not destructive in nature.

F.3 FFTF EXPERIMENTAL WORKLOAD EXAMINATION REQUIREMENTS

The estimate of expected examination facilities throughput from LMFBR and other experimental programs is highly dependent on several factors which cannot be well defined at this stage of LMFBR development program implementation. As a result, this estimate is based on opinion as to the probable average utilization of FFTF experimental facilities and the average duration of such utilization.

Table F.II is a breakdown of estimated numbers and types of experiments to be carried out in FFTF together with an estimate of the fractions of those experiments which will be examined in the FFTF examination facility.

---

1. Refer to Support Information Requirements, Appendix B, Items 1 and 2.
2. Refer to Conceptual Design Evaluation, Appendix D, Item 4.
3. Refer to Interfaces, Appendix C, Item 19.

TABLE F.1

PLANT SURVEILLANCE

NON-DESTRUCTIVE EXAMINATION WORKLOAD

	Limited Interim Non-Destructive	Extended Interim Non-Destructive	Final	
			Initial	Steady State
Driver Fuel Assemblies[1]	0	0	25	75
Control Rods	0	1	1	1
Control Rod Shrouds	5	1	1	1
Removable Reflector Assembly	2	1	1	1
Closed Loop Tubes	0	2	2	3
Materials Surveillance Packages	2	0	(150 samples/yr.)	
Instrumentation	25	25	25	25

DESTRUCTIVE EXAMINATION WORKLOAD

Fuel	Initial	Steady State
Driver Fuel Pins[1]	250-375	150
Materials		
Driver Duct Samples	50	25
Reactor Component Samples	50	50
Materials Irradiations	150	150
Instrumentation	25-50	25
Total Materials	275-300	250

1. It is estimated that fission gas pressure and profilometer measurements will be performed on 40 to 50 pins per assembly initially. Thereafter a total of 1000 measurements will be performed. All ducts will be measured for bowing, expansion and dimensions. For the first two years 10 to 15 pins per assembly will go to radiometallurgy for destructive examination. After this the annual workload will be about 150 pins per year. Two samples per duct will be destructively examined for the first two years, for the third year on 25 to 50 samples will go to radiometallurgy.

TABLE F.II. ESTIMATED EXPERIMENTAL WORKLOAD EXAMINATION REQUIREMENTS

ESTIMATED AVERAGE UTILIZATION OF FFTF TESTING FACILITIES

Test Facility	No. Available	Average Use	Average Time-Yr	No. of Tests Per Yr	% of Tests Fuel Base	Fuel Tests Per Yr	% Test Materials	Materials Tests Per Yr
Closed Loops	5	4	0.5	8	90	7	10	1
Open Test Positions	3	3	1	3	33	1	66	2
Reflector Open Test Positions	2	2	1	2	100	2	0	0
Driver Position Experimental Fuel	-	6	1	6	100	6	0	0
Driver Position Materials Irradiation	-	3	0.5	6	0	0	100	6
Reflector Positions Materials	-	5	1	5	0	0	100	5
Short Term Irradiation Facility	1	1	7(days)	40	25	10	75	30

ESTIMATED AVERAGE EXAMINATION REQUIRED OF EXPERIMENTS IN FFTF

	Extended Interim Non-Destructive Examination @ 40%		Limited Interim Non-Destructive Examination		Non-Destructive Examination		On Site Radiometallurgy			
							Fuels @ 40%		Materials @ 20%	
Test Facility	Fuels Tests	Materials Tests	Fuels Tests	Materials Tests	Fuels Tests	Materials Tests	Tests	Pieces	Tests	Pieces
Closed Loops	3	0.2	8	0.3	6	0.5	2.8	84	0.2	25 + 28
Open Test Positions	0.4	1.0	0	1	1	2	0.4	40	0.4	40 + 10
Reflector Open Test Positions	0.8	0	0.5	0	2	0	0.8	60	0	0
Driver Position Experimental Fuel	2.4	0	3.6	0	5	0	2.4	100	0	12
Driver Position Materials Irradiation	0	1	0	6	0	6	0	0	1.2	100
Reflector Positions Materials	0	1	0	5	0	5	0	0	1	80
Short Term Irradiation Facility	0	0	0	0	10	20	4	20	4	40
								304		297

Above estimates for steady state operation. Initial operation would be 1/3 of steady state.

To facilitate the development of an estimate of the numbers and types of examinations a series of arbitrary definitions of "standard" tests is given for each test facility. These "standard" tests are considered to be only a description of the typical makeup of a test in each of the several test facilities for purposes of indicating the types and complexity of required examination. The numbers of experimental pieces in Table II are derived directly from the "standard" tests and the estimated numbers of tests of each type.

F.3.1 Closed Loops

A. Fuels Test -- Contains an average of 30 fuel pins in each test assembly and an average of 20 material specimens of a non-fuel nature, including cladding, which require detailed testing and examination. Instrumentation includes several thermocouples and two special instrumentation features.

B. Materials Test -- Contains an average of 50 materials specimens in each assembly which require examination and testing. Several thermocouples are included.

F.3.2 Open Test Position Experiments

A. Fuel Test -- Contains an average of 150 fuel pins in each test assembly of which half require detailed examination. Instrumentation includes several thermocouples and one special instrumentation feature (such as a pressure transducer or specially located flux monitor). Each fuel test assembly includes 30 materials specimens which require testing and examination.

B. Materials Test -- Contain an average of 50 specimens which will require examination. Assembly includes extensive instrumentation. Interim examination will include repairs to instrumentation and test equipment.

F.3.3 Reflector Open Test Position

Fuel Test -- Because of restrictions on test composition, fuel tests in these positions are heavily blanket testing oriented. Each fuel test is assumed to include 75 pins per test assembly requiring examination. Balance of reflector test assembly does not require examination.

F.3.4 Short Term Test Facility

A. Fuel Test -- Short (less than nine inches) 5 pin cluster.

B. Materials Test -- Contains average of 10 specimens requiring examination.

F.3.5 Driver and Reflector Materials Irradiation

A driver or reflector assembly will be replaced with a materials irradiation holder which will be removed at intervals for removal of irradiated samples and insertion of new samples. Each holder will contain about 200 specimens with a 1-1/2 year average exposure.

F.3.6 Driver Positions Experimental Fuel

Contains an average of 150 fuel pins in each test assembly of which 38 pins will go to destructive examination. Non-destructive examination will include dimensional measurements and gamma scan of 1/3 of the pins. Measurements on fuel ducts will be required. About 10 materials samples will be taken for radiometallurgy.

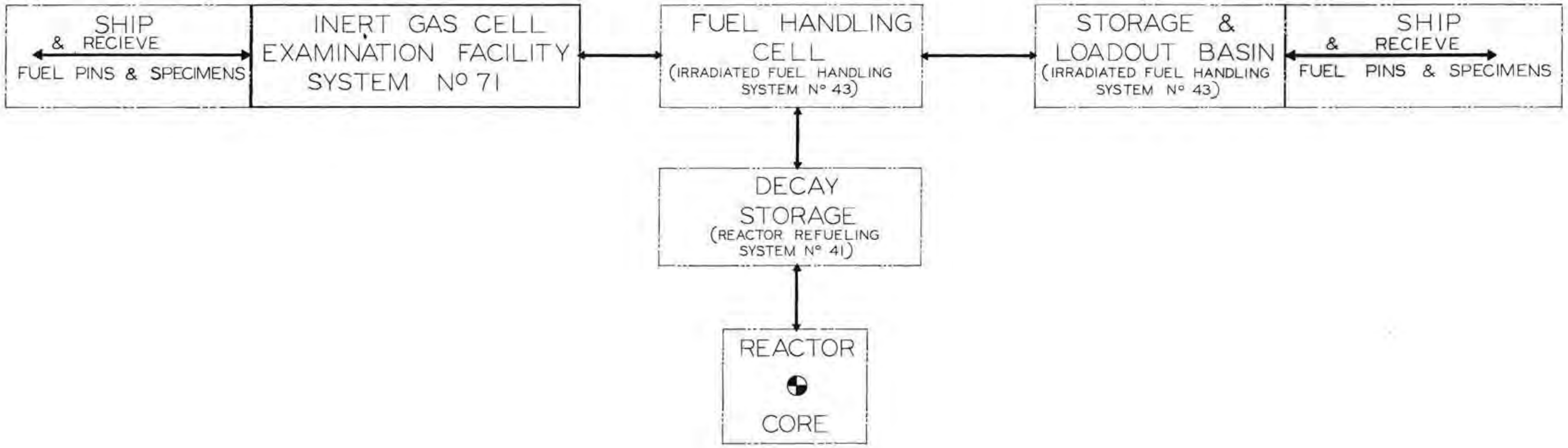
APPENDIX G

DRAWINGS

SK-3-12569

SK-3-12858
Sheets 1, 2, & 3

SK-3-12992



CONCEPTUAL

COMPLETELY REDRAWN 3-27-69

5TH ISSUE 4-10-69
4TH ISSUE 3-27-69

U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE

THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASH.

SCALE NONE
DRAWN BY W. H. DAVENPORT — DATE 3-27-69
RESPONSIBLE ENGR. E. B. RAMSEY — 3-27-69
APPROVED
APPROVED
APPROVED
CLASSIFIED BY [signature] 4-8-69
CLASSIFICATION NONE

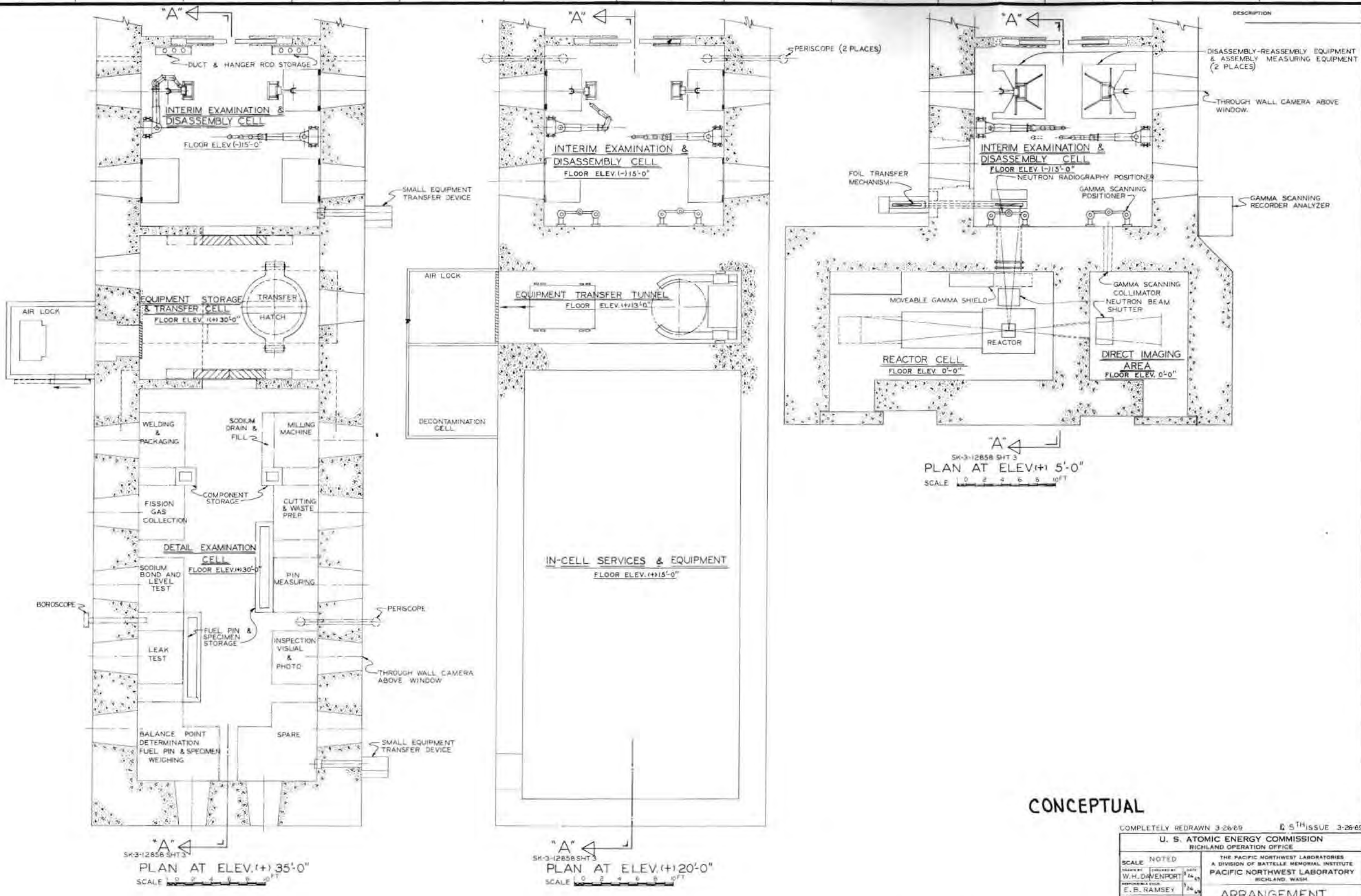
MATERIAL FLOW CHART INERT GAS CELL EXAM. FACILITY SYSTEM Nº 71

PROJ. TITLE FAST FLUX TEST FACILITY
BLDG. NO. 300GEN — PROJ. NO. — INDEX NO. 0800.01
DWG. NO. SK-3-12569 — SHEET NO. 1 — SHEETS 1 — REV. 0

NO.	DESCRIPTION	REV. BY DATE	APP'D BY	FOR	DATE
	REVISIONS				

REF. NO.	DWG. NO.	DRAWING TITLE
	REFERENCE DRAWINGS	
NEXT USED ON		

QTY. | PT. NO. | DESCRIPTION



CONCEPTUAL

COMPLETELY REDRAWN 3-26-69 — 5TH ISSUE 3-26-69

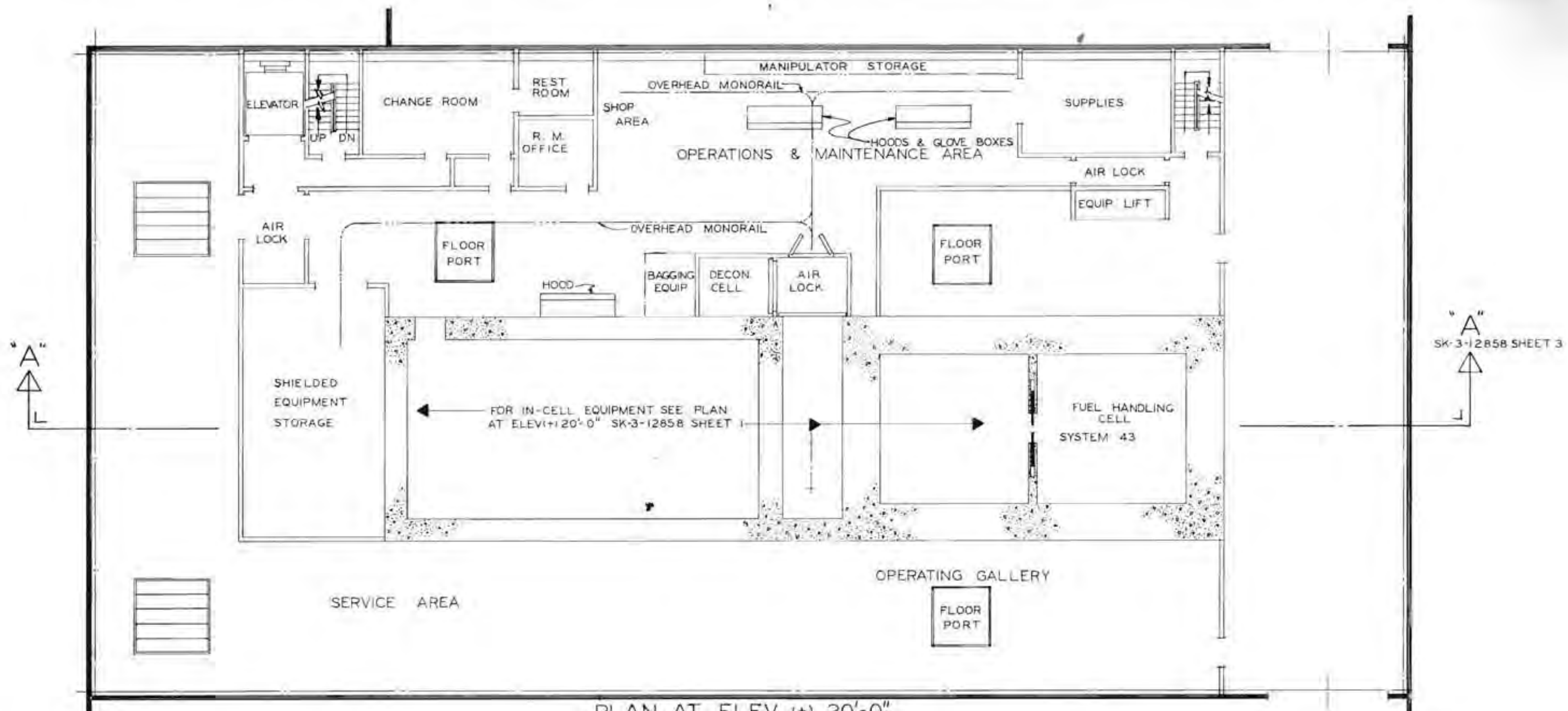
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE

THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASH.

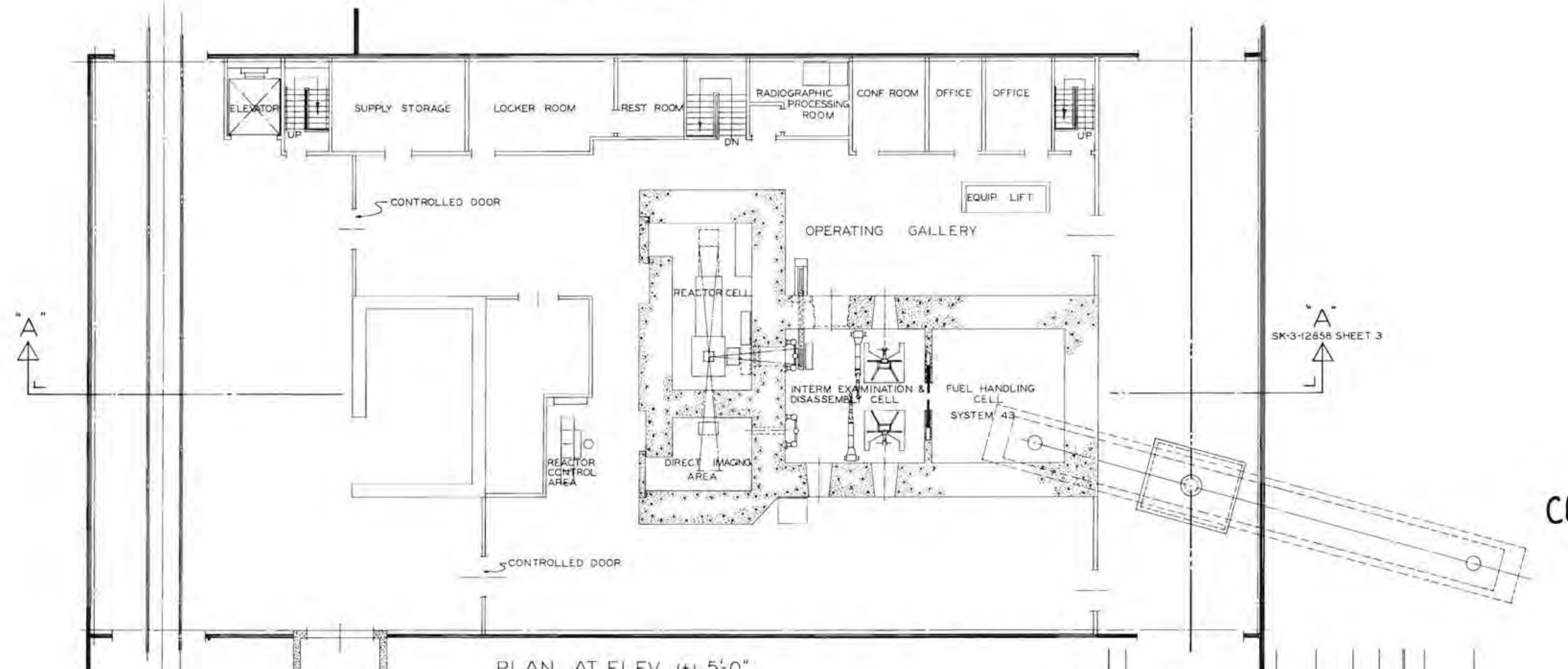
ARRANGEMENT
EXAMINATION CELLS
SYSTEM Nº 71

SCALE	NOTED
DRAWN BY / CHECKED BY	W.H. DAVENPORT 3/24/69
RESPONSIBLE ENGR.	E.B. RAMSEY 3/24/69
CLASSIFICATION	NONE
PROJ. TITLE	FAST FLUX TEST FACILITY
BLDG. NO.	300GEN
INDEX NO.	0800.01
DWG. NO.	SK-3-12858
SHEET NO.	1
SHEETS	3
REV.	0

REVISIONS — REFERENCE DRAWINGS — NEXT USED ON



PLAN AT ELEV. (+) 20'-0"
FLOOR ELEV (+) 15'-0"
SCALE 0 5 10 15 FT



PLAN AT ELEV (+) 5'-0"
FLOOR ELEV (+) 0'-0"
SCALE 0 5 10 15 FT

CONCEPTUAL COMPLETELY REDRAWN 3-27-69 "5TH ISSUE 3-27-69

U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE

THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASH.

SCALE NOTED
DRAWN BY W. H. DAVENPORT DATE 3/27/69
RESPONSIBLE ENGR. E B RAMSEY 3/27/69
APPROVED
APPROVED
APPROVED
CLASSIFIED BY [signature] 4-8-69
CLASSIFICATION NONE

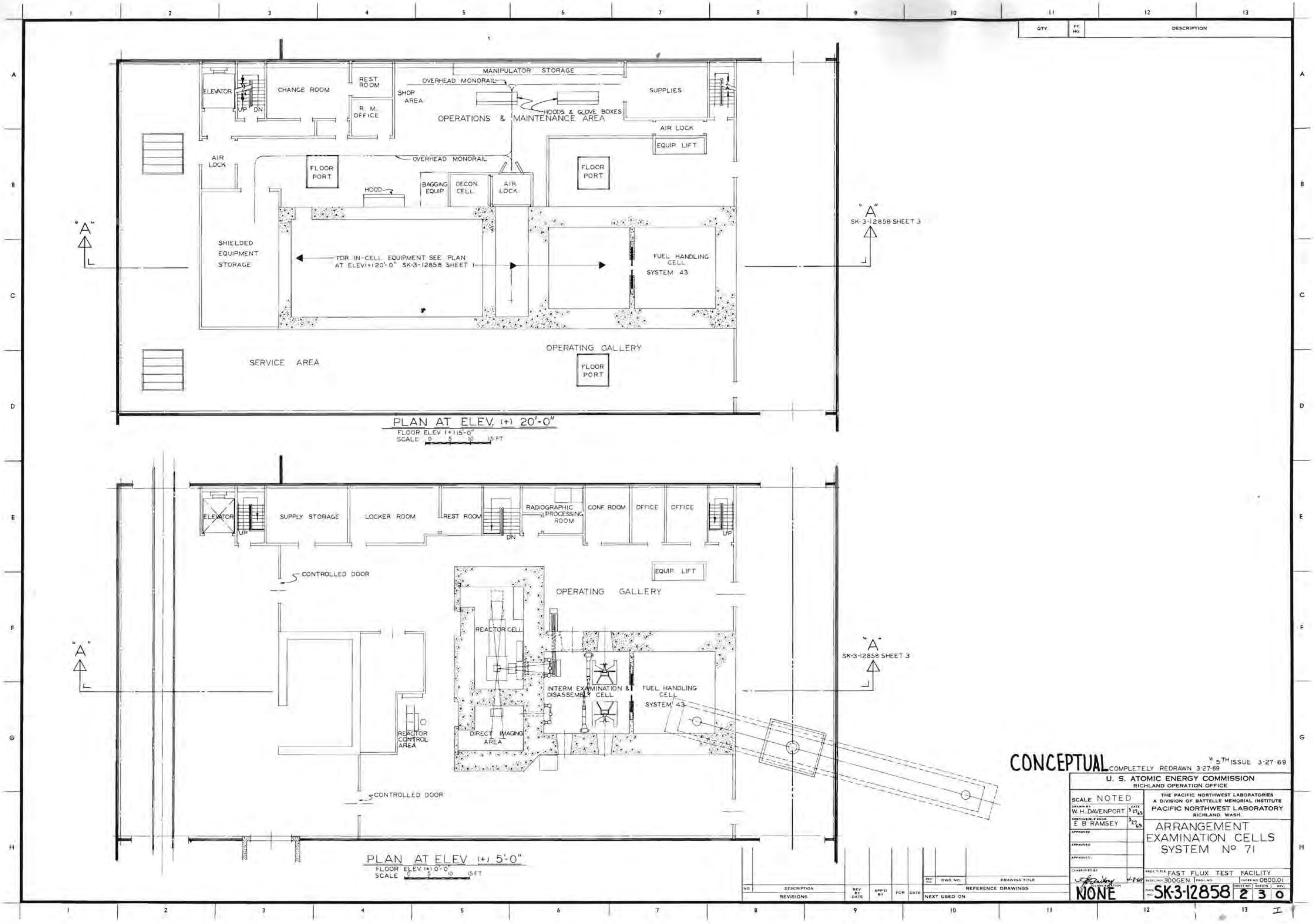
ARRANGEMENT
EXAMINATION CELLS
SYSTEM Nº 71

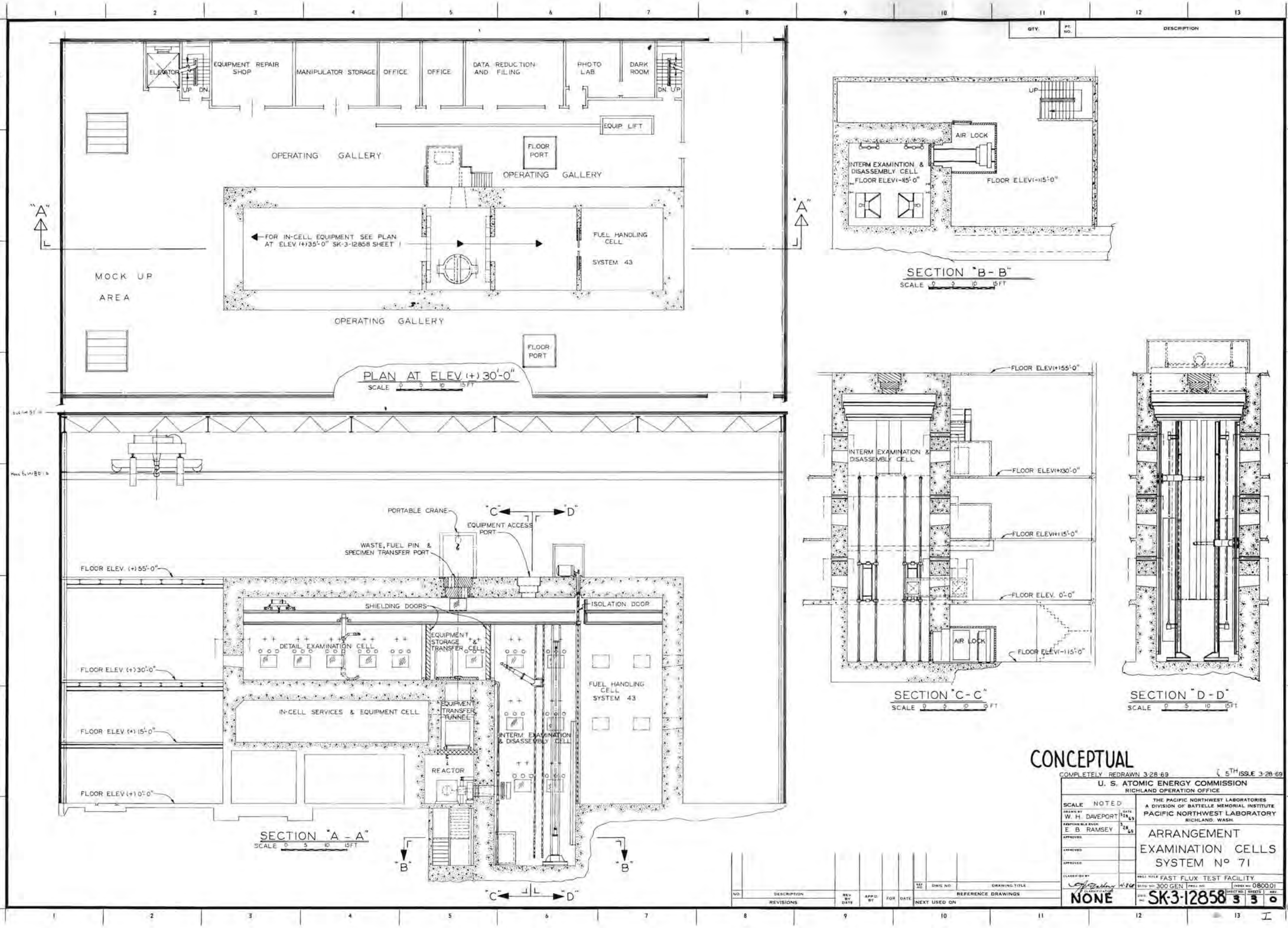
PROJ. TITLE FAST FLUX TEST FACILITY
BLDG NO. 300GEN PROJ. NO. INDEX NO. 0800.01
DWG NO. SK-3-12858 SHEET NO. 2 SHEETS 3 REV. 0

NO.	DESCRIPTION	REV. BY DATE	APP'D BY	FOR	DATE
	REVISIONS				

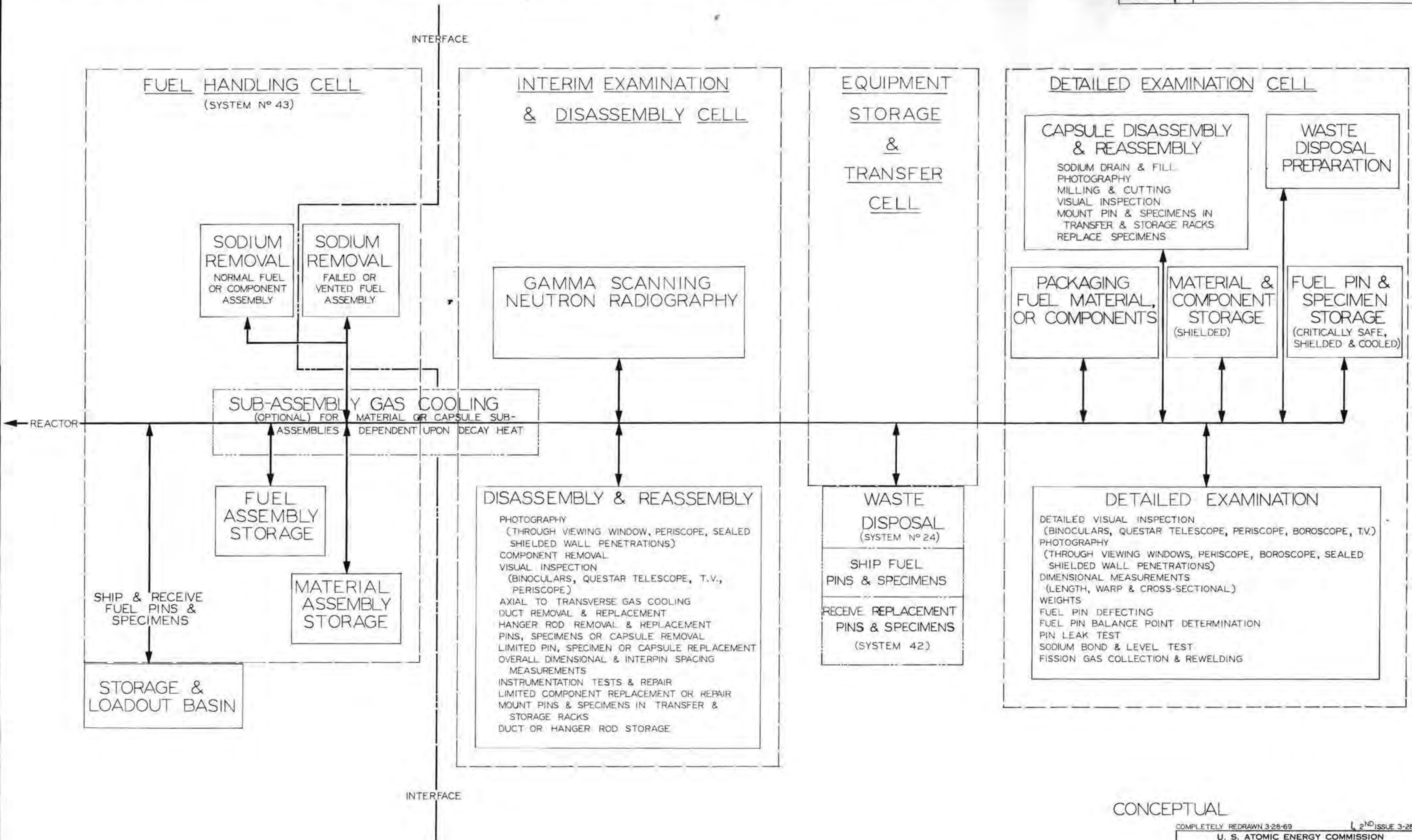
REF. NO.	DWG NO.	DRAWING TITLE
	REFERENCE DRAWINGS	
NEXT USED ON		

QTY.	PT. NO.	DESCRIPTION


MANIPULATOR STORAGE
OVERHEAD MONORAIL
ELEVATOR
UP
DN
CHANGE ROOM
REST ROOM
R. M. OFFICE
SHOP AREA
HOODS & GLOVE BOXES
SUPPLIES
OPERATIONS & MAINTENANCE AREA
AIR LOCK
EQUIP. LIFT
AIR LOCK
FLOOR PORT
HOOD
BAGGING EQUIP
DECON CELL
AIR LOCK
FLOOR PORT
"A"
SK-3-12858 SHEET 3
SHIELDED EQUIPMENT STORAGE
FOR IN-CELL EQUIPMENT SEE PLAN AT ELEV(+)20'-0" SK-3-12858 SHEET 1
FUEL HANDLING CELL
SYSTEM 43
OPERATING GALLERY
SERVICE AREA
FLOOR PORT
PLAN AT ELEV. (+) 20'-0"
FLOOR ELEV (+) 15'-0"
SCALE 0 5 10 15 FT
ELEVATOR
SUPPLY STORAGE
LOCKER ROOM
REST ROOM
RADIOGRAPHIC PROCESSING ROOM
CONF. ROOM
OFFICE
OFFICE
CONTROLLED DOOR
EQUIP. LIFT
OPERATING GALLERY
REACTOR CELL
INTERM EXAMINATION & DISASSEMBLY CELL
FUEL HANDLING CELL
SYSTEM 43
REACTOR CONTROL AREA
DIRECT IMAGING AREA
CONTROLLED DOOR
PLAN AT ELEV (+) 5'-0"
FLOOR ELEV (+) 0'-0"
SCALE 0 5 10 15 FT
QTY.
PT. NO.
DESCRIPTION
NO.
DESCRIPTION
REVISIONS
REV. BY DATE
APP'D BY
FOR
DATE
DWG NO.
DRAWING TITLE
REFERENCE DRAWINGS
NEXT USED ON
CONCEPTUAL
COMPLETELY REDRAWN 3-27-69
5TH ISSUE 3-27-69
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE
SCALE NOTED
DRAWN BY W.H. DAVENPORT 3-27-69
RESPONSIBLE ENGR. E B RAMSEY 3-27-69
APPROVED
APPROVED
APPROVED
CLASSIFIED BY
4-8-69
CLASSIFICATION NONE
THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND WASH.
ARRANGEMENT
EXAMINATION CELLS
SYSTEM Nº 71
PROJ. TITLE FAST FLUX TEST FACILITY
BLDG. NO. 300GEN
PROJ. NO.
INDEX NO. 0800.01
DWG NO. SK-3-12858
SHEET NO. 2
SHEETS 3
REV. 0



PLAN AT ELEV (+) 30'-0"
SCALE 0 5 10 15FT
ELEVATOR
UP DN
EQUIPMENT REPAIR SHOP
MANIPULATOR STORAGE
OFFICE
OFFICE
DATA REDUCTION AND FILING
PHOTO LAB
DARK ROOM
DN UP
EQUIP. LIFT
FLOOR PORT
OPERATING GALLERY
OPERATING GALLERY
OPERATING GALLERY
FOR IN-CELL EQUIPMENT SEE PLAN AT ELEV (+)35'-0" SK-3-12858 SHEET 1
FUEL HANDLING CELL
SYSTEM 43
MOCK UP AREA
FLOOR PORT
"A"
"A"
SECTION "A - A"
SCALE 0 5 10 15FT
PORTABLE CRANE
"C"
"D"
EQUIPMENT ACCESS PORT
WASTE, FUEL PIN & SPECIMEN TRANSFER PORT
FLOOR ELEV. (+)55'-0"
SHIELDING DOORS
ISOLATION DOOR
DETAIL EXAMINATION CELL
EQUIPMENT STORAGE & TRANSFER CELL
FLOOR ELEV. (+)30'-0"
FUEL HANDLING CELL
SYSTEM 43
IN-CELL SERVICES & EQUIPMENT CELL
EQUIPMENT TRANSFER TUNNEL
INTERM. EXAMINATION & DISASSEMBLY CELL
FLOOR ELEV. (+)15'-0"
REACTOR
FLOOR ELEV. (+)0'-0"
"B"
"B"
"C"
"D"
SECTION "B - B"
SCALE 0 5 10 15FT
UP
AIR LOCK
INTERM EXAMINTION & DISASSEMBLY CELL
FLOOR ELEV(-)15'-0"
FLOOR ELEV(-)15'-0"
SECTION "C - C"
SCALE 0 5 10 15FT
FLOOR ELEV(+)55'-0"
INTERM EXAMINATION & DISASSEMBLY CELL
FLOOR ELEV(+)30'-0"
FLOOR ELEV(+)15'-0"
FLOOR ELEV. 0'-0"
AIR LOCK
FLOOR ELEV(-)15'-0"
SECTION "D - D"
SCALE 0 5 10 15FT
QTY.
PT. NO.
DESCRIPTION
CONCEPTUAL
COMPLETELY REDRAWN 3-28-69
5TH ISSUE 3-28-69
U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE
THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASH.
SCALE NOTED
W. H. DAVEPORT
E. B. RAMSEY
ARRANGEMENT
EXAMINATION CELLS
SYSTEM Nº 71
FAST FLUX TEST FACILITY
300 GEN
0800.01
NONE
SK-3-12858
3
3
0
REFERENCE DRAWINGS
NEXT USED ON
REVISIONS



CONCEPTUAL

COMPLETELY REDRAWN 3-28-69 — 2ND ISSUE 3-28-69

U. S. ATOMIC ENERGY COMMISSION
RICHLAND OPERATION OFFICE

SCALE NONE
DRAWN BY W. H. DAVENPORT
RESPONSIBLE ENGR. E. B. RAMSEY
APPROVED
APPROVED
APPROVED
CLASSIFIED BY
CLASSIFICATION NONE

THE PACIFIC NORTHWEST LABORATORIES
A DIVISION OF BATTELLE MEMORIAL INSTITUTE
PACIFIC NORTHWEST LABORATORY
RICHLAND, WASH.

PROCESS FLOW CHART
INERT GAS CELL EXAMINATION FACILITY – SYSTEM Nº 71

PROJ. TITLE FAST FLUX TEST FACILITY
BLDG. NO. 300GEN PROJ. NO. INDEX NO. 0800.01
DWG. NO. SK-3-12992 SHEET NO. 1 SHEETS 1 REV. 0

NO.	DESCRIPTION	REV. BY DATE	APP'D BY	FOR	DATE
	REVISIONS				

REF. NO.	DWG. NO.	DRAWING TITLE
	REFERENCE DRAWINGS	
NEXT USED ON		

DISTRIBUTION

No. of Copies	
32	AEC Division of Reactor Development and Technology
	M Shaw, Director, RDT Asst Dir for Nuclear Safety Analysis & Evaluation Br, RDT:NS Environmental & Sanitary Engrg Br, RDT:NS Research & Development Br, RDT:NS Asst Dir for Plant Engrg, RDT Facilities Br, RDT:PE (3) Components Br, RDT:PE Instrumentation & Control Br, RDT:PE Liquid Metal Systems Br, RDT:PE Asst Dir for Program Analysis, RDT Asst Dir for Project Mgmt, RDT Liquid Metals Projects Br, RDT:PM FFTF Project Manager, RDT:PM (3) Asst Dir for Reactor Engrg, RDT Control Mechanisms Br, RDT:RE Core Design Br, RDT:RE (2) Fuel Engineering Br, RDT:RE Fuel Handling Br., RDT:RE Reactor Vessels Br, RDT:RE Asst Dir for Reactor Tech, RDT Coolant Chemistry Br, RDT:RT Fuel Recycle Br, RDT:RT Fuels & Materials Br, RDT:RT Reactor Physics Br, RDT:RT Special Technology Br, RDT:RT Asst Dir for Engrg Standards, RDT
2	AEC Chicago Patent Group
	G. H. Lee, Chief R. K. Sharp (Richland)
3	AEC Idaho Operations Office Nuclear Technology Division
	C. W. Bills, Director
3	AEC Richland Operations Office FFTF Program
	J. M. Shivley
1	AEC San Francisco Operations Office Director, Reactor Division

No. of Copies	
4	AEC Site Representatives -BNW
	P. G. Holsted
4	AEC Site Representatives
	Argonne National Laboratory Atomics International Atomic Power Development Assoc. General Electric Co.
6	Argonne National Laboratory
	K. P. Ferguson, ID R. A. Jaross LMFBR Program Office N. J. Swanson (3)
1	Atomic Power Development Assoc.
	Document Librarian
4	Atomics International
	D. J. Cockeram (2)
	Liquid Metal Information Center
	J. J. Droher (2)
2	Babcock & Wilcox Co. Atomic Energy Division
	S. H. Esleeck G. B. Garton
3	Battelle Memorial Institute
6	Bechtel Corporation
	J. J. Teachnor, Project Administrator, FFTF (5) D. H. Weiss (Richland)
1	BNW Representative
	N. A. Hill (ZPR-III)
1	Combustion Engineering 1000 MWe Follow-On Study
	W. P. Staker, Project Manager
7	General Electric Co. Advanced Products Operation
	Karl Cohen (3) M. Pluta (2) Bertram Wolfe
	Nuclear Systems Programs
	D. H. Ahmann

No. of Copies	
2	Gulf General Atomic Inc. General Atomic Div. D. Coburn
1	Idaho Nuclear Corporation D. R. deBoisblanc
1	Los Alamos Scientific Laboratory J. W. Schulte
3	Oak Ridge National Laboratory H. G. Duggan (2) W. O. Harms
1	Stanford University Nuclear Division Division of Mechanical Engrg R. Sher
1	United Nuclear Corporation Research and Engineering Center R. F. DeAngelis
6	Westinghouse Electric Corp. Atomic Power Division Advanced Reactor Systems J. C. R. Kelly (5) R. Strzelecki (Richland)
96	Battelle-Northwest W. G. Albert S. O. Arneson E. R. Astley J. M. Batch A. L. Bement H. E. Borgeson C. L. Boyd (12) D. C. Boyd J. L. Boyd C. L. Brown W. L. Bunch C. A. Burgess A. C. Callen J. R. Carrell W. E. Cawley W. L. Chase

Battelle-Northwest (contd)

T. T. Claudson
J. C. Cochran
P. D. Cohn
D. L. Condotta
R. R. Cone
J. M. Davidson
D. R. Doman
R. V. Dulin
E. A. Evans
L. M. Finch
B. D. Fleming
E. E. Garrett
E. D. Grazzini
F. C. Gronemeyer
J. P. Hale
J. E. Hanson
R. A. Harvey
B. R. Hayward
J. W. Helm
R. J. Hennig
P. L. Hofmann
B. M. Johnson
E. M. Johnston
D. C. Lehfeldt
C. E. Love
B. Mann
D. Marinos
W. B. McDonald
J. S. McMahon
J. W. Mitchell
C. A. Munro
C. N. Orsborn
R. E. Peterson
M. O. Rankin
W. E. Roake
R. L. Roske
F. H. Shadel
D. W. Shannon (2)
C. B. Shaw
D. E. Simpson
R. J. Squires
G. H. Strong
C. D. Swanson
J. C. Tobin
K. G. Toyoda
M. A. Vogel
R. C. Walker
J. H. Westsik
N. G. Wittenbrock
J. M. Yatabe
FFTF Files (10)
FFTF Technical Reports Office
Technical Files (5)
Technical Publications (2)
Legal (2)