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Rockwell Hanford Operations
Richland, WA 99352

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PWR CORE 2

OPERATIONS SAFETY REQUIREMENTS

B. C. McClelland

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PWR CORE 2

OPERATIONS SAFETY REQUIREMENTS

B. C. McClelland
Process Engineering Department
Research and Engineering

June 1978

Operated for the U. S. Department of Energy by
Rockwell Hanford Operations under Contract EY-77-1030

OUTLINE

1.0 Introduction

2.0 Safety Limits and Limiting Control Settings

2.1 Radiation Alarm Settings

2.2 Minimum Value of Kr Concentration in the Cask Air Space for Indication of Fuel Cladding Failure

2.3 Maximum Railroad Car Speed with Cask in the Vertical Position

2.4 Storage Cell Water Level

3.0 Limiting Conditions for Operations

3.1 Ventilation System Requirements

3.2 Redundant and Back-Up Equipment

3.3 Canyon Isolation During Fuel Transfer from Shipping Cask to the Storage Cell

3.4 Fuel Storage Protection from Mechanical Damage

3.5 Release Survey of Tools and Equipment

3.6 Authorized Material in 221-T T Plant Canyon

3.7 Nitrogen Purge of the M-160 Container Air Space

4.0 Surveillance Requirements

4.1 Inspection of Radiation Monitoring Devices

4.2 Storage Cell Water Testing

5.0 Design Features

5.1 Control of Facility and Equipment Design and Modification

6.0 Administrative Controls

6.1 Organization and Administrative Systems

6.2 Documentation for Operations

1.0 INTRODUCTION

These Operations Safety Requirements (OSR's), written in compliance with DOE Manual Chapter 0531, define the approved safety specifications, and basis thereof, imposed upon the unloading and storage of Pressurized Water Reactor (PWR) Core 2 spent fuel assemblies in the interest of the health and safety of the public and operating personnel. These requirements are specific to the unloading and storage of PWR Core 2 Blanket Assemblies. Under no circumstances do they entail analysis, design or operational studies involving storing of additional fuel modules. The identification of these requirements are based on and are to be considered part of the safety analysis presented in the Safety Assessment Document - PWR Core 2 Project Document No. RHO-CD-356.

The OSR's are divided into the following categories:

SAFETY LIMITS AND LIMITING CONTROL SETTINGS

Safety limits apply to safety-related process variables which are observable and measurable. The safety limit for a given variable is a value of that variable at which no serious consequences will occur. If the value of the variable were to reach this limit, no hazard to the public health and safety would exist even if all other variables were at the upper bounds of their operating ranges.

Exceeding a safety limit by a small amount would not produce hazardous consequences. However, this action would represent a significant and undesirable departure from proper operation. To exceed a safety limit, significant equipment malfunction or failure, or one or more significant deviations from operating procedures, or both, would have to occur.

A limiting control setting is a value selected at a level on the safe side of a safety limit. The control setting activates alarms prior to exceeding the safety limit for corrective action to be taken to return the system to normal or to stop the process.

The Normal Operation Zone is set on the safe side of the limiting control setting. The limiting control setting value reflects a setting that allows for an operating range due to normal fluctuations in the process and any instrument drift.

The result of the relation between the safety limit, limiting control setting, and normal operating zone is that the limiting control setting should seldom be exceeded and any corrective action to the system, should be made in the normal operating zone.

LIMITING CONDITION FOR OPERATION

Limiting conditions are provided for (1) equipment, (2) technical conditions and characteristics of the process necessary for continued operation.

(1) Equipment requirements are established at the lowest acceptable level of performance for a system or component and the minimum number of components operating or available.

(2) Technical conditions or characteristics of the process are requirements imposed on that system for safe operation.

SURVEILLANCE REQUIREMENTS

Surveillance requirements are the tests, calibrations, and inspections necessary to ensure the instrument and equipment systems are operating and performing properly.

DESIGN FEATURES

Design features requirements are conditions to control the design or design change to the facilities or equipment that effect the physical barriers on containment of radioactivity.

ADMINISTRATIVE CONTROLS

Administrative controls are to ensure proper management is provided, operating procedures are written, records are maintained, personnel are properly trained and review and audit of operations are conducted to assure safe operations.

2.0 SAFETY LIMITS AND LIMITING CONTROL SETTINGS

2.1 Radiation Alarm Settings

2.1.1 a. Title: Airborne Beta-Gamma Alarm Setting

b. Applicability: This specification applies to the alarm setting for beta-gamma particulate detection.

c. Objective: To define the radioactive limits required for alarm settings in the 221-T Plant Canyon.

d. Specification:

- The safety limit value for airborne beta-gamma shall be 2,750,000 dpm (1000 MPC hours).
- The limiting control value for the airborne beta-gamma detector shall be 55,000 dpm (20 MPC hours). At this value the alarm will sound.
- The detector shall be located in the canyon by Radiological Engineering in the PWR Core 2 working area.

e. Action: In the event of the airborne beta-gamma alarm sounding, evacuation of the 221-T Plant canyon shall be required.
Reentry, for investigation, shall be made with fresh air respiratory protection, if readings do not exceed 1000 MPC. Reentry during readings of greater than 1000 MPC shall have the autorhization of the Manager, Environmental and Occupational Safety Department.

f. Bases: The alarm setting (the limiting control value) represents the maximum permissable concentration (MPC) for ^{90}SR in air (20×10^{-9} µCi/ml) from DOE Manual Chapter 0524. The setting was calculated using existing canyon airflow in the working area (1.5 cfm) for one continuous hour. Due to the greater limiting factor of the MPC of ^{90}Sr, it was used as a bases for the setting. Filtered respiratory protection provides protection twenty times the MPC value and was used in calculating the alarm setting. Fresh air respiratory protection provides protection up to limits of 1000 times greater than MPC. This was the basis for the safety limit value.

2.1.2 a. Title: High Radiation Alarm Setting

b. Applicability: This specification applies to the alarm setting for high radiation detection.

c. Objective: To define the radioactive limits required for high radiation settings in the 221-T Plant canyon.

d. Specification:

- The high radiation detector safety limit shall be set to alarm at 5 R/hr.
- The high radiation detector limiting control setting shall be set to alarm at 1 R/hr.
- The high radiation detector shall be located in the canyon adjacent to the storage cell. Remote indicators, showing dose rate and alarm levels and audio and visual alarms shall be located per Radiological Engineering instruction.

e. Action: In the event of the high radiation limiting control setting alarm sounding, indicating radiation of 1 R/hr, Radiation Monitoring personnel shall immediately investigate the cause. Should the safety limit alarm sound, indicating radiation of greater than 5 R/hr, the canyon shall be evacuated and the cause investigated.

f. Bases: The alarm settings represent a value at which abnormal conditions must exist to activate the alarms. The settings allow for normal background fluctuation and instrument drift and yet provides adequate time for corrective action to be taken to avoid excessive personnel exposure.

The location of the high radiation detector was selected on the bases of the most likely position for a source of radiation.

The location of the remote indicators allow for access to the dose rate information without being in the area of the detector and the audio and visual alarm locations will warn personnel throughout the 221 T-Plant canyon.

2.2 Minimum Value of ^{85}Kr Concentration in the cask air space for indication of fuel cladding failure.

a. Title: ^{85}Kr Concentration

b. Applicability: This specification applies to the sampling for ^{85}Kr in the cask air space.

c. Objective: To define the lower limits of ^{85}Kr present in the cask air space that indicates a fuel cladding failure.

d. Specification:

- A safety limit value for cask air concentration of greater than 1.0×10^{-2} μCi/ml of ^{85}Kr indicates a significant breech of cladding.

- A limiting control value for cask air concentration of greater than 2.5×10^{-6} μCi/ml of ^{85}Kr indicates a possible breech of cladding.

e. Action: If laboratory analysis indicate a cask air concentration of greater than 2.5×10^{-6} μCi/ml of ^{85}Kr and less than 1.0×10^{-2} μCi/ml of ^{85}Kr. Additional monitoring of storage pool characteristics will have to be defined by Engineering. At cask air concentrations greater than 1×10^{-2} μCi/ml, additional engineering analysis shall be performed to determine the method of unloading and storage, depending upon the particular concentration found.

f. Bases: To define a significant breech of cladding the following method was employed.

There are 60 fuel plates in one blanket module with 13.6 curies of ^{85}Kr in each plate. Assuming only one plate is damaged and 1.0 percent of the ^{85}Kr escapes, and using the total volume of the cask, the calculated concentration of ^{85}Kr in the cask air space is greater than 1.0×10^{-2} μCi/ml. A breech of cladding yielding the above amounts of ^{85}Kr would require special unloading and storage procedures. The breeched fuel module(s) would have to be identified and stored under special conditions.

A possible breech of cladding was defined using the following method. A minimum detectable limit of ^{85}Kr concentration in air was found. This concentration (2.5×10^{-7} µCi/ml) was used as a bases for determining a suspect breech of cladding. A concentration ten times this value, the multiple factor determined by Radiological Engineering, allows for background fluctuation and instrument drift.

2.3 Maximum Railroad Car Speed with Cask in the Vertical Position

a. Title: Railcar Speed

b. Applicability: This specification applies to the speed of railcar No. 1 during transfer between the 221 T-Plant tunnel and uprighting area when the cask is in the vertical position.

c. Objective: To prevent the cask from potentially overturning and breaking the vent piping on the closure head and releasing contamination to the environs.

d. Specification:

- o Safety Limit - The speed of the railcar while the cask is in the vertical position, shall not exceed ten miles per hour.
- o Limiting Control Speed - The speed of the railcar, when the cask is in the vertical position, shall not exceed five miles per hour.

e. Action: Should the speed of the cask car exceed the safety limit value (10 MPH), the locomotive shall decrease its speed, at a safe deceleration rate, to within the specified requirement.

f. Bases: The safety limit valve reflects calculations from the vendor that state the maximum speed of the railcar in the vertical position, when negotiating a curve with a radius of curvature of 150 feet to avoid overturning is 22.5 miles per hour. With the above radius of curvature as the most limiting, a safety factor of 2 was applies to yield the safety limit.

The limiting control speed (five mph) is given as a maximum value from revised NAVSHIPS 389-0412 Technical Manual, M-160 Standardized Shipping Container. This value differs from the Safety Assessment Document PWR Core 2 project, Document RHO-CD-356 that was based on a past issue of the NAVSHIPS Manual.

2.4 Storage Cell Water Level

a. Title: Water level

b. Applicability: This specification applies to water level in the fuel storage cell (No. 4) in the 221 T-Plant canyon.

c. Objective: To define the minimum water level limits to provide adequate shielding for personnel in the 221 T-Plant canyon.

d. Specification:

- o The safety limit value for the water level shall be 15'8".
- o The limiting control value for the water level shall be 16'8".

e. Action: In the event of a low water level condition in violation of the limiting control value, additional water shall be supplied to the normal operating levels (19'-2" ± 2") and an investigation to the cause conducted. Should the water level decrease to an elevation in violation of the safety limit value, the canyon shall be evacuated, and an investigation of the cause conducted.

f. Bases: The safety limit value for water elevation represents an elevation of water at which the radiation from seventy-six blanket fuel modules would be exceeding the levels of high radiation causing the alarm to sound to evacuate the canyon. The limiting control value of water elevation represents an elevation of water at which the radiation from seventy-six blanket fuel modules would be exceeding the levels of high radiation causing the alarm to sound for Radiation Monitoring personnel to immediately investigate the cause.

3.0 LIMITING CONDITIONS FOR OPERATIONS

3.1 Ventilation System Requirements

a. Title: Operation of Building Ventilation System

b. Applicability: This specification applies to the operation of the 221 T Plant Building ventilation system.

c. Objective: To define the minimum equipment which shall be operable in the ventilation systems to maintain releases of radioactive effluents within acceptable limits and to maintain proper channeling of air streams within the operating areas.

d. Specification:

- o A negative pressure differential in the 221 T Plant canyon, relative to atmospheric, shall be maintained by the exhaust system located on the canyon roof and/or the 291-T stack and sand filter system; and the canyon air supply system located in the 221-TA Building. At least one exhaust system shall be operating at all times.
- o The exhaust system filters shall be DOP (Dioctyl-Phthalate) smoke tested per established Rockwell Policy.
- o Both exhaust systems shall be equipped with stack beta-gamma monitors and radiation alarms set to alarm at a reading of less than 30,000 dpm.

- o Entry into the canyon shall not be made for unloading operations unless at least one exhaust fan is operating and the canyon negative pressure is at least 0.025 inches of water or greater.

e. Action: In the event of a loss of negative pressure differential or stack monitor alarm sounding, the 221 T-Plant canyon shall be evacuated and an investigation conducted.

f. Bases: The above equipment maintains negative pressure differentials (-0.025 to -0.75 inches of water relative to atmospheric) during operation of both exhaust systems and ensures proper air flow patterns and filtration of the air and off-gases prior to releasing to the environs. The alarm setting is based on RHO-MA-139 Section 4.

3.2 Redundant and Back-up Equipment

3.2.1 a. Title: Auxiliary Grappler

b. Applicability: This specification applies to the grappling of a fuel module.

c. Objective: To prevent dropping of a fuel module due to the failure of the primary fuel module grappler.

d. Specification: Prior to lifting a fuel module from the shipping cask, the module shall be grappled by a primary grappler and an auxiliary grappler independently suspended from the hook of the three-ton hoist.

e. Action: Operations to remove a fuel module from the shipping container shall be suspended until this specification has been satisfied.

f. Bases: Since the fuel modules will be transferred from the shipping cask to the storage pool unprotected, the possibility of a dropped fuel module, resulting in a cladding failure and contamination, increases. A redundant grappling system will significantly reduce the possibility of a dropped fuel module, therefore, reducing the probability of contamination escaping to the environs.

3.2.2 a. Title: Three-Ton Hoist

b. Applicability: This specification applies to the lifting configuration of the hoisting system of a fuel module during removal from the shipping cask.

c. Objective: To provide an alternate and redundant system for raising or lowering a fuel module during the transfer of an unshielded fuel module from the shipping cask to the storage cell without personnel entry into the canyon.

d. Specification:

- o Prior to raising a fuel module from the shipping cask, the auxiliary three-ton hoist shall be rigged to the hook of the 10-ton crane.
- o An independent power supply from the crane cab to each hoist shall be provided.
- o A load limiting device, set to discontinue lifting at a force of 1500 pounds, shall be equipped on the three-ton hoist.

e. Action: Operations to remove a fuel module from the shipping container shall be suspended until this specification has been satisfied.

f. Bases: Since the fuel modules will be transferred from the shipping cask to the storage pool unshielded, personnel entry into the canyon to repair a malfunctioning crane would result in excessive personnel exposure. The three-ton hoist will provide an alternate and redundant system to lower the fuel module into the pool or cask to provide the necessary shielding for canyon entry.

The independent power supply to the hoists will provide added assurance of the back-up system, should an electrical malfunction occur.

The lifting limiting device provides assurance that an excessive lifting force will not be applied and result in damage to a fuel module during removal from the cask.

3.3 Canyon Isolation During Fuel Transfer from the Shipping Cask to the Storage Cell

a. Title: Canyon Isolation

b. Applicability: This specification applies to all personnel in the vicinity of 221 T-Plant canyon during fuel transfer.

c. Objective: To prevent unnecessary radiation exposure to personnel.

d. Specification: The 221 T-Plant canyon, the head end, roof and railroad tunnel shall be vacated by all personnel except those required in the crane cab, during a fuel module transfer from the M-160 shipping container to the storage cell.

e. Action: Operations to remove a fuel module from the shipping container shall be suspended until this specification has been satisfied.

f. Bases: Due to the high radiation levels from an unshielded fuel element, personnel exposure in the canyon would be well above maximum permissable limits during transfer.

3.4 Fuel Storage Protection from Mechanical Damage

a. Title: Cover Blocks

b. Applicability: This specification applies to the fuel module storage cell.

c. Objective: To prevent mechanical damage of a fuel module as a result of a load dropped from the building crane.

d. Specification: Cover blocks shall be placed over the area of the storage cell containing fuel modules during storage. The cover blocks shall be lowered into the storage cell adjacent to the storage racks and then transversed to a position over the fuel.

e. Action: In the event the cover blocks are not in their proper location, loads carried over the storage racks shall be suspended until this specification has been satisified.

f. Bases: The cover blocks will protect the fuel modules from being damaged due to dropped loads. To prevent a cover block from damaging the fuel, the blocks shall not be lowered directly over the fuel, but be lowered into the recess of the storage cell adjacent to the storage rack and then transversed along the recess until in a position over the fuel. With this added protection, the probability of releasing contamination to the environs from damaged fuel is minimized.

3.5 Unconditional Release Survey of Tools and Equipment

a. Title: Equipment Release Smear Survey

b. Applicability: This specification applies to all tools and equipment, excluding the fuel module hold-downs, used for the handling of the M-160 cask and fuel modules; when they are released from Rockwell.

c. Objective: To prevent the release of contaminated tools and equipment and prevent the spread of contamination to the environs.

d. Specification: All tools and equipment will be surveyed before unconditional release to an uncontrolled area. The release level on smearable contamination for alpha is to be less than 200 dpm/100 cm^2 and for beta-gamma 1000 dpm/100 cm^2 .

e. Action: If tools or equipment become contaminated to limits above release level, decontaminate as required per approved Rockwell procedures (RHO-MA-134) for PWR Core 2 tools and equipment.

f. Bases: The tools and equipment used for unloading the fuel have the potential of becoming contaminated. Uncontrolled release of this equipment would result in contamination of personnel and the environment. The limits specified will permit the equipment to be transported without radiological controls.

3.6 Authorized Material in 221 T-Plant Canyon

a. Title: Authorized Materials.

b. Applicability: This specification applies to the type and amount of fissile material allowed in the 221 T Plant canyon.

c. Objective: To define those nuclear materials which may safely be handled during storage of PWR Core 2 spent fuel.

d. Specification:

- Storage of nuclear fuel in Cell 4 of the 221 T-Plant canyon is limited to 76 PWR Core 2 Blanket fuel assemblies.

- No additional fuel assemblies, fissile material or equipment with a total accumulate of 15 grams or greater of fissile material may be stored or processed in the 221 T-Plant canyon.

e. Action: To handle or store any additional fissile material exceeding the specified requirements, an engineering criticality analysis and specification shall be performed.

f. Bases: The PWR Core 2 blanket assemblies in the flooded condition have an infinite multiplication factor (K_∞) for the total blanket of 0.89. The most reactive single blanket assembly has a K_∞ of 0.91. Subcriticality of the blanket assemblies is assured under these circumstances. However, with additional fissile material in storage in the cell or fissile material in the vicinity, subcriticality cannot be assured without further criticality analysis.

3.7 Nitrogen purge of the M-160 Container Air Space

a. Title: Nitrogen Purge

b. Applicability: This specification applies to the air sample taken from the cask air space when determining if a flammable atmosphere exists.

c. Objective: To dilute the cask air space with an non-explosive gas to reduce the probability of explosion.

d. Specification: The M-160 container shall be purged with nitrogen when it has been determined from an explosive meter sample test, to contain a flammable atmosphere.

e. Action: If an explosive atmosphere exists, operations to vent the cask shall be suspended until the cask has been purged with nitrogen. An air sample shall be collected prior to purging.

f. Bases: Purging the M-160 container with nitrogen will dilute the flammable atmosphere and reduce the probability of explosion during subsequent operations.

4.0 SURVEILLANCE REQUIREMENTS

4.1 Inspection of Radiation Monitoring Devices

a. Title: Radiation Monitoring Devices

b. Applicability: This specification applies to the airborne beta-gamma alarm and the high radiation alarm instruments.

c. Objective: To periodically verify the operability of the monitoring devices and establish routine inspection for readings.

d. Specification: The instruments listed in 4.1.b shall be calibrated at least every six months, response checked at least monthly and readings recorded at least twice weekly.

e. Action: In the event of a lapse of proper equipment surveillance, the equipment shall be maintained per this requirement as soon as practicably feasible.

f. Bases: In order to ensure the validity of the instruments and monitors, periodic verification of their calibration is required. This will assure the readings given are accurately recorded, and in the event of high radiation, an accurate dose rate will be obtained. The response check will assure the instruments will properly alarm in the event of high radiation. Bi-weekly readings will provide necessary data to evaluate the trends and characteristics of the radiation in the canyon.

4.2 Storage Cell Water Testing

a. Title: Storage Cell Water Testing and Characteristics

b. Applicability: This specification applies to the water in the fuel storage cell.

c. Objective: To define the testing and characteristics of the water in the fuel storage cell.

d. Specification: The water in the storage cell shall be tested at least once every two weeks to verify that the quality meets pH of 4.5 - 9.5, chloride ion concentration is less than 10 ppm and the activity is less than 1×10^{-2} μCi/ml at equilibrium.

e. Action: In the event of these requirements being exceeded, engineering shall investigate the cause and corrective action.

f. Bases: The fuel storage rack, support structures and fuel cladding are subject to stress, pitting, or crevice corrosion at high or low pH values and high concentrations of chloride. The limits specified represent conservative values based on past reports of fuel in storage.

The water testing frequency specified is adequate because the large volume of water tends to prevent rapid changes in conditions.

The chloride ion concentration was selected from a study of various water storage pools. The concentrations of existing storage pools are usually less than 1.5 ppm at equilibrium. However, some pools normally operate up to 10 ppm, th concentrations as high as 100-200 ppm used in the past.

The radioactivity in the storage pool is from activation products on crud on the fuel modules and possible fission products from breeched fuel plates. The radionuclide concentrations in storage pools vary from 10^{-1} to 10^{-7} μCi/ml with the concentration level rising during fuel discharge into the storage pool. The value specified will limit dose rates above the pool to within specified requirements and allow for fluctuation during fuel discharge. The specified concentration may be exceeded during fuel discharge but shall be within limits during equilibrium.

In addition to the specified testing, other measurements such as temperature and conductivity shall be made.

5.0 DESIGN FEATURES

5.1 Control of Facility and Equipment Design Modification

a. Title: Engineering Review

b. Applicability: This specification applies to all facility designs and equipment designs that are used for the unloading and storage of PWR Core 2 spent fuel.

c. Objective: To ensure qualified engineering and safety review of all facility or equipment designs or modifications prior to installation or use to assure personnel safety and containment of radiation and contamination.

d. Specification: All designs and modifications to the facility or equipment used in the unloading and storage of PWR Core 2 spent fuel shall require prior engineering approval, per established Rockwell Policy ARH-MA-150.

e. Action: A proper review per this requirement shall be made prior to initial or continued modification of the equipment or facility.

f. Bases: This specification assures that prior to the use of new facilities or equipment, a proper engineering review has been performed to ensure the facility or equipment will not effect the integrity of the physical barrier of radiation and contamination containment.

6.0 ADMINISTRATIVE CONTROL SYSTEMS

6.1 Organization and Administrative Systems

a. Title: Management Organization

b. Applicability: This specification applies to the management and responsibilities for the PWR Core 2 project.

c. Objective: To summarize the descriptions of administrative control for the project. A complete description is discussed in the Safety Assessment Document - PWR Core 2 Project, Document No. RHO-CD-356.

d. Specification:

- The responsibility for the management of the PWR Core 2 project is assigned to the Chemical Processing Program Organization. Responsibility for operation of the 221 T-Plant facility is assigned to the Director, Production Operations Function. Overall coordination and direction of unloading activities is assigned to a Defueling Director, who reports to the Manager, Plutonium Operations, who reports to the Director.

- The Defueling Director, or a qualified alternate, shall be present during all operations on the M-160 shipping container.

- Only trained qualified personnel, as determined by the Defueling Director, shall be permitted to perform operations on the M-160 shipping container.

e. Bases: Management of this project is based on the Rockwell Hanford Operations' Policy Manual. To ensure safe handling of the shipping cask and equipment, the assignment of a Defueling Director was made. This was based on the need for overall coordination and direction of a project requiring sequential performance of operations.

6.2 Documentation for Operations

a. Title: Records and Procedures

b. Applicability: This specification applies to the recording of data associated with the unloading operations, storage, surveillance, and the procedures to perform these operations.

c. Objective: To establish minimum requirements for record keeping and operation.

d. Specification:

- All operations on cask handling are to be performed per approved procedures.

- Revisions to the procedures are to be made via procedure departure authorization via established Rockwell Policy.

- A summary of operations, all malfunctions and non-conforming conditions are to be recorded in the M-160 logbook.

- Training records of personnel shall be maintained by the training organization.

- Records on surveillance of stored fuel shall be maintained by Operations for the entire storage period.

e. Bases: The operations required to unload the shipping cask involve detailed sequential steps. This includes assembly and disassembly of cask components. With the use of procedures, these operations shall be controlled to maintain the integrity of the cask and fuel containment.

The records on surveillance of the stored fuel will enable Engineering to follow the trends and characteristics of the fuel and storage cell.

Approved by R. J. Thompson for EJK Date 7/6/78
Manager - Process Engineering

Approved by [signature] Date 7/6/78
Manager - Plutonium Operations

Approved by G C Owens Date 7/6/78
Manager - Environmental and Occupational Safety

Approved by [signature] FOR P.B. FISK Date 7/6/78
Manager - Quality Assurance