Status Report on Readiness to Receive Fuel Activities

Fuel Cycle Research & Development

Prepared for
U.S. Department of Energy
Used Fuel Disposition Campaign

Steven C. Marschman
Stephen A. Warmann
Eric C. Woolstenhume

Revision 0
Idaho National Laboratory
September 26, 2014
FCRD-UFD-2014-000049

FCRD-UFD-2014-000049

Status Report on Readiness to Receive Fuel Activities

Steven C. Marschman
Stephan A. Warmann
Eric C. Woolstenhume

Revision 0
September 26, 2014

Idaho National Laboratory
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of Used Nuclear Fuel Disposition Research and Development
Under DOE Idaho Operations Office Contract DE-AC07-05ID14517

This page intentionally left blank.

Status Report on Readiness to Receive Fuel Activities

FCRD-UFD-2014-00049

Revision 0
September 26, 2014

Peer Review:

Brady D. Hanson — September 26, 2014 (Date)
Pacific Northwest National Laboratory

Concurrence:

Sylvia J. Saltzstein for Ken B. Sorenson — September 26, 2014 (Date)
Ken B. Sorenson, S&T Control Account Manager
Sandia National Laboratory

Submitted by

Steven C. Marschman — September 26, 2014 (Date)
Idaho National Laboratory

This page intentionally left blank.

SUMMARY

This report fulfills the M2 milestone, M2FT-14IN0802016 Status Report on Readiness to Receive Fuel Activities, under Work Package Number FT-14IN080202.

The U.S. Department of Energy Office of Nuclear Energy (DOE-NE), Office of Fuel Cycle Technology, has established the Used Fuel Disposition Campaign (UFDC) to conduct the research and development activities related to storage, transportation, and disposal of used nuclear fuel (UNF) and high-level radioactive waste. The mission of the UFDC is to identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of UNF and wastes generated by existing and future nuclear fuel cycles. The UFDC Storage and Transportation staffs are responsible for addressing issues regarding the extended or long-term storage of UNF and its subsequent transportation. The near-term objectives of the Storage and Transportation task are to use a science-based approach to develop the technical bases to support the continued safe and secure storage of UNF for extended periods, subsequent retrieval, and transportation.

While low burnup fuel [that characterized as having a burnup of less than 45 gigawatt days per metric tonne uranium (GWD/MTU)] has been stored for nearly three decades, the storage of high burnup (HBU) used fuels is more recent. The DOE has funded a High Burnup Dry Storage Cask Research and Development project (R&D Project) to confirm the behavior of used high burnup fuel under prototypic conditions. The Electric Power Research Institute (EPRI) is leading a project team to develop and implement a plan to collect this data from a UNF dry storage system containing high burnup fuel. The plan for the R&D Project outlines the data to be collected; the high burnup fuel to be included; and the storage system design procedures and licensing necessary to implement the Test Plan. To provide data that is most relevant to high burnup fuel in dry storage, the design of the test storage system must closely mimic real conditions high burnup UNF experiences during all stages of dry storage: loading, cask drying, inert gas backfilling, and transfer to an Independent Spent Fuel Storage Installation (ISFSI) for multi-year storage.

To document the initial condition of the used fuel prior to placement in a storage system, "sister" fuel rods will be harvested and sent to a national laboratory for characterization, testing, and archival purposes. This report presents the activities that need to be completed and a proposed schedule for the work assuming the sister rods were to be sent to INL. It was determined the activities could be complete in about 11 months, and, at the date of this report there are about 17 months remaining until the fuel rods would be shipped to a laboratory for characterization and analysis.

This page intentionally left blank.

CONTENTS

FIGURES

TABLES

ACRONYMS

BHS	Blanket Hull Storage
BWR	Boiling Water Reactor
CRA	Contractor Readiness Assessment
CVL	Containment Vessel Long
DEQ	Department of Environmental Quality
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DSA	documented safety analysis
EBR	Experimental Breeder Reactor
EC	Environmental Checklist
EM	electro-mechanical manipulator
EPRI	Electric Power Research Institute
FY	Fiscal Year
FFTF	Fast Flux Test Facility
GWD	gigawatt•day
HBU	high burnup
HFEF	Hot Fuel Examination Facility
INL	Idaho National Laboratory
ISFSI	Independent Spent Fuel Storage Installation
IWC	Inner Waste Can
LI	Laboratory Instruction
LIMS	Laboratory Information Management System
LWR	light water reactor
LWT	Legal Weight Truck
MAR	Material at Risk
MCP	Management Control Procedure
MFC	Materials and Fuels Complex
MSA	Management Self-Assessment
MTG	Materials Tracking system
MTU	metric tonne Uranium (typically U-235)
NAC	NAC International, Inc.
NE	Nuclear Energy (as in DOE-NE)
NRC	Nuclear Regulatory Commission

OI	Operating Instruction
OSB	Operational Safety Board
PE	Project Engineer
PEP	Project Execution Plan
PM	Project Manager
PSC	Process Scrap Container
PWR	pressurized water reactor
QA	Quality Assurance
QAPP	Quality Assurance Program Plan
R&D	research and development
R&D Project	High Burnup Dry Storage Cask Research and Development Project
RWP	Radiological Work Permit
SAR	Safety Analysis Report
S&S	Safeguards and Security
TPBAR	Tritium-Producing Burnable Absorber Rod
TSR	Technical Safety Requirement
U5E	U-235 equivalence
UFDC	Used Fuel Disposition Campaign
UNF	used nuclear fuel
USQ	unreviewed safety question

STATUS REPORT ON READINESS TO RECEIVE FUEL ACTIVITIES

1. INTRODUCTION

The U.S. Department of Energy Office of Nuclear Energy (DOE-NE), Office of Fuel Cycle Technology, has established the Used Fuel Disposition Campaign (UFDC) to conduct the research and development activities related to storage, transportation, and disposal of used nuclear fuel (UNF) and high-level radioactive waste. The mission of the UFDC is to identify alternatives and conduct scientific research and technology development to enable storage, transportation and disposal of UNF and wastes generated by existing and future nuclear fuel cycles. The UFDC Storage and Transportation staffs are responsible for addressing issues regarding the extended or long-term storage of UNF and its subsequent transportation. The near-term objectives of the Storage and Transportation task are to use a science-based approach to develop the technical bases to support the continued safe and secure storage of UNF for extended periods, subsequent retrieval, and transportation.

The DOE has funded a High Burnup Dry Storage Cask Research and Development Project (R&D Project) to confirm the behavior of high burnup (HBU) used fuel (burnup > 45 GWD/MTU) under prototypic dry storage conditions. The Electric Power Research Institute (EPRI) is leading the project team that will perform this R&D Project. The Test Plan (EPRI, 2014) for the R&D Project outlines the data to be collected; the HBU UNF to be included; and the storage system design procedures and licensing necessary to implement the Test Plan. To provide data that is most relevant to HBU UNF in dry storage, the design of the test storage system will closely mimic real conditions HBU UNF experiences during all stages of dry storage: loading, cask drying, inert gas backfilling, and transfer to an Independent Spent Fuel Storage Installation (ISFSI) for multi-year storage.

To document the initial condition of the used fuel prior to placement in a storage system, "sister" fuel rods will be harvested and sent to a national laboratory for characterization, testing, and archival purposes. This report supports the R&D Project by describing how sister rods could potentially be shipped and received at INL. Further, this report provides a detailed cost estimate and proposed schedule associated with the activities that would be needed to bring the sister rods to INL, place them in safe storage, and have them ready for characterization and testing.

2. FUEL ROD SELECTION

The main purpose of the R&D Project is to evaluate the effect of long-term storage on the mechanical properties of HBU UNF. This requires knowing the properties of the fuel prior to dry storage and comparing those properties to fuel that has been dried and then stored in a cask/canister for a long period of time. It is important that fuel rods with similar characteristics be selected for both initial characterization and for inclusion in the R&D Project to ensure pre- and post-test fuel characteristics can be compared.

It should be noted that sister rods need not come from the same assembly; a fuel rod with similar characteristics (e.g., irradiation history, enrichment, clad type, etc.) from a different assembly may be determined to be an appropriate “sister” for another fuel rod. It is expected that some sister rods will, by necessity, come from fuel assemblies that will not be used in the R&D Project.

The fuel assemblies used at North Anna are of the Westinghouse 17x17 design. North Anna has one of the largest selections of HBU UNF in the country; including AREVA M5® clad fuel and Westinghouse Zircaloy-4, Zircaloy-4 low-tin, and Zirlo® clad fuels. The decision regarding which specific assemblies will be used in the R&D Project has recently been settled (see Figure 2-1). However, the evaluation of the actual sister rods to be shipped is part of an ongoing discussion between the EPRI team, DOE, and the UFDC national labs. This is planned to be resolved in late Fiscal Year (FY) 2014 or early FY 2015.

	1 6T0 Zirlo, 54.2 GWd 4.25%, 3cy, 11yr 1013/818W	2 3K7 M5, 53.4 GWd 4.55%, 3cy, 8yr 1167/837W	3 3T6 Zirlo, 54.3 GWd 4.25%, 3cy, 11yr 1015/820W	4 6F2 Zirlo, 51.9 GWd 4.25%, 3cy, 13yr 909/756W	DRAIN PORT
5 3F6 Zirlo, 52.1 GWd 4.25%, 3cy, 13yr 914/761W	6 30A M5, 52.0 GWd 4.55%, 3cy, 6yr 1276/832W	7 22B M5, 51.2 GWd 4.55%, 3cy, 5 yr 1503/841W	8 20B M5, 50.5 GWd 4.55%, 3cy, 5 yr 1477/827W	9 5K6 M5, 53.3 GWd 4.55%, 3cy, 8yr 1163/834W	10 5D5 Zirlo, 55.5 GWd 4.2%, 3cy, 17yr 906/796W
11 Vent Port 5D9 Zirlo, 54.6 GWd 4.2%, 3cy, 17yr 885/778W	12 28B M5, 51.0 GWd 4.55%, 3cy, 5 yr 1496/837W	13 F52 Zirc-4, 58.1 GWd 3.59%, 4cy, 28yr 858/803W	14 57A M5, 52.2 GWd 4.55%, 3cy, 6yr 1281/834W	15 30B M5, 50.6 GWd 4.55%, 3cy, 5 yr 1482/830W	16 3K4 M5, 51.8 GWd 4.55%, 3cy, 8 yr 1120/803W
17 5K7 M5, 53.3 GWd 4.55%, 3cy, 8yr 1165/835W	18 50B M5, 50.9 GWd 4.55%, 3cy, 5 yr 1492/835W	19 3U9 Zirlo, 53.1 GWd 4.45%, 3cy, 10yr 1037/805W	20 0A4* Low-Sn Zy-4, 50 GWd 4.0%, 2cy, 22yr 725/664W	21 15B M5, 51.0 GWd 4.55%, 3cy, 5 yr 1496/837W	22 6K4 M5, 51.9 GWd 4.55%, 3cy, 8 yr 1121/804W
23 3T2 Zirlo, 55.1 GWd 4.25%, 3cy, 11yr 1036/837W	24 3U4 Zirlo, 52.9 GWd 4.45%, 3cy, 10yr 1031/801W	25 56B M5, 51.0 GWd 4.55%, 3cy, 5 yr 1495/837W	26 54B M5, 51.3 GWd 4.55%, 3cy, 5 yr 1511/846W	27 6V0 M5, 53.5 GWd 4.4%, 3cy, 8yrs 1178/843W	28 3U6 Zirlo, 53.0 GWd 4.45%, 3cy, 10yr 1035/803W
	29 4V4 M5, 51.2 GWd 4.40%, 3cy, 8yr 1073/787W	30 5K1 M5, 53.0 GWd 4.55%, 3cy, 8yr 1155/828W	31 5T9 Zirlo, 54.9 GWd 4.25%, 3cy, 11yr 1031/832W	32 4F1 Zirlo, 52.3 GWd 4.25%, 3cy, 13yr 918/764W	

Figure 2-1. Proposed loading pattern for the TN-32B storage cask that will be used for the R&D Project. From these assemblies (and potentially one or two that are not going to be used in the R&D Project) will come the sister rods. The information in each square represents the fuel clad type (e.g. M5®, Zircaloy-4), the assembly average burnup (in GWD/MTU), the fuel enrichment (e.g. 4.2%, 4.55% U-235), the number of reactor cycles the fuel was in-core, and the assembly heat content (watts, when R&D Project cask is loaded, and at the end of 10 years).

The NAC International, Inc. Legal Weight Truck (NAC-LWT) can be used to ship up to 25 HBU fuel rods. No more than 25 HBU fuel rods can be shipped in this cask due to restrictions in the thermal limit of the cask design. It is the intent of the EPRI team to send up to 25 sister rods to a national laboratory.

3. SUPPORTING SISTER ROD ACTIVITIES AT NORTH ANNA

Once the sister fuel rods are identified, they will be “harvested” from the fuel assemblies in the North Anna Spent Fuel Pool. Because there are two fuel vendors represented, the fuel will be harvested in two separate campaigns, one will be performed with Westinghouse, one with AREVA. A third campaign will be conducted to load the fuel into a shipping cask[1], the NAC-LWT, for transport to a national laboratory (assumed to be INL for this report).

INL will support these campaigns by providing staff(s) to witness the fuel harvesting activities at the spent fuel pool. This activity will be conducted to assure each sister fuel rod is documented, as well as can be done poolside, prior to its loading into the transport container that will be loaded into the NAC-LWT transport cask. It is expected photos or video of each fuel rod will be taken prior to loading in the transport container. It is expected each fuel rod will be loaded into the transport container in the same orientation (preferably “up” will

[1] The NAC International Inc. Legal Weight Transport (LWT) cask has been selected for transporting the sister rods from the North Anna Power Station to a national laboratory (assumed in this report to be INL).

be at the top of the transport container). Observations will include a subjective judgment of the rod bow, visible scratches, or other notable features that may be observed. It will also be verified that the correct rods are being harvested.

INL will also support the third campaign which involves the loaded transport container being placed in the transport cask, sealing, draining, backfilling, vacuum drying, and finally loading onto the truck transport and shipping from the North Anna site. INL will witness the cask loading and post-loading radiological smears to help assure the transport package is as radioactively clean as possible before it is shipped.

4. HFEF PREPARATION

An important phase of the used fuel acquisition process is preparing INL's Hot Fuel Examination Facility (HFEF) for receipt of the used fuel. To ensure the fuel is acceptable to be brought into the HFEF main cell the content and form of the fuel must be verified to meet all safeguards and security (S&S), criticality control, and nuclear safety requirements at HFEF. Additionally, to ensure HFEF is prepared to receive the fuel, a storage location for the fuel must be identified, all receipt equipment fabricated and/or located and staged, all associated fuel receipt equipment preventative maintenance performed, and all cask and fuel handling operational procedures updated. Receipt of the sister rods at HFEF is required to meet the requirements of LWP-9830, "Managing Research Quantities of Commercial Used Nuclear Fuel." This procedure was written to ensure compliance with the Memorandum of Agreement between DOE and the State of Idaho (see Appendix A) regarding research quantities of commercial UNF.

4.1 Fabrication of Parts in Advance of Fuel Receipt

Once the fuel shipment arrives at HFEF, the fuel rods need to be removed from the transport container. Each of the 25 fuel rods will be lifted one at a time with the Window 1M manipulators and have a Type D end fitting secured to it using the end fitting station. Type D end fittings (Figure 4-1) have an adjustable collet, allowing them to be used on fuel rods up to 0.375 in. (9.525 mm) in diameter (Westinghouse 17x17 fuel rods are 0.374 in [9.5 mm] in diameter). Thirty of these fittings will be fabricated in advance of the sister rod receipt (25 plus spares).

Figure 4-1. Type D end fittings that are attached to the end of each fuel rod for handling.

Fuel storage containers also need to be fabricated to safely store the sister rods once they are removed from the transport cask. It is proposed that a 12-element storage container (previously designed) be used for this purpose. The 12-element storage can is sized to fit full-length Pressurized Water Reactor (PWR) fuel rods. This container is constructed of 8-in. (203 mm) schedule 10 aluminum pipe and has a capacity of 12 fuel rods. A design study is being conducted to determine if the storage container might be reconfigured to hold 13 fuel rods. In that event, once fabricated, two of these containers would be needed for the 25 fuel rods. If the container can be redesigned, two containers will be fabricated. If not, three containers will be fabricated for use. A schematic drawing of the 12-element storage container is shown in Figure 4-2.

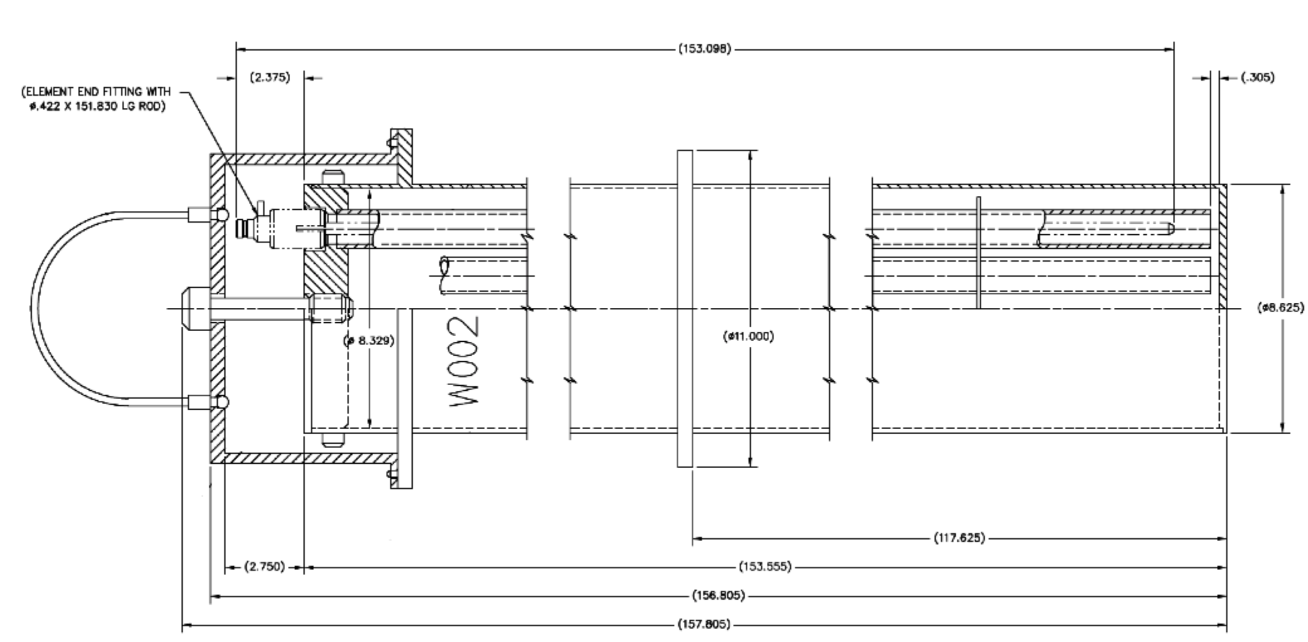


Figure 4-2. Assembly drawing of the 12-element container.

Based on existing INL procedures associated with the handling of the NAC-LWT cask, an assessment was conducted to determine which equipment was available and what will need to be fabricated to support fuel receipt, transfer, and storage in HFEF. The assessment identified the need for a short and long grapple for handling the NAC-LWT fuel transport container and "negator" spring hook with gripper attachment. All of this equipment has been previously designed and used in previous NAC-LWT receipts at HFEF. A complete listing of the necessary equipment requiring fabrication, including drawing numbers, appears in Appendix D.

4.2 Selection of Fuel Storage Location

The location of each sister fuel rod must be carefully tracked. Initially, the 12-element containers will be stored near the middle of the HFEF main cell in storage wells. Within HFEF there are 32 criticality zones in the main hotcell[2]. Zone 17M[3] has been selected as the storage location for the PWR spent fuel since it is directly adjacent to Zone 4M, which is where the fuel rods will be selected from the 12-element container as needed for PIE examination. This minimizes movement of the fuel across multiple zones within the main cell.

Zone 17M contains 15 storage pits located in an area of the main hotcell where there is a subfloor (shown in Figure 4-3). The storage pits are made from carbon steel pipes installed in the steel decking at the operating floor level. The carbon steel pipes extend about 4 inches (102 mm) above the steel decking and about 12.5 inches (318 mm) below the decking. The pits can be fitted with a lid as desired. These pipes do not extend down to the subfloor (which is 8 feet [2438 mm] below the operating floor elevation). These pipes serve only to align and protect containers that are placed in them; there is open space under the carbon steel pipes. The hot cell atmosphere is free to circulate below the operating floor to provide cooling for materials that may be stored in the pits. The pits can accommodate items up to 15 inches (381 mm) in diameter.

---

[2] See Appendix B for a map of the hotcell criticality zones.

[3] Identification of items within the HFEF hotcell are often accompanied by a letter 'M' (main hotcell, argon atmosphere) or 'D' (decontamination cell, air atmosphere) that indicate which side of the hotcell the item is located.

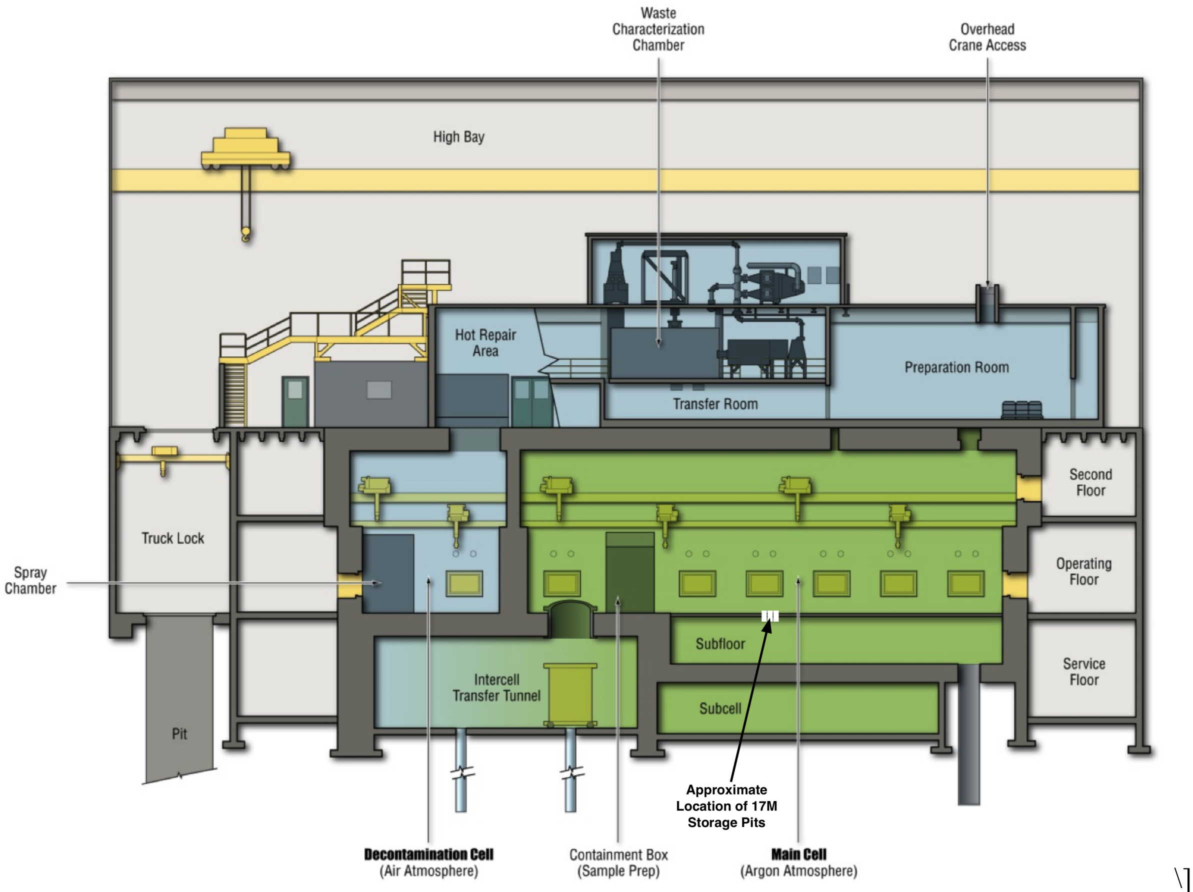


Figure 4-3. HFEF elevation schematic.

4.3 Safeguards and Security

In order to ensure that HFEF is prepared to receive the sister rods from an S&S perspective, the safeguards category of the fuel will be determined. Used commercial fuel typically fits within an Attractiveness Level E designation and, by definition, are Safeguards Category IV (highly irradiated forms with U-235 less than 20 wt%). However, INL Safeguards and Security must confirm this. If this categorization is confirmed, no special tracking processes from a safeguards perspective (other than the material having been received) is necessary. The safeguards categorization will be formalized on the shipper/receiver agreement in the weeks immediately preceding actual fuel shipment to HFEF. The graded safeguards approach is outlined in Table 1.

4.4 Criticality Control

The HFEF Operating Instruction, HFEF-OI-1020, "Criticality Hazards Control Statement," designates Zone 17M as a "fuel element, cladding hull and waste storage area." In addition to a limit of 10 kg U5E[4] and 500 g moderator, HFEF-OI-1020, Section 4.4.2, indicates that each pit in Criticality Hazards Control Zone 17M is limited to one of the following:

A. A single closed Inner Waste Can (IWC) of Process Scrap Containers (PSCs) or Blanket Hull Storage Containers (BHSs), or

B. A single closed IWC of generic materials, or

C. A Single Fuel Element Magazine.

[4] The term U5E is used to describe a mass of fissionable material converted to a U-235 equivalent. Each gram of U-235 and transuranium isotopes (Np and Am) is considered as one gram U5E, while each gram of Pu and U-233 is considered as four grams of U5E.

Note the specification of the closed IWCs within the Zone 17M pits, but its absence from option C for a Single Fuel Element Magazine. The glossary contained in HFEF-OI-1020 specifically addresses this issue with the following information: "Containers which do not have the capability to collect and hold moderator (drainable baskets, fuel element magazines, etc.) meet the intent of the closed container definition with regards to storage of fissionable material." In addition, intact fuel cladding is considered a closed container for purposes of criticality safety. Similarly, the HFEF Technical Safety Requirement, HFEF-TSR, Rev. 5, "HFEF Technical Safety Requirements," places limitations on "exposed fuel" when the facility is in a repair mode. Exposed fuel is further defined in Section 1.1 as "any fuel that is not clad or whose cladding integrity has been compromised." If the PWR fuel has been cut or segmented, it will need to be stored in an IWC or PSC closed container if not in use, or sealed in another manner (e.g. Swagelok® sealed end cap placed over the cut ends).

Table 1. Graded Safeguards Table taken from INL Laboratory Requirements Document, LRD-11500, Nuclear Materials Management, Control and Accountability Plan.

	Attractiveness Level	Pu / U-233 Category (kg)				Contained U-235 / Separated Np-237 / Separated Am-241 and Am-243 Category (kg)				All E Materials Category IV
		I	II	III	IV[1]	I	II	III	IV[1]	N/A
WEAPONS Assembled weapons and test devices	A	All	N/A	N/A	N/A	All	N/A	N/A	N/A	N/A
PURE PRODUCTS Pits, major components, button ingots, recastable metal, directly convertible materials	B	≥2	≥0.4<2	≥0.2<0.4	<0.2	≥5	≥1<5	≥0.4<1	<0.4	N/A
HIGH GRADE MATERIAL Carbides, oxides, nitrates, solutions (≥25 g/L) etc.; fuel elements and assemblies; alloys and mixtures; UF_4 or UF_6 (≥50% enriched)	C	≥6	≥2<6	≥0.4<2	<0.4	≥20	≥6<20	≥2<6	<2	N/A
LOW GRADE MATERIALS Solutions (1 to 25 g/L), process residues requiring extensive reprocessing; moderately irradiated material; Pu-238 (except waste); UF_4 or UF_6 (≥20% <50% enriched)	D	N/A	≥16	≥3<16	<3	N/A	≥50	≥8<50	<8	N/A
ALL OTHER MATERIALS Highly irradiated forms, solutions (<1 g/L), uranium containing <20% U-235 or <10% U-233[2] (any form, any quantity)	E	N/A	N/A	N/A	Reportable Quantities	N/A	N/A	N/A	Reportable Quantities	Reportable Quantities

[1]The lower limit for Category IV is equal to reportable quantities in this Manual.
[2]The total quantity of U-233 = [Contained U-233 + Contained U-235]. The category is determined by using the Pu/U-233 side of this table.

A Fuel Element Magazine is a specific container used for the handling and storage of Experimental Breeder Reactor (EBR) and Fast Flux Test Facility (FFTF) fuel elements. The Fuel Element Magazine holds 20 fuel elements, each hanging individually from evenly spaced slots around the internal perimeter of the magazine. It is not a sealed or even a physically closed container; however, it meets criticality safety requirements by containing only fuel elements with intact cladding and being unable to collect and hold moderator. From a criticality control standpoint, the 12-element container should be treated as equivalent to a single Fuel Element Magazine. The 12-element container is a closed container and moderator materials cannot leak in from the outside (e.g. inadvertent water or oil that might become present in the hot cell due to leakage of a window or cooling system). There is a small possibility that moderator could enter a 12-element container while the lid is removed. This risk is considered small and can be managed by procedural controls.

The current inventory of Zone 17M includes two fuel magazines; one partially filled, the other is empty. The inventory also includes an empty LTA-1 container and a bag with two simulated metal waste form ingots. Currently 12 of the 15 pits in Zone 17M are empty. Currently the U5E inventory for the zone is zero and can easily accommodate the storage of 25 PWR rods from a criticality control standpoint.

Also of consideration when planning a new storage operation is the presence of a worktable shared between Zone 17M and Zone 16M. It would be necessary to relocate the worktable to access some of the pits in 17M. However, with 12 of the 15 pits empty, sufficient empty pits will still be accessible for PWR fuel storage without the additional step of moving the table. The worktable is mobile and is typically moved for such storage pit operations.

An estimate of the U5E value for 25 low-enriched PWR fuel rods is shown in Table 1. A U5E value at HFEF is calculated with the following gram mass summation:

$$U5E = (^{235}U + ^{237}Np + ^{241}Am) + 4 \times (^{233}U + Pu).$$

The highest initial enrichment of a sister fuel rod is 4.55% by weight burned to 55 GWD/MTU provided the anticipated actinide breakdown used in Table 2. Assuming 2 kg of heavy metal per rod, a U5E contribution for each isotope was then calculated on a per rod basis.

Table 2. Estimated U5E value for a single sister rod.

Fissionable isotope	Grams present in a HBU PWR used fuel rod	U5E Multiplier	U5E Contribution (grams)
U-235	50	1	50
Np-237	1.8	1	1.8
Am-241	2.2	1	2.2
U-233	Negl.	4	Negl.
Pu (-239, -241, -240)	68	4	272
Total U5E per HBU used fuel rod (grams)			326

A conservative estimate then would be approximately 350 g U5E per rod, or 8.75 kg U5E for the entire shipment of 25 sister fuel rods. This quantity of U5E fits within the criticality control limit of 10 kg U5E for Zone 17M, and allows some room to share the space with other projects that may need to store full-length fuel rods.

4.5 Nuclear Safety

A particular challenge regarding the receipt of UNF at HFEF is the concurrent timeline for the implementation of a new Safety Analysis Report (SAR) for the HFEF. The primary areas of concern related to sister rod receipt associated with the new SAR are revised material tracking and material storage requirements. While the material tracking system is being changed from the Material Tracking (MTG) system to a Laboratory Information Management System (LIMS), the project will need to remain aware that the rigor for tracking Material-at-Risk (MAR) and fissile material inside the hotcell will be increasing. Additionally, the requirements for closed metal containers that can provide a reduction of MAR may also change (undeterminable at this time). It is assumed that clad fuel rods will continue to be deemed a closed metal container and a low impact to the facility MAR. Nevertheless, the program will be prepared to modify the design of 6-CVL (Containment Vessel Long) containers (see Figure 4-4) in case a requirement arises that the fuel be stored in defense-in-depth containers. The 6-CVL would need to be lengthened and a new insert designed. The project will author a technical evaluation regarding how the cost and schedule risks associated with these nuclear safety changes will be mitigated for fuel receipt upon project initiation.

For this fuel receipt effort, it is not necessary to have an estimate of expected MAR at this time. However, the expected MAR impacts on the facility must be evaluated prior to beginning PIE activities with the sister rods. It is recommended this be completed about 1/2 year prior to fuel receipt so PIE efforts can begin shortly after sister rod receipt.

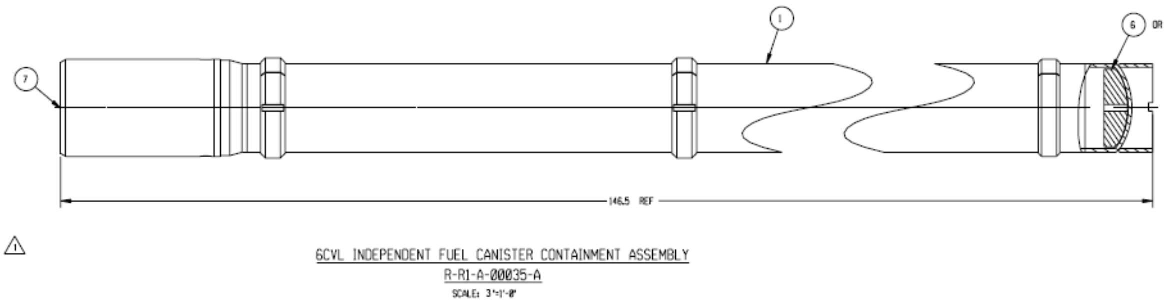


Figure 4-4. Schematic of the 6-CVL defense-in-depth container.

4.6 Operating Procedures

One facility operating procedure is required for receipt of the fuel. HFEF-OI-6205, "NAC-LWT Cask" is used to control the cask receipt and unloading operation. This procedure will need to be verified prior to receipt of the sister rods.

A Laboratory Instruction (LI) will be used to govern the in-cell operations related to fuel handling, end fitting installation, fuel rod identification and marking, initial visual inspection and observation recording, placing the rods in the 12-element containers, and placing those containers in a storage well. An ALARA (as low as reasonably achievable) review must be written to review the operating procedures and the associated Radiological Work Permit (RWP) for the work. The operational sequence drawing in Appendix C will solely be used as an operator aid during cask and in-cell handling operations.

4.7 Waste Management and Environmental Impacts

Prior to initiation of the fuel shipment, a DOE-approved environmental checklist (EC) must be completed to ensure regulatory compliance of the forecast work scope. DOE-ID has completed and approved an EC for this activity. For the purposes of fuel receipt, this EC is deemed adequate. However, INL will validate the assumptions made in the DOE-ID EC, particularly for air emissions and the potential for other environmental releases from the various facilities where PIE work will be performed in the future. This will be done to ensure the protection of the facilities, the workers, and the public.

Total project waste volume from the research performed subsequent to receipt of the fuel is projected to be less than 1 m^3. The INL Waste Management Program and MFC Waste Generator Services staff will be consulted for characterization and disposition pathways determinations for all generated wastes. Potential disposition pathways for any remaining UNF will be confirmed with DOE prior to initiation of PIE activities.

4.8 HFEF Readiness Activities

Prior to receiving the NAC-LWT cask, a full readiness review should not be required because another NAC-LWT fuel shipment is anticipated to be received at HFEF in FY 2015. That shipment will serve to prepare the facility for receipt of the NAC-LWT and provide the facility with "refresher" experience in handling that cask.

Nevertheless, there will be a need for some level of readiness assessment activities for the sister rod receipt. It is expected there could be lessons-learned from the shipment in FY 2015 that may need to be incorporated into procedures and operator training. There may be lessons related to radiological control that should be incorporated into Radiological Work Permits. Lifting operations may reveal opportunities for increased safety or more efficient operations. The project team will work with MFC and HFEF facility leadership to determine what topics should be addressed for project readiness based upon these types of lessons.

Based on results of the MFC Operational Safety Board (OSB) review of the Management Control Procedure, MCP-9902 "*Verification of Readiness to Start Up or Restart Nuclear Facilities*" forms for receipt of used fuel, it is expected that the greatest rigor required for readiness activities for the project would be an observed dry run with the NAC-LWT cask and dummy payload, a management self-assessment (MSA), and a contractor readiness assessment (CRA). The MSA and CRA are expected to be performed concurrently and to include a tabletop review of training and qualifications, procedures, and lessons learned from the observed dry run. Since the observed dry run will be conducted for the FY 2015 shipment, it is not anticipated this dry run will have to be repeated. However, because those activities have not happened, for the purposes of this document and the attached schedule and cost estimate, it will be assumed a readiness assessment will be required. This mitigates possible impacts from a scope or schedule change.

4.9 Optional Dry Run

A contract will be released by EPRI for the NAC-LWT lease and for logistical support for the sister rod shipment. INL will provide input to the contracting effort as needed.

If there is a need for this project to perform a dry run in support of HFEF readiness (e.g. if a fuel shipment to INL scheduled for FY 2015 does not occur), then a sole-source procurement will be needed to lease the NAC-LWT for that purpose. That contract would also include on-site technical support during cask dry run operations. For the purposes of this document and the attached schedule and cost estimate, it will be assumed a readiness assessment will be required, and the procurement needed. This mitigates any possible impacts from a scope or schedule change.

5. SHIPPING SUPPORT

Fuel shipping includes all of those activities necessary to support execution of the sister rod shipment. There are activities that must be accomplished prior to the shipment happening. In this case the national laboratory will be a participant in those activities but not the lead. For the assumptions of this report, INL will request copies of most shipping paperwork to ensure the shipment can be received when it arrives at the INL site. INL would participate in any site assessment of the shipping facility, review the shipment route survey and associated Nuclear Regulatory Commission (NRC) approval, review the preparation of the shipping facility, and review all preliminary shipping documentation.

As part of the preliminary activities for fuel shipment, the fuel ownership title must be transferred from NRC to DOE. It is assumed that this activity will be performed by DOE-ID. Additionally, the State of Idaho must be notified of the intent to bring research quantities of commercial UNF to the INL per the Memorandum of Agreement (Appendix A), and it is also assumed this will be performed by DOE-ID. This notification includes the source of the UNF, the quantity of "heavy metal" (i.e. fissile isotopes, U-235, etc.) in the shipment, the research purpose of the fuel, the schedule of completion for the research project, the anticipated volume of waste to be generated, and the potential disposition path for remaining UNF.

As stated earlier, the EPRI team will utilize the NAC-LWT transport cask for shipping sister fuel rods from Dominion's North Anna Power Station to INL's HFEF. The NAC-LWT is a steel-encased, lead-shielded Legal Weight Truck transportation cask. Up to 25 rods of PWR or Boiling Water Reactor (BWR) HBU UNF can be shipped in this cask with a burnup up to 80 GWD/MTU and cooling times as short as 150 days (keeping under the 2.3 kW for PWR or 2.1 kW for BWR fuels). A special 25-rod container is used for this purpose. This container will accommodate fuel rods up to 165 inches (419 cm) in length. A container will be sent to North Anna and placed in the spent fuel pool for use by the fuel vendors.

The sister rods will be loaded into this 25-rod container (see Section 3). Records will be kept by Dominion to ensure the location and orientation of each fuel rod is known. Once the 25-rod container is loaded, and once the fuel shipment window is reached, NAC will send a LWT cask to North Anna for loading, drying, and transport. The cask will be placed inside the spent fuel pool, and the container containing the fuel rods will be loaded into the cask. The inner lid will be placed in the cask while underwater. The cask will then be removed from the water and set next to the spent fuel pool where the bolts can be placed in the lid and tightened followed by water removal. The cask is then vacuum-dried. Once the cask internal pressure is sufficiently low (~3 torr), the vacuum pumping system is valved off and the internal pressure is monitored to see if the vacuum is stable (very little rise over time). This "pressure rebound test" is often characterized as being "passed" if the cask internal pressure does not rise over a one half hour period. Passage of the pressure rebound test indicates the cask can be backfilled with helium (typically a bit higher than atmospheric pressure). Then, the outer lid can be placed on the cask and the cask prepared for transport (i.e. leak check, decontamination, loading into the ISO-container [an intermodal steel container that can be shipped by rail, truck, air], loaded onto a trailer for transport).

NAC was contracted to perform a thermal analysis of the cask loading, vacuum drying, and shipment of the 25 sister rods fuel rods to a national laboratory (NAC 2014). Bounding properties (e.g. fuel burnup, cooling time) were provided to NAC and they used those values to calculate the maximum temperature of the fuel expected during these operations. Their analysis concluded the fuel (and clad) should not exceed 66 ºC (151 ºF) during these operations. This low temperature suggests the sister rods will arrive at a national laboratory without changes to the clad or fuel microstructure, as is desired.

The NAC-LWT will be shipped under the conditions of the cask Certificate of Compliance, using truck transport (see Figure 5-1). It is expected the transport from North Anna to INL will take no more than three days. Once at INL, a receiving inspection will be performed at the Materials and Fuels Complex (MFC) to ensure the cask seal has been maintained over the course of transport and no other tampering or damage has occurred.

Figure 5-1. NAC-LWT loaded in an ISO-container on a transport trailer demonstrating the transport configuration. The lid is not installed in this image, nor is the end-wall of the ISO-container.

6. CASK RECEIPT AND RETURN

6.1 NAC-LWT Cask Receipt

Once cleared at the MFC entrance, the truck is escorted to HFEF where the trailer is brought inside the HFEF truck lock for unloading. Figure 6-1 shows the unloading of a NAC-LWT in the HFEF. The NAC-LWT cask has been handled in the HFEF eight times since 2006, and the 25-rod container has also been handled at the facility. The HFEF has operating procedures for loading and unloading the cask's payload into the main hotcell. The main hotcell utilizes an argon atmosphere. The NAC-LWT must be vented to the radioactive ventilation system to install a "shutter shield" assembly that is used to mate the cask with the hotcell. The cask remains under air atmosphere for about one day during the unloading operations. Once the cask is mated to the main hotcell, the cask contents are again under inert atmosphere from the hotcell. The limited time of air exposure will have no negative effect on the fuel rods as the fuel is expected to be below 200 ºF.

Following receipt of the tractor-trailer in the truck lock, the ISO-container can be opened and the cask lifted free of the cask cradle. The cask is next lowered through a hatch-covered opening down into the cask transfer tunnel. The cask will be secured to the cask transfer cart for all further operations and until the cask is lifted out of the cask transfer tunnel for reloading into the ISO-container. Appendix C contains a series of diagrams that illustrate the loading/unloading sequence for the NAC-LWT in HFEF.

Figure 6-1. A NAC-LWT cask being unloaded in HFEF. The cask is lifted out of the ISO-container and lowered into the cask transfer tunnel and onto the cask transfer cart.

Once positioned, the cask will be accessed and the 25-rod container lifted and secured through the Window 1M cask access hatch of the HFEF main cell using the HFEF 1M1 Universal Support Fixture. The 25-rod container is shown in Figure 6-2. Each of the 25 fuel rods will be lifted one at a time with the Window 1M manipulators and have a Type D end fitting secured to it using the portable end fitting station (discussed in Section 4.1). Type D end fittings have an adjustable collet, allowing them to be used on the sister rods.

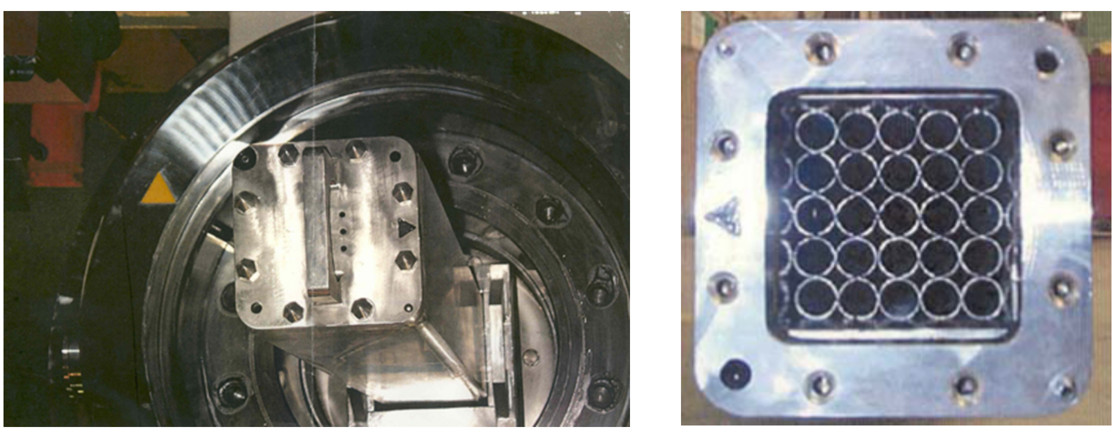


Figure 6-2. The 25-rod container in closed (left) and open (right) configuration.

Following attachment of the end fittings, the fuel rods will be secured in a 12-element container for protection and preservation. The 12-element containers are discussed in Section 4.1.

For transfer of the sister rods to 12-element[5] containers, the most efficient handling method is to unload the NAC-LWT 25-rod container immediately upon cask receipt. After fittings are installed onto the ends of fuel rods, fuel can be transferred from the NAC-LWT container to 12-element containers via a below-the-hook lifting attachment with gripper adapter attachment (see Appendix C, step 14). The 12-element container is capable of storing fuel rods with installed end fittings in a closed configuration. The container closure is a top hat-shaped lid that installs to a flange partway down the main container body.

[5] "12-element" is used throughout for convenience, even though the cans may be redesigned to hold 13 fuel rods.

Evaluating clearances, the interior of the 12-element container provides a plate with penetrations to hold the end fittings. There are 153.555 in (3900 mm) from this fixed point to the bottom of the 12-element container. There are 2.375 in (60 mm) of the end fitting above this fixed point. If a fuel rod could be inserted completely through the end fitting, the maximum fuel rod length that could be accommodated is (153.555 + 2.375 =) 155.93 in (3960 mm). However, the end fittings are not designed to allow full penetration. In fact, the "insertion depth" of a fuel rod into an end fitting is governed by a variable length "push rod" that is inserted into the end fitting with the fuel rod. By changing the length of the push rod, the user can choose where on the fuel rod the collet will be tightened. TPBARs that were ~154.15 in (3915 mm) long were stored in this container with 0.625 in (16 mm) clearance on the bottom. The TPBARs were inserted about 1.75" (44.5 mm) into the end fittings. The sister fuel rods are 152.795 in (3881 mm long). If the sister rods are inserted 1.75" (44.5 mm) into the end fittings, there will be ~2 in (51 mm) clearance between the end of the fuel rods and the bottom plate of the 12-element container.

The location of each fuel rod must be carefully tracked. Initially, the 12-element containers will be stored near the middle of the HFEF main cell in storage wells. As fuel rods are examined, there will come a time when some of the rods are sectioned for destructive examination. Small rod segments will be taken from the fuel rods leaving shorter sections that must be permanently marked/identified with their orientation and location within the fuel rod. These segments will be capped with end cap fittings, and then placed in pipe nipples for protection and preservation. The details of this marking will be included in a test plan that will guide the examination of each fuel rod.

6.2 NAC-LWT Cask Return

Following completion of the cask unloading, HFEF operations will replace the lid of the 25-rod container, and lower it back into the cask. Operations will perform the steps in Appendix C in reverse order to return the cask to the truck bay. Once the lid is bolted to the cask to seal it (seals will be replaced as needed), radiological surveys will be conducted to determine the presence of any residual contamination that might need cleaning. Following decontamination, the truck and trailer with the ISO-Container will be brought into the truck bay and the cask will be placed in the ISO-Container. A final radiological survey will be conducted and the shipping paperwork finalized. Once the shipping papers are in order, the transport can leave the HFEF and MFC and the cask delivered to NAC's facility in Pennsylvania.

7. PROJECT MANAGEMENT ACTIVITIES

7.1 Project Management

This work scope will be managed as a project in accordance with INL Project Management requirements. The project team has followed the guidance of General Project Management Methods: Section B, Technical Strategy. The purpose of this guide is to assure that activities necessary to develop a sound technical strategy are properly planned and documented. It is the responsibility of the project team to properly identify technical needs or the uncertainties associated with the sister rod receipt project while in the initiation phase. This allows the development of a sound technical strategy to successfully execute the project.

The Project Manager (PM) has overall responsibility for the technical, financial and schedule performance of the project, and for coordinating communications with the team members and INL management. The PM will direct the approval of all project generated documents unless otherwise stated and ensures compliance with regulatory and quality assurance (QA) requirements. The PM will issue a Project Execution Plan (PEP) that will guide the project through the execution phase.

7.2 Quality Assurance

A Quality Assurance Project Plan (QAPP) will be prepared for this work. INL has established a quality assurance program in compliance with NQA-1 as required by the INL prime contract with DOE. UFDC also has a quality assurance program that establishes requirements for UFD activities. The EPRI team has been informed by the NRC that the R&D Project is expected to be performed to a quality program that meets the requirements of 10CFR50 and 10CFR72 (NQA-1 meets those requirements). Because these programs will have different interpretations of the quality requirements needed to meet these regulations, a QAPP will be developed and concurrence sought from all customers/participants. Work will be performed according to approved procedures by trained personnel and documented in written records. These principles will be implemented in a manner that assures the quality of the work and allows flexibility in operations to accomplish project objectives. The program shall flow specific requirements to any and all subcontractors performing quality related activities such as evaluations, calculations, etc.

8. PROJECT ASSUMPTIONS AND RISK MITIGATION

The following assumptions were made in developing the preliminary cost and schedule estimate for sister rod receipt. These assumptions are those with the highest risk of potentially large impacts to project cost and schedule.

- The R&D Project led by EPRI will be responsible for the lease of the NAC-LWT and costs associated with all operations including the sister rod recovery from the North Anna Spent Fuel Pool, loading the cask, and transportation to, and return from, INL.
- Fuel rods should be easily removed from the 5x5 PWR basket in the NAC-LWT. No binding is expected and as such no special remote tooling should be required for these operations.
- The MAR impacts of the sister rods will be less than 10% of the facility MAR limit such that impacts do not require design of "closed metal containers."
- If a full dry run with the NAC-LWT becomes required for any reason, this project would become responsible for leasing the cask and all other costs associated with a dry run. The additional cost is shown in the high cost estimate.
- Major equipment maintenance and repair of items such as facility cranes and manipulators at HFEF will not be required. It is also assumed that any such repairs will be funded by INL and not by this project.
- The HFEF safety basis will not require a revision to support receipt of the sister rods.
- Air infiltration at the main cell cask transfer port will not be an issue during the unloading of sister rods from the NAC-LWT cask.
- Fuel rod cladding will be deemed intact per the HFEF safety basis even if pinhole defects are present in the cladding.

To mitigate the risks associated with these assumptions, the project has performed or will perform the following actions:

- Fuel rod "sticking" was investigated by interviewing facility operators who have previously removed PWR fuel rods from a similar basket at HFEF. NAC personnel were also questioned to verify that bowed fuel rods have not previously been an issue for removal from the cask payload basket. In both cases it was felt the risk of rod sticking was low. Therefore, no costs were included in the estimate to develop additional tools to remove any fuel rods that might not be easily removed from the cask.
- A preliminary MAR analysis has been performed to bound the impacts of 25 HBU PWR fuel rods with the HFEF operating MAR limits. This analysis suggests the impact will be minimal. A nuclear and criticality safety technical evaluation has been budgeted for and will be developed at project initiation and when more accurate sister rod data is available.
- NAC has provided a budgetary cost estimate for leasing of the NAC-LWT cask to support an HFEF dry run. These costs have been included in the high range cost estimate for sister rod receipt.

- HFEF manipulators and cranes will be available, in good repair, and not cause schedule delays. No additional project cost has been included for repair of manipulators and cranes.
- An Unresolved Safety Question (USQ) evaluation will be performed upon project initiation to confirm that no safety basis revisions will be needed (included in project cost estimate).
- Cask crew operations personnel and HFEF facility operators and managers were interviewed to determine if past cask handling operations have caused air infiltration issues at HFEF. Those discussions have suggested that careful preparation of the cask and hotcell can keep air in-leakage to the argon atmosphere main hotcell low. If air in-leakage were to increase, the facility has a plan for stopping work, and resealing the cask to the hotcell. Experience with similar casks was deemed sufficient for verification. No additional cost has been added to the estimate as a result.
- Preliminary interviews of MFC nuclear safety personnel confirmed that pinholes in fuel clad are acceptable when considering fuel cladding to be intact. This will help control the accident scenarios that are used when developing MAR estimates for the sister rod receipt. No storage cans capable of being exempting material from MAR have been added to the budget.

9. SCHEDULE

Attached in Appendix E is the project schedule that accounts for the major project activities. The total duration of the project is approximately 11 months. That amount of time assumes the project could be conducted from start to finish without interruption. In reality, the R&D Project has several fixed activities (i.e. fuel operations in the North Anna Spent Fuel Pool). These are reflected in Appendix E, which shows a 17 month project duration. The forecasted shipment date that fits the outage schedule of the North Anna reactor is February 2016. The project schedule indicates that there is substantial float available to accommodate meeting this delivery timeline assuming a start date early in the first quarter of FY 2015.

10. CONCLUSIONS

INL may be considered as a site for receiving the sister fuel rods from the R&D Project. The activities that must be completed to receive that fuel and place it in safe storage have been evaluated and documented. A schedule has been prepared to determine if those activities could be complete in time to support the R&D schedule. It was determined the activities could be complete in about 11 months, and, at the date of this report there are about 17 months remaining until the fuel rods would be shipped to a laboratory for characterization and analysis.

11. REFERENCES

PROCEDURES

- HFEF-OI-1020, "Criticality Hazards Control Statement"
- HFEF-OI-6205, "NAC-LWT Cask"
- LRD-11500, "Nuclear Materials Management, Control and Accountability Plan"
- MCP-9902, "Verification of Readiness to Start Up or Restart Nuclear Facilities"

NUCLEAR SAFETY DOCUMENTS

- HFEF-TSR, Rev. 5, "HFEF Technical Safety Requirements"

TECHNICAL EVALUATIONS

- TEV-1861, *Exemption of Cask Operations at MFC from the MCP-9902 Review Process*

CALCULATIONS

- NAC International, Inc., 2014. *Thermal Analysis for LWT Cask with High Burnup Fuel Rods, Appendix F, Thermal Analyses of the BEA PWR High Burn-Up Fuel Rod Packaging and Shipment Study*, Calculation Number 14829-315-3000, proprietary to NAC International, Inc.

CODES AND STANDARDS

- 10 CFR 50, "Domestic Licensing of Production and Utilization Facilities"
- 10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste"
- ASME NQA-1, "Quality Assurance Requirements for Nuclear Facility Applications"

Appendix A
2011 Memorandum of Agreement

MEMORANDUM OF AGREEMENT CONCERNING RECEIPT, STORAGE, AND HANDLING OF RESEARCH QUANTITIES OF COMMERCIAL SPENT NUCLEAR FUEL AT THE IDAHO NATIONAL LABORATORY

This Memorandum of Agreement (Agreement) is entered this 6th day of January 2011 between the United States Department of Energy (DOE) by and through the Manager and Designated Head of Contracting Activity for the DOE Idaho Operations Office and the State of Idaho by and through the Governor of the State of Idaho and the Idaho Attorney General (Idaho).

PURPOSE:

Consistent with the principles set forth in that certain Settlement Agreement and Order dated October 13, 1995 in the matter of Public Service Co. of Colorado v. Batt, No. CV 91-0035-S-EJL (D. Id.) and United States v. Batt, No. CV-91-0054-S-EJL (D. Id.) ("1995 Agreement"), the purpose of this Agreement is to provide for efficient and safe development of research capacities at the Idaho National Laboratory (INL) related to the next generation of nuclear reactor fuels while continuing to ensure Idaho does not become a defacto repository for the Nation's spent nuclear fuel from commercial nuclear power plants. For this reason the DOE and Idaho (collectively "the Parties") agree as follows:

RECITALS

WHEREAS, the United States is pursuing energy independence and research on energy processes which will reduce the amount of carbon dioxide generated in the energy cycle and it is anticipated that, to some degree, these goals will involve increased reliance on nuclear power; and

WHEREAS, the United States' ability to increase its reliance upon nuclear energy will, in turn, be dependent upon development of the next generation of nuclear fuels which will provide greater energy efficiency, reduced lifecycle costs and the generation of less waste; and

WHEREAS, the 1995 Agreement provides in section F that the INL is designated as the DOE Spent Fuel Lead Laboratory for the "research development and testing of treatment, shipment and disposal technologies for all DOE spent fuel" and provides for the receipt of DOE spent nuclear fuel for research purposes; and

WHEREAS, in furtherance of this mission, the INL has developed and possesses unique technologies and capabilities which will further the research development and testing of new fuel types and technologies; and

WHEREAS, in 2002 the DOE designated the INL as the Nation's lead laboratory for nuclear energy research; and

WHEREAS, section D.2.e of the 1995 Agreement restricts the INL from accepting any shipments of "spent fuel from commercial nuclear power plants" (Commercial Power SNF) impeding INL from utilizing its unique capabilities and technologies to assist in the important work of research and development of the next generation of commercial fuel technology, slowing that development and making it more costly to the American public; and

WHEREAS, the Parties concur that legitimate research conducted at the INL in furtherance of safe and efficient nuclear power production, including research on commercial spent nuclear fuel, is consistent with the spirit and intent of the 1995 Agreement; and

WHEREAS, section J.1 of the 1995 Agreement provides that Idaho, in its sole discretion, may waive portions of the 1995 Agreement; and

WHEREAS, Idaho will continue to insist upon the safe management of spent nuclear fuel and nuclear waste and the ultimate disposition of such materials outside of the State of Idaho;

NOW THEREFORE IT IS HEREBY AGREED:

1. This Agreement is terminable at will in the sole and exclusive discretion of the State of Idaho upon written notice to the DOE and no implied covenant of good faith and fair dealing shall be applicable to Idaho's decision to exercise this right.

2. Pursuant to the terms and conditions of this Agreement and solely for the purpose of research conducted at the INL; Idaho in its sole and exclusive discretion, grants a conditional waiver of the section D.2.e prohibition on the shipment of spent nuclear fuel from commercial nuclear power plants to the INL.

Specific Conditions

3. Limits and Material Management:

(a) INL may receive for the purpose of research and examinations conducted at the INL research quantities of Commercial Power SNF. For purposes of this Agreement "research quantities" shall mean only those quantities of Commercial Power SNF necessary for the specific research project for which the shipment to INL is made. This will be documented pursuant to paragraph 6 below.

(b) As further limitation, not more than 400 kilograms total heavy metal content of Commercial Power SNF may be received in any calendar year. This will be documented pursuant to paragraph 6 below.

(c) A shipment of Commercial Power SNF to INL will count as a shipment of DOE SNF for purposes of the annual shipment limits contained in section D.2.f of the 1995 Agreement for each calendar year in which such shipment occurs.

(d) The amount of Commercial Power SNF, measured in fractions of metric tons heavy metal (MTHM), including the equivalent amount contained in any wastes generated during research, remaining on site at the end of each calendar year will count toward the total metric tonnage limits for DOE SNF contained in section D.2.c of the 1995 Agreement. However, equivalent amounts of MTHM contained in any wastes generated during research that are shipped off-site in subsequent years may be deducted from the total metric tonnage limits for DOE SNF contained in section D.2.c of the 1995 Agreement.

(e) The Commercial Power SNF will be stored in appropriate SNF storage and will be managed as SNF until shipped off-site in compliance with the 2035 shipment deadline of the 1995 Agreement.

(f) Nothing in this Agreement shall be construed to allow DOE to exceed the 55 MTHM limit for SNF allowed by the 1995 Agreement.

4. <u>Management of wastes generated during examination</u>: Wastes generated during the research activity will be managed dependent upon the nature of research conducted in the form of destructive or non-destructive examination. Material that is classified as transuranic or low level waste may be consolidated with other laboratory wastes and managed appropriately.

5. <u>Library Storage for Future Research</u>: DOE shall further be permitted to keep a library of spent fuel types at the INL consisting of materials brought to INL under Paragraph 3. At no time shall the library contain an amount more than ten (10) kilograms total heavy metal which shall be documented pursuant to paragraph 6 of this Agreement.

(a) Said library of materials shall be solely for the purpose of retaining existing samples for future research at the INL.

(b) All materials kept in library storage shall count towards the over-all limit established by Section D.2.c of the 1995 Settlement Agreement and nothing in this Agreement shall be construed to allow DOE to exceed that limit.

(c) Library storage of the research quantities of SNF at the INL shall be permitted only for the duration of this Agreement and only so long as INL continues to be designated as the DOE lead laboratory for nuclear energy research.

6. Notification and Reporting:

(a) Prior to January 1 of each calendar year the DOE will notify Idaho of potential receipts of Commercial Power SNF to be shipped to the INL during the following calendar year pursuant to this Agreement. Such notification will specify:

(i) the source of Commercial Power SNF,

(ii) the amount of MTHM contained in each shipment,

(iii) the research purpose for each shipment including documentation showing that a research project has been authorized, contracted or funded,

(iv) the schedule for completion of the research project,

(v) the anticipated volume of waste to be generated by the research, and

(vi) The potential disposition path for remaining SNF material.

(b) By not later than January 31 of each calendar year Idaho will be notified of the amounts of Commercial Power SNF actually received in the previous calendar year. The DOE will further provide a report updating the information concerning previous shipments and research projects including the information contained in paragraph 6.a.(i-vi) above related to each shipment.

(c) By not later than January 31 of each calendar year the DOE will provide a report on the status of the library of Commercial Power SNF kept at INL pursuant to paragraph 5 above, including the following:

(i) The total amount of material in library storage;

(ii) The source of each material in library storage;

(iii) The amount of each material in library storage specific to each source or fuel type;

(iv) The anticipated future research related to each type and amount of material in library storage; and

(v) The anticipated date upon which research related to each type and amount of material in library storage will occur.

(d) A separate copy of all reports and or notifications required by this Agreement shall be submitted to Idaho at the following addresses:

Idaho Department of Environmental Quality
Attn: Director
1410 N. Hilton
Boise Idaho 83706

Idaho Department of Environmental Quality
Attn: INL Oversight Program
1410 N. Hilton
Boise Idaho 83706

Office of the Idaho Attorney General,
Natural Resources Section
700 W. State Street
P.O. Box 83720
Boise Idaho 83720-0010

7. This Agreement reflects a conditional waiver of section D.2.e of the 1995 Agreement related to the shipment of research quantities of Commercial Power SNF to Idaho. This Agreement shall not be construed to alter or amend any provisions of the 1995 Agreement.

8. All Commercial Power SNF shipped to Idaho pursuant to this Agreement and stored at the INL for any reason shall be removed from Idaho in accordance with the deadline set forth in section C.1 of the 1995 Agreement.

9. If for any reason this Agreement is terminated by either party or if the mission of the INL is changed and it loses its lead laboratory for nuclear energy status, shipments of research quantities of Commercial Power SNF shall cease immediately and all SNF stored or otherwise located at the INL shall be removed from Idaho in accordance with the deadline set forth in section C.1 of the 1995 Agreement.

DATED this 6 day of January, 2011.

Richard B. Provencher
Manager, Idaho Operations Office
United States Department of Energy

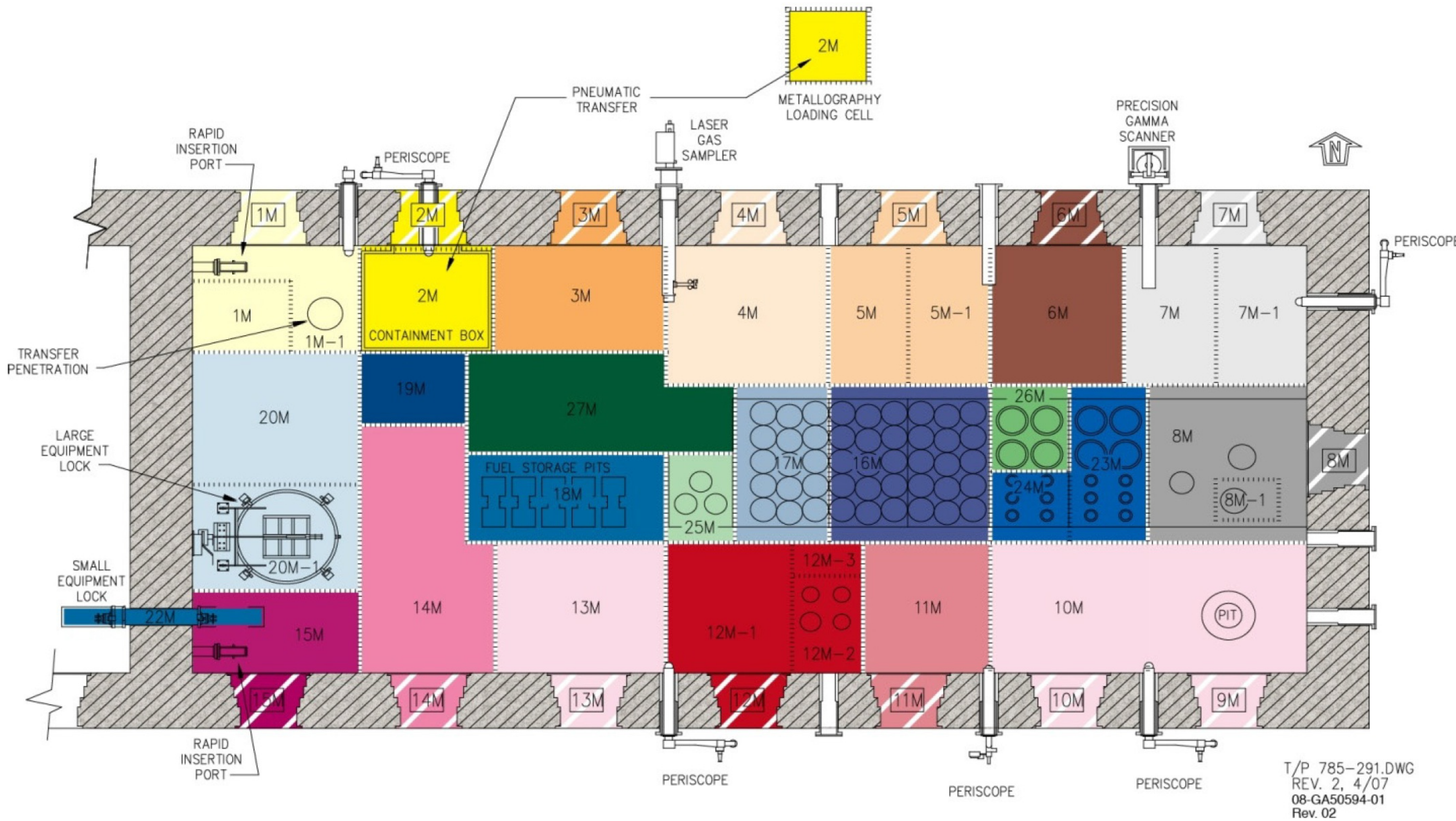
DATED this 6 day of January, 2011.

C. L. "Butch" Otter
Governor of Idaho

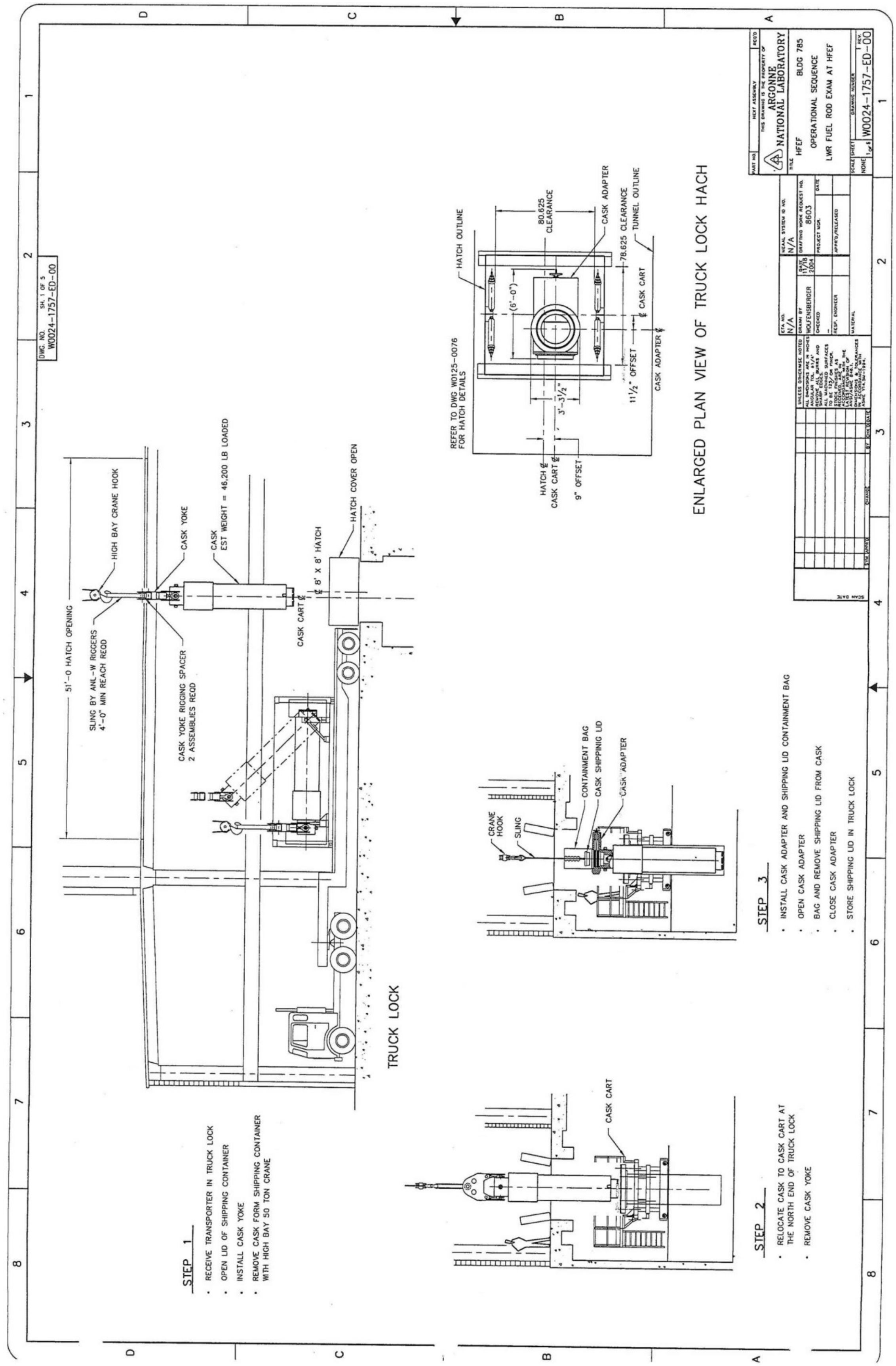
DATED this 6th day of January, 2011.

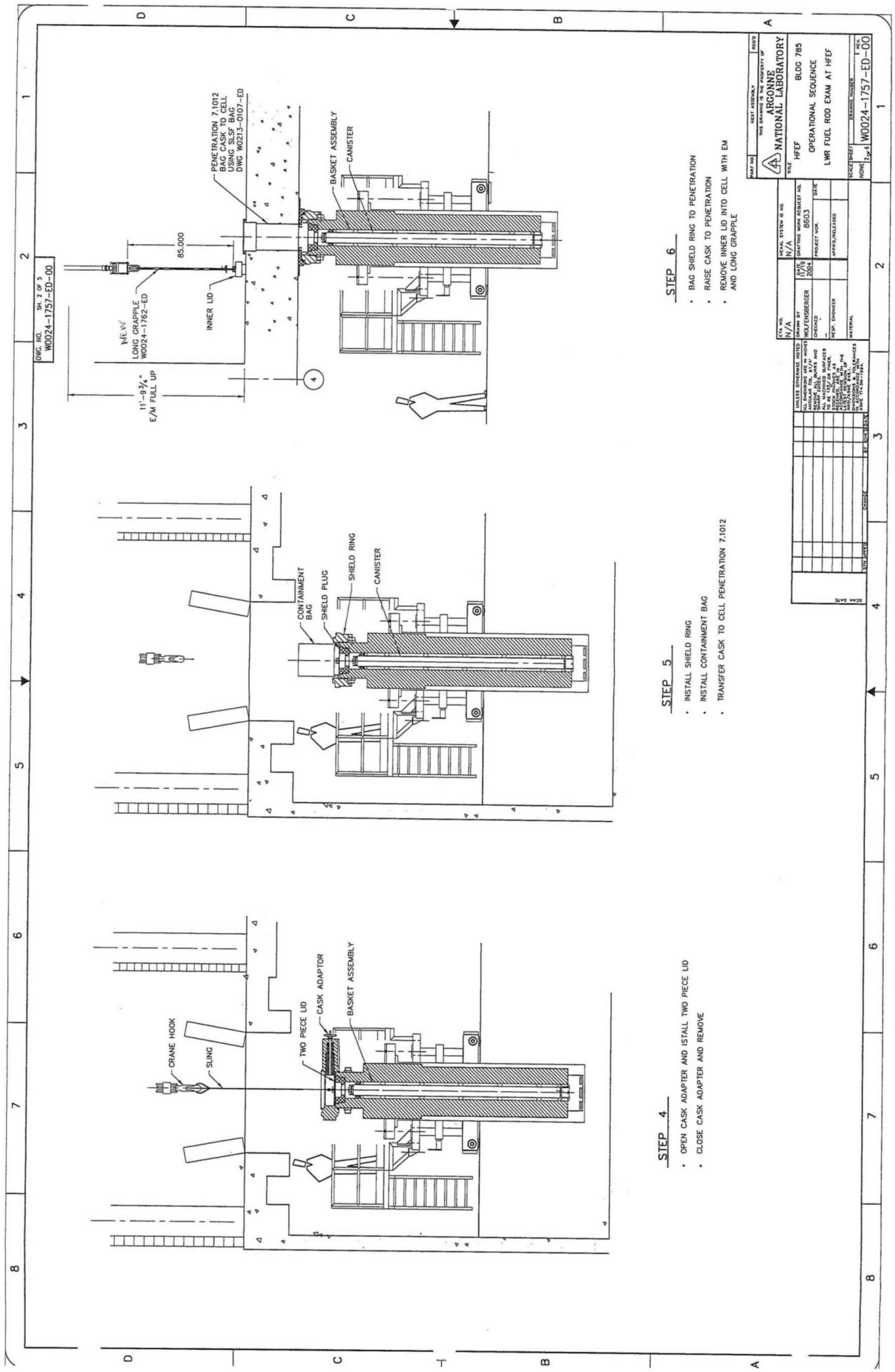
Lawrence Wasden
Idaho Attorney General

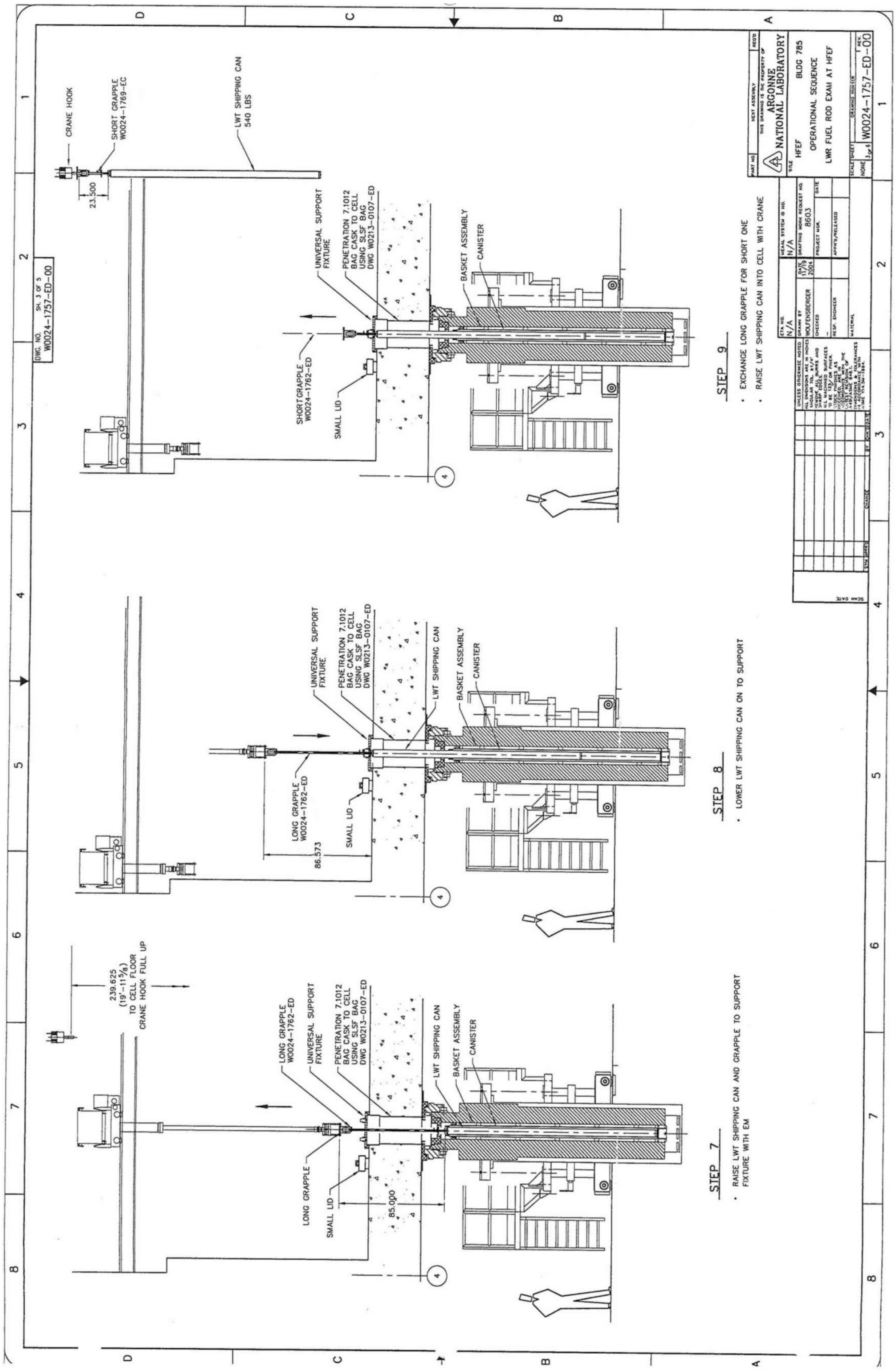
Appendix B
HFEF Main Cell Criticality Control Zone Map

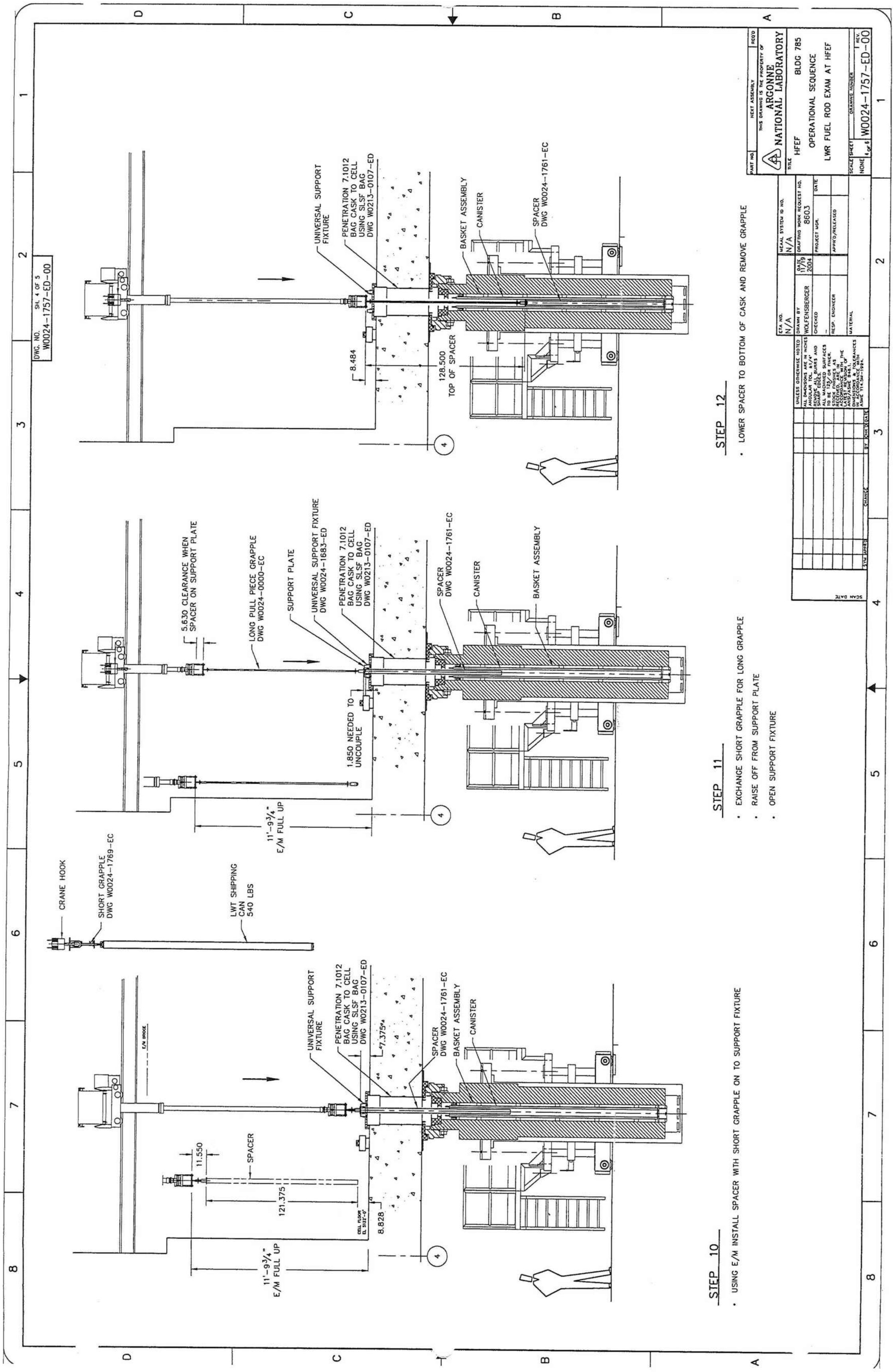


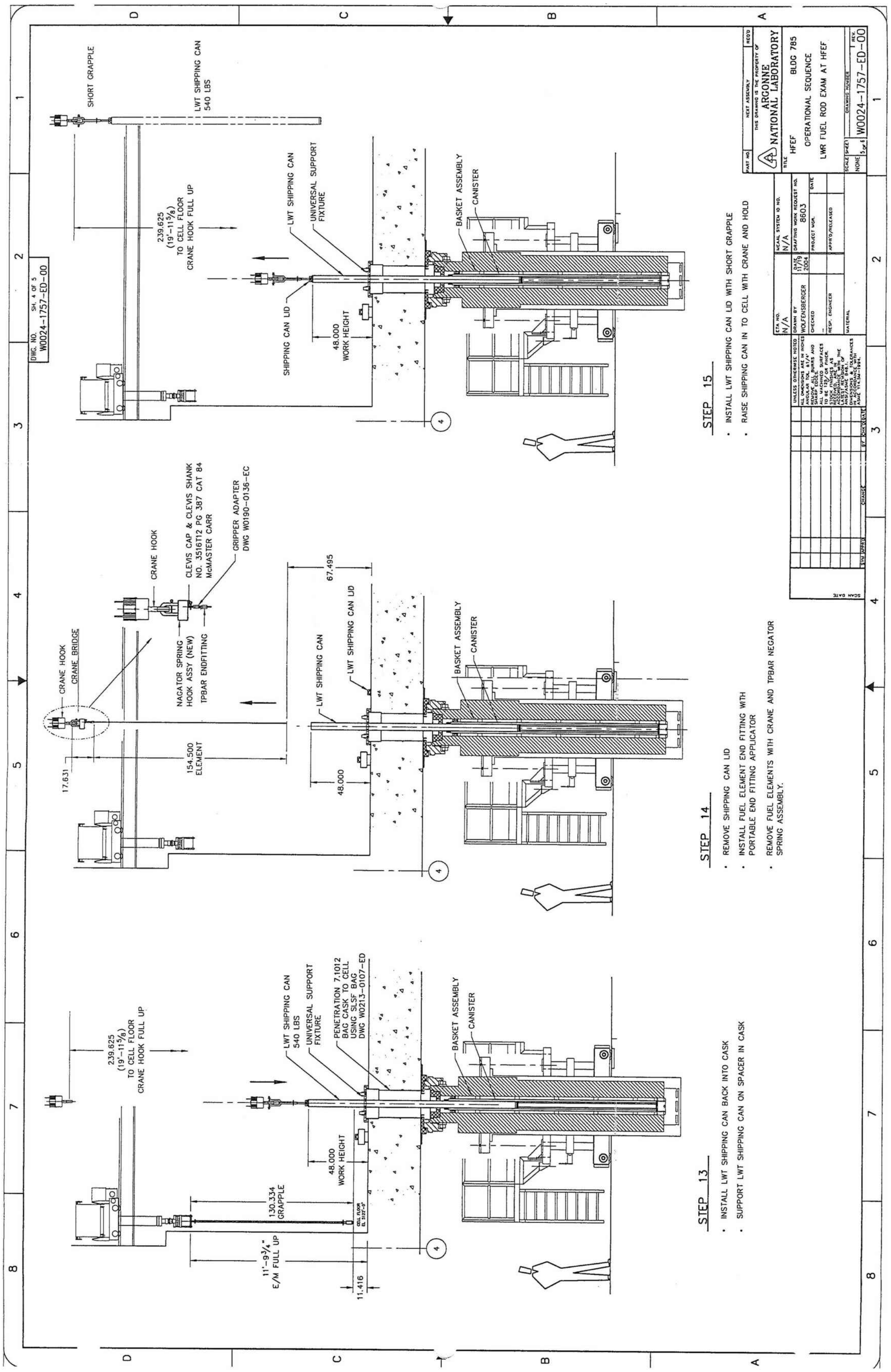
Appendix C
Operational Sequence for Handling the NAC-LWT Cask

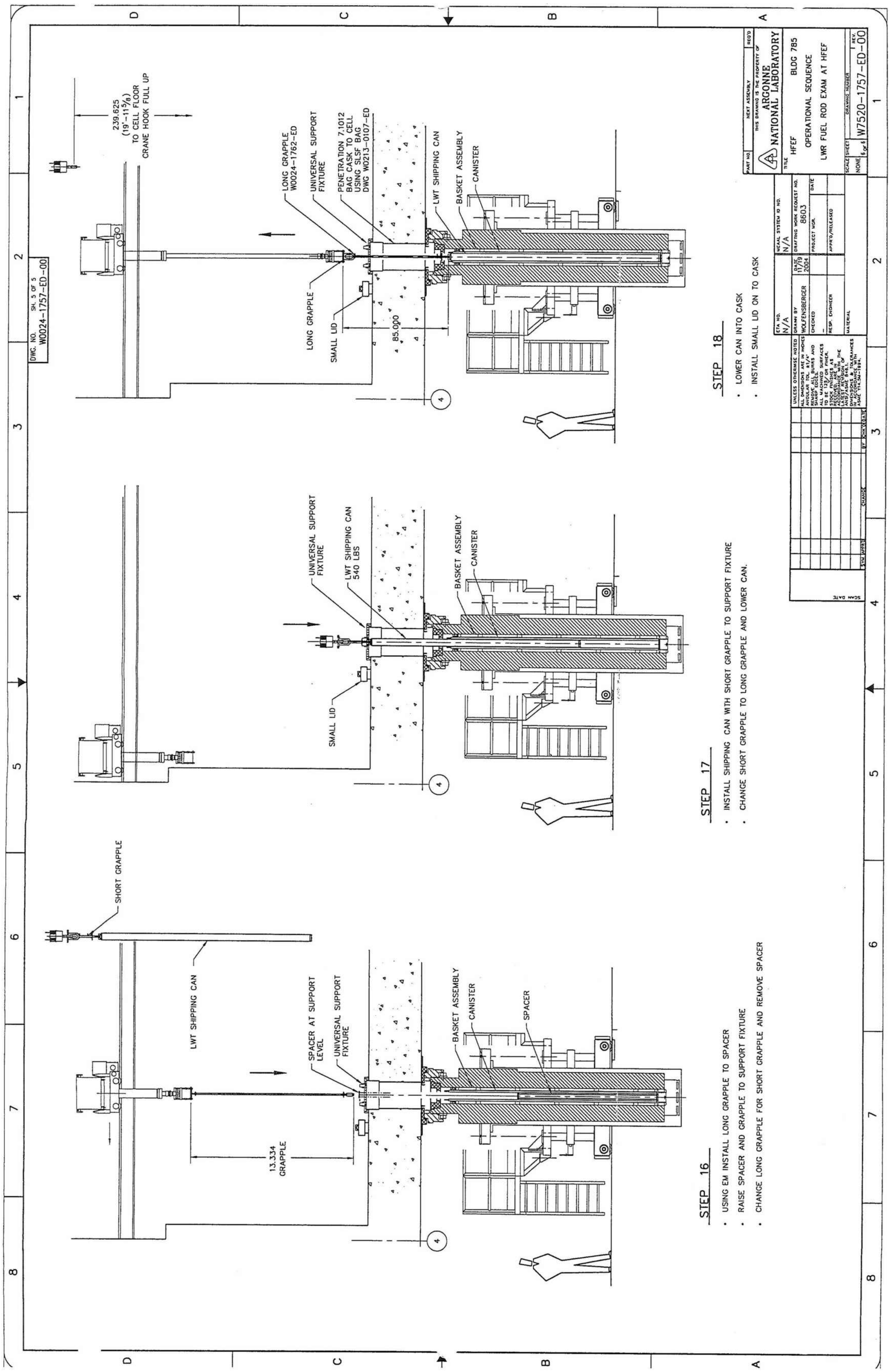

DWG. NO. W0024-1757-ED-00 SH. 1 OF 5
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
W0024-1757-ED-00
ENLARGED PLAN VIEW OF TRUCK LOCK HACH
REFER TO DWG W0125-0076 FOR HATCH DETAILS
HATCH OUTLINE
80.625 CLEARANCE
CASK ADAPTER
78.625 CLEARANCE
TUNNEL OUTLINE
CASK CART ℄
CASK ADAPTER ℄
11 1/2" OFFSET
3'-3 1/2"
(6'-0")
HATCH ℄
CASK CART ℄
9" OFFSET
51'-0 HATCH OPENING
SLING BY ANL-W RIGGERS 4'-0" MIN REACH REQD
HIGH BAY CRANE HOOK
CASK YOKE
CASK EST WEIGHT = 46,200 LB LOADED
CASK YOKE RIGGING SPACER 2 ASSEMBLIES REQD
CASK CART ℄
℄ 8' X 8' HATCH
HATCH COVER OPEN
TRUCK LOCK
STEP 1
RECEIVE TRANSPORTER IN TRUCK LOCK
OPEN LID OF SHIPPING CONTAINER
INSTALL CASK YOKE
REMOVE CASK FORM SHIPPING CONTAINER WITH HIGH BAY 50 TON CRANE
CASK CART
STEP 2
RELOCATE CASK TO CASK CART AT THE NORTH END OF TRUCK LOCK
REMOVE CASK YOKE
CRANE HOOK
SLING
CONTAINMENT BAG
CASK SHIPPING LID
CASK ADAPTER
STEP 3
INSTALL CASK ADAPTER AND SHIPPING LID CONTAINMENT BAG
OPEN CASK ADAPTER
BAG AND REMOVE SHIPPING LID FROM CASK
CLOSE CASK ADAPTER
STORE SHIPPING LID IN TRUCK LOCK


STEP 4
· OPEN CASK ADAPTER AND ISTALL TWO PIECE LID
· CLOSE CASK ADAPTER AND REMOVE
CRANE HOOK
SLING
TWO PIECE LID
CASK ADAPTOR
BASKET ASSEMBLY
STEP 5
· INSTALL SHIELD RING
· INSTALL CONTAINMENT BAG
· TRANSFER CASK TO CELL PENETRATION 7.1012
CONTAINMENT BAG
SHIELD PLUG
SHIELD RING
CANISTER
STEP 6
· BAG SHIELD RING TO PENETRATION
· RAISE CASK TO PENETRATION
· REMOVE INNER LID INTO CELL WITH EM AND LONG GRAPPLE
PENETRATION 7.1012 BAG CASK TO CELL USING SLSF BAG DWG W0213-0107-ED
BASKET ASSEMBLY
CANISTER
85.000
INNER LID
NEW LONG GRAPPLE W0024-1762-ED
11'-9¾" E/M FULL UP
DWG. NO. SH. 2 OF 5 W0024-1757-ED-00
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
W0024-1757-ED-00
N/A
8603


DWG. NO. W0024-1757-ED-00 SH. 3 OF 5
CRANE HOOK
SHORT GRAPPLE W0024-1769-EC
LWT SHIPPING CAN 540 LBS
23.500
UNIVERSAL SUPPORT FIXTURE
PENETRATION 7.1012 BAG CASK TO CELL USING SLSF BAG DWG W0213-0107-ED
SHORT GRAPPLE W0024-1762-ED
SMALL LID
BASKET ASSEMBLY
CANISTER
STEP 9
EXCHANGE LONG GRAPPLE FOR SHORT ONE
RAISE LWT SHIPPING CAN INTO CELL WITH CRANE
LWT SHIPPING CAN
LONG GRAPPLE W0024-1762-ED
86.573
STEP 8
LOWER LWT SHIPPING CAN ON TO SUPPORT
239.625 (19'-11 5/8) TO CELL FLOOR CRANE HOOK FULL UP
LONG GRAPPLE
85.000
STEP 7
RAISE LWT SHIPPING CAN AND GRAPPLE TO SUPPORT FIXTURE WITH EM
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
W0024-1757-ED-00


DWG. NO. W0024-1757-ED-00 SH. 4 OF 5
STEP 10
USING E/M INSTALL SPACER WITH SHORT GRAPPLE ON TO SUPPORT FIXTURE
STEP 11
EXCHANGE SHORT GRAPPLE FOR LONG GRAPPLE
RAISE OFF FROM SUPPORT PLATE
OPEN SUPPORT FIXTURE
STEP 12
LOWER SPACER TO BOTTOM OF CASK AND REMOVE GRAPPLE
CRANE HOOK
SHORT GRAPPLE DWG W0024-1769-EC
LWT SHIPPING CAN 540 LBS
UNIVERSAL SUPPORT FIXTURE
PENETRATION 7.1012 BAG CASK TO CELL USING SLSF BAG DWG W0213-0107-ED
SPACER DWG W0024-1761-EC
BASKET ASSEMBLY
CANISTER
SPACER
11'-9¾" E/M FULL UP
11.550
121.375
8.828
7.375
LONG PULL PIECE GRAPPLE DWG W0024-0000-EC
SUPPORT PLATE
UNIVERSAL SUPPORT FIXTURE DWG W0024-1683-ED
5.630 CLEARANCE WHEN SPACER ON SUPPORT PLATE
1.850 NEEDED TO UNCOUPLE
8.484
128.500 TOP OF SPACER
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
W0024-1757-ED-00
WOLFENSBERGER
8603


STEP 13
INSTALL LWT SHIPPING CAN BACK INTO CASK
SUPPORT LWT SHIPPING CAN ON SPACER IN CASK
LWT SHIPPING CAN 540 LBS
UNIVERSAL SUPPORT FIXTURE
PENETRATION 7.1012 BAG CASK TO CELL USING SLSF BAG DWG W0213-0107-ED
BASKET ASSEMBLY
CANISTER
239.625 (19'-11⅝) TO CELL FLOOR CRANE HOOK FULL UP
130.334 GRAPPLE
48.000 WORK HEIGHT
11'-9¾" E/M FULL UP
11.416
STEP 14
REMOVE SHIPPING CAN LID
INSTALL FUEL ELEMENT END FITTING WITH PORTABLE END FITTING APPLICATOR
REMOVE FUEL ELEMENTS WITH CRANE AND TPBAR NEGATOR SPRING ASSEMBLY.
CRANE HOOK
CRANE BRIDGE
NAGATOR SPRING HOOK ASSY (NEW)
TPBAR ENDFITTING
CLEVIS CAP & CLEVIS SHANK NO. 3516T12 PG 387 CAT 84 McMASTER CARR
GRIPPER ADAPTER DWG W0190-0136-EC
LWT SHIPPING CAN
LWT SHIPPING CAN LID
17.631
154.500 ELEMENT
67.495
48.000
STEP 15
INSTALL LWT SHIPPING CAN LID WITH SHORT GRAPPLE
RAISE SHIPPING CAN IN TO CELL WITH CRANE AND HOLD
SHORT GRAPPLE
LWT SHIPPING CAN 540 LBS
SHIPPING CAN LID
48.000 WORK HEIGHT
DWG. NO. W0024-1757-ED-00 SH. 4 OF 5
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
WOLFENSBERGER
8603
W0024-1757-ED-00


STEP 16
USING EM INSTALL LONG GRAPPLE TO SPACER
RAISE SPACER AND GRAPPLE TO SUPPORT FIXTURE
CHANGE LONG GRAPPLE FOR SHORT GRAPPLE AND REMOVE SPACER
STEP 17
INSTALL SHIPPING CAN WITH SHORT GRAPPLE TO SUPPORT FIXTURE
CHANGE SHORT GRAPPLE TO LONG GRAPPLE AND LOWER CAN.
STEP 18
LOWER CAN INTO CASK
INSTALL SMALL LID ON TO CASK
SHORT GRAPPLE
LWT SHIPPING CAN
SPACER AT SUPPORT LEVEL
UNIVERSAL SUPPORT FIXTURE
BASKET ASSEMBLY
CANISTER
SPACER
13.334 GRAPPLE
SMALL LID
LWT SHIPPING CAN 540 LBS
LONG GRAPPLE
LONG GRAPPLE W0024-1762-ED
PENETRATION 7,1012 BAG CASK TO CELL USING SLSF BAG DWG W0213-0107-ED
85.000
239.625 (19'-11⅝) TO CELL FLOOR CRANE HOOK FULL UP
DWG. NO. W0024-1757-ED-00 SH. 5 OF 5
ARGONNE NATIONAL LABORATORY
HFEF BLDG 785
OPERATIONAL SEQUENCE
LWR FUEL ROD EXAM AT HFEF
W7520-1757-ED-00
WOLFENSBERGER
8603

Appendix D
Equipment to be Fabricated in Support of Fuel Receipt for UFD

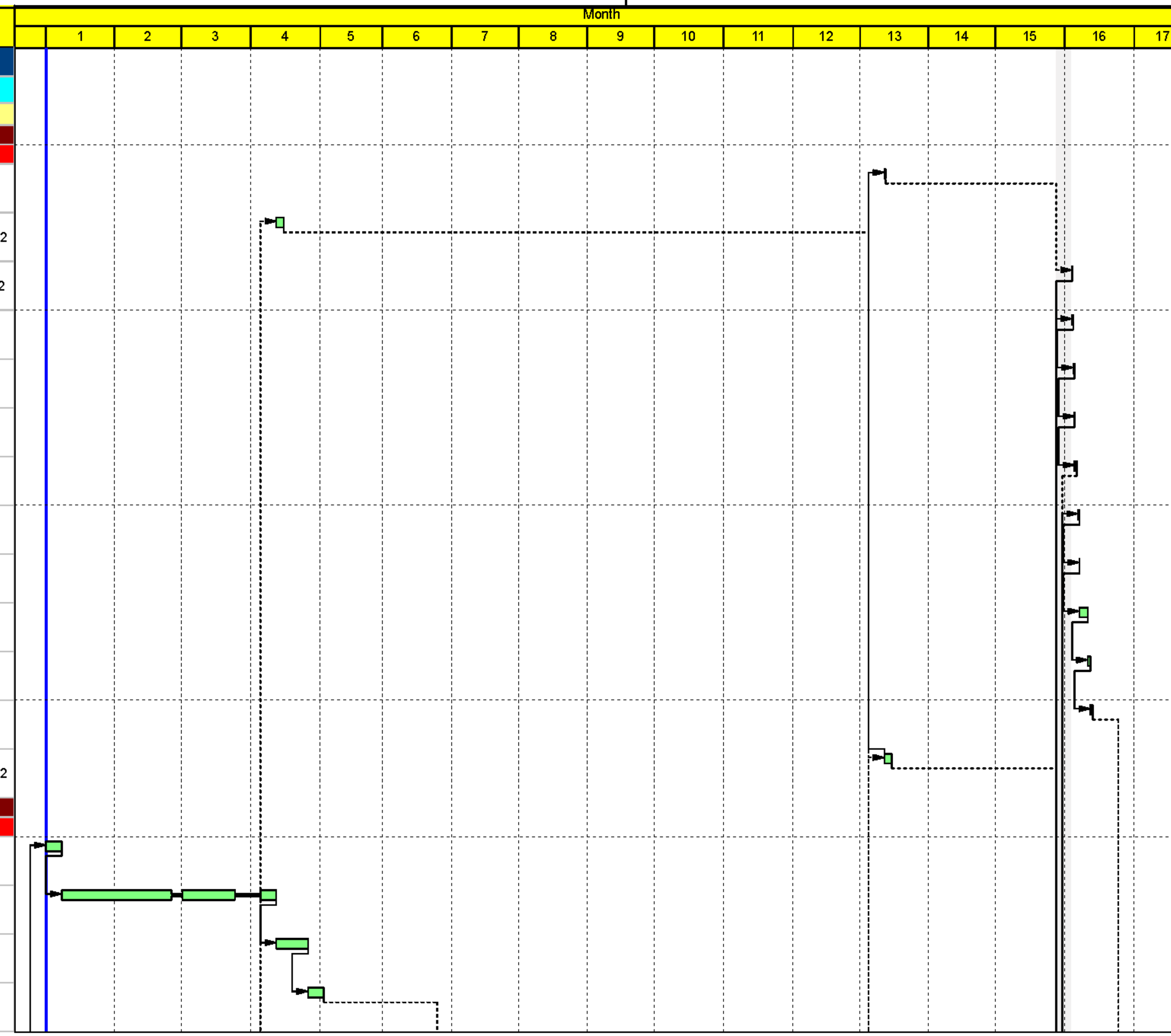
Name	Qty	Drawings	Use
Spacer	1	W0024-1761-ED-00	Installed in cask penetration. LWT shipping container is placed on the spacer to allow for end fitting installation
12-Element Canister	2	W0024-1549-ED-00 W0024-1690-ED-00 W0024-1690-PL-00 W0024-1691-ED-00 W0024-1700-ED-00 W0024-1581-EB-00	Fuel rod storage
Type-D End fitting	28	W0024-0147-PL W0024-0147-DC W0024-0149-DC W0024-0153-DC W0024-0166-DB W0024-1389-EC	Attaches to end of fuel rod to allow for lifting
Negator Spring Hook	3	W0024-1550-PL-00 W0024-1550-ED-00 W0024-1551-ED-00 W0024-1552-EC-00 W0024-1553-EC-00	Installed below crane hook, attaches to gripper adapter
Gripper	3	W0190-0136-PL W0190-0136-EC W0190-0137-EC W0190-0138-EC W0190-0139-EC	Attaches to end fitting and installs to negator spring hook for overhead crane lists
Long NAC-LWT Insert Grapple	1	W0024-1762-ED-00 W0024-1762-PL-00 W0024-1763-ED-00 W0024-1764-EC-00 W0024-1765-EB-00 W0024-1767-EC-00	Attaches to NAC-LWT insert and used to lift the insert with the hotcell crane
Short NAC-LWT Insert Grapple	1	W0024-1765-EB-00 W0024-1769-PL-00 W0024-1769-EC-00 W0024-1770-EC-00	Attaches to NAC-LWT insert and used to lift the insert with the hotcell crane

Appendix E
Project Schedule

UFD - Detailed Field Schedule

Estimated Cost and Schedule for Sister Rod Receipt

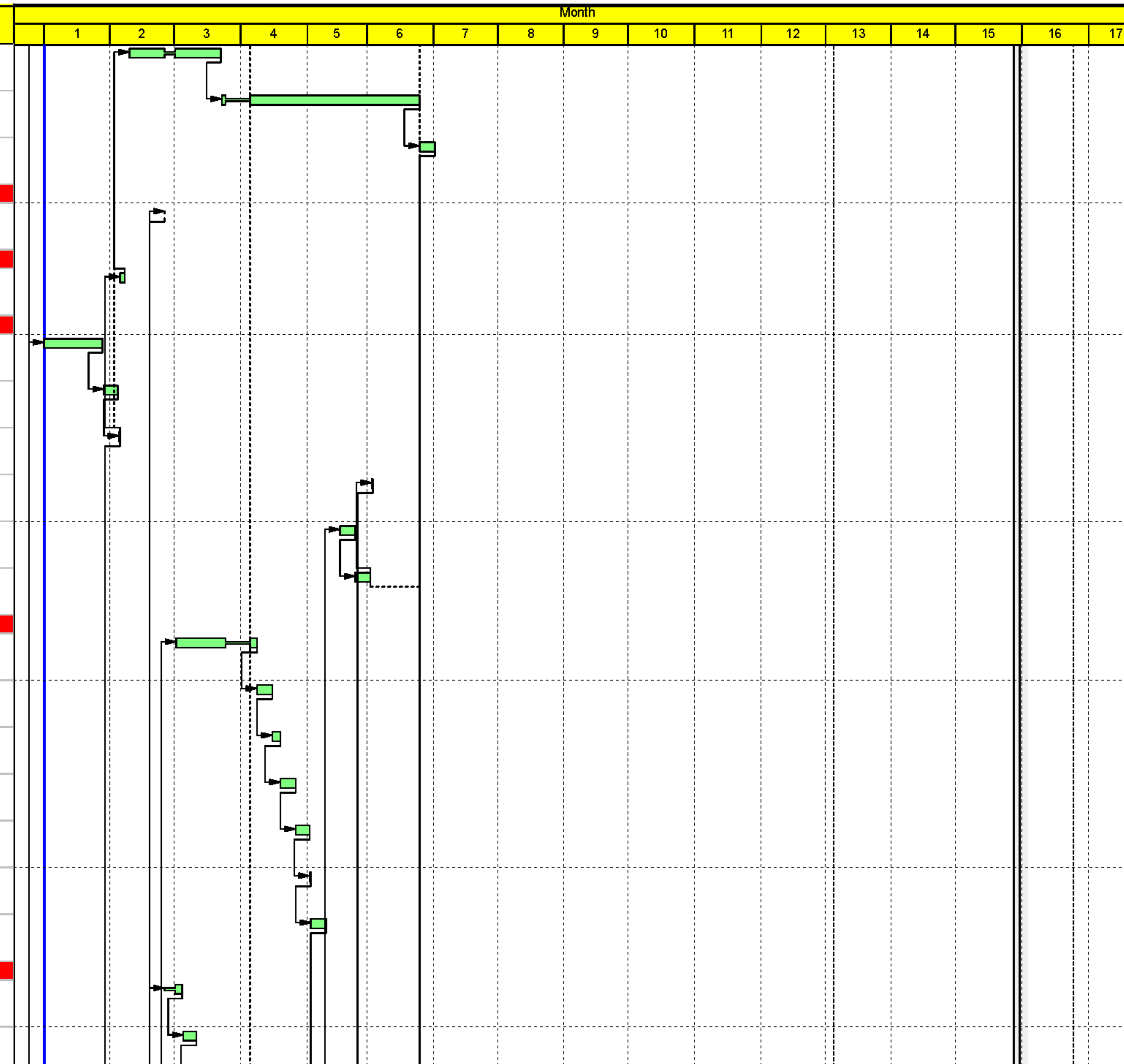
Activity ID	Activity Description	Orig Dur	Predecessors	Successors	Resource IDs
Total		303.2d			
Estimated Cost and Schedule for Sister R		303.2d			
Used Fuel Disposition - Sister Rod Receipt		303.2d			
Supporting Sister Rod Activities @ North Anna		226.1d			
Supporting Sister Rod Activities @ North Anna		226.1d			
UFD-1720	Walkdown facility and identify fuel element-handling/packaging/cask-loadi steps	0.4d	UFD-2431	UFD-2110	X19C0G66
UFD-1730	Witness AREVA Loading	4.0d	UFD-0100	UFD-2431	X19C0G66, F34GBG56, NJ12
UFD-2110	Witness packaging PWR Rod Transport Canister into Cask	0.4d	UFD-1720	UFD-2140, UFD-2050	P33B3G56, X19C0G66, NJ12
UFD-2140	Witness Cask Sealing and Vaccuum Drying	0.4d	UFD-2110	UFD-2150	P33B3G56, X19C0G66
UFD-2150	Witness Cask Loading into ISO Container	0.4d	UFD-2140	UFD-2160	P33B3G56, X19C0G66
UFD-2160	Witness application of TID	0.4d	UFD-2150	UFD-2165	P33B3G56, X19C0G66
UFD-2165	Witness and Obtain Results of Rad Survey of Cask and ISO Container	0.4d	UFD-2160	UFD-2170	P33B3G56, X19C0G66
UFD-2170	Witness Transport Vehicle Inspection	0.4d	UFD-2165, UFD-2130	UFD-2180	P33B3G56, X19C0G66
UFD-2180	Obtain Copy of Final Documentation for the Carrier	0.4d	UFD-2170	UFD-2190	P33B3G56
UFD-2190	Obtain Record of Date & Time of Departure	1.0d	UFD-2180	UFD-2200	P33B3G56
UFD-2200	Obtain Copy of Report per 10CFR71.97	1.0d	UFD-2190	UFD-2240	P33B3G56
UFD-2240	Confirm Receipt of 7-Day Notification Letters with State & Tribes	1.0d	UFD-2200	UFD-2266	P33B3G56
UFD-2431	Witness Westinghouse Loading	4.0d	UFD-1450, UFD-1730	UFD-1720, UFD-1520	X19C0G66, F34GBG56, NJ12
HFEF Preparation		131.5d			
Fabrication of Parts in Advance of Fuel Receipt		98.5d			
UFD-1000	Fabricate Negator Spring Hooks @ FCF Mockup Shop	4.0d	UFD-0100	UFD-1010	T04J1G54
UFD-1010	Fabricate Gripper, Spacer, Short Grapples, Spare End Fitting Applicator& End Fittings	48.6d	UFD-1000	UFD-1020	U26J1G54
UFD-1020	Fabricate Long Grapples	8.0d	UFD-1010	UFD-1030	U26J1G54
UFD-1030	Mock Up Test Parts	4.0d	UFD-1020	UFD-1260	T04J1G54



Actual Work
Critical Remaining Work
Remaining Work
Milestone

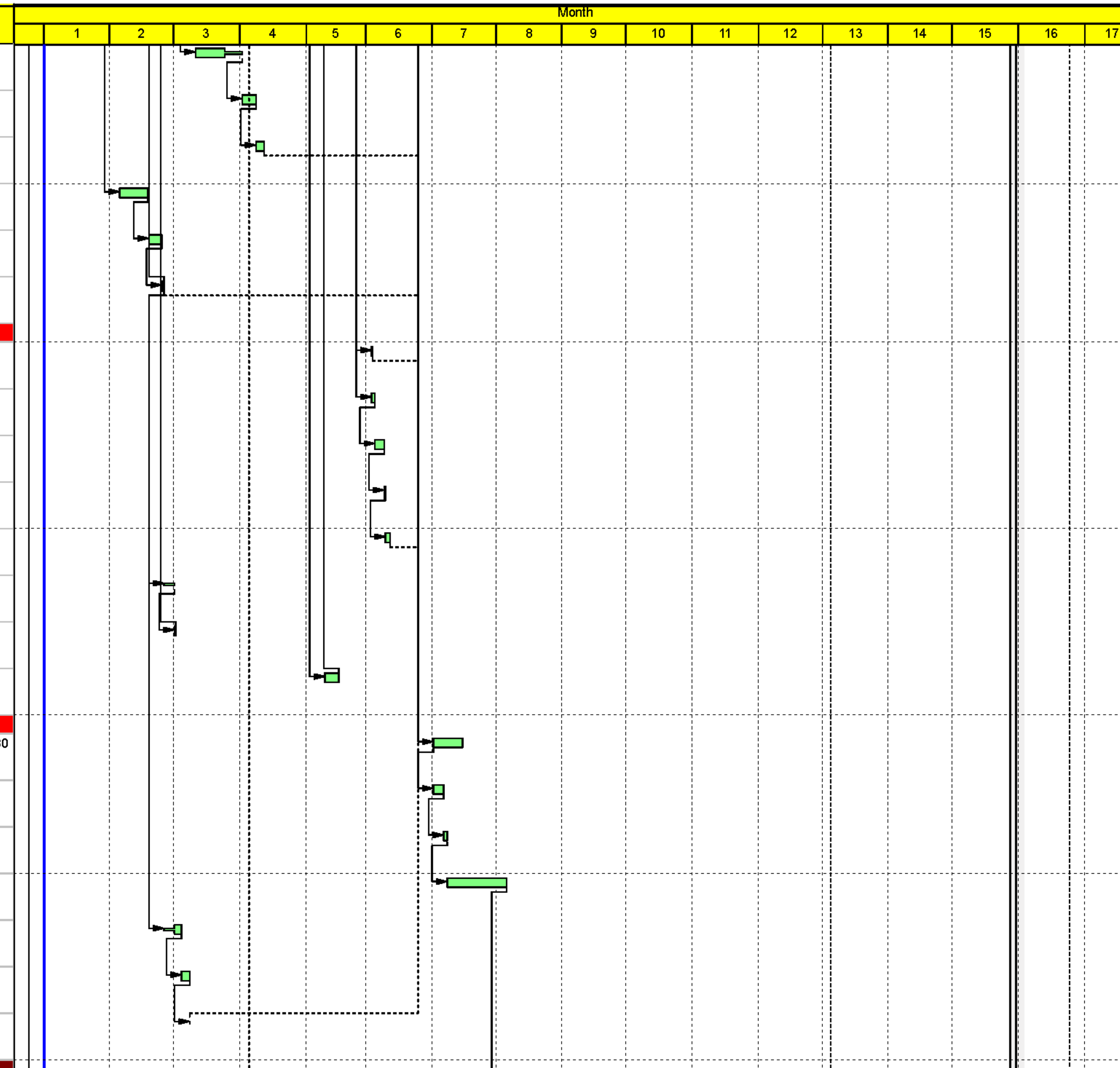
Page 1 of 5

Activity ID	Activity Description	Orig Dur	Predecessors	Successors	Resource IDs
UFD-1045	Design Modification to 12 Element Container (Closed Metal Container)	24.0d	UFD-1093, UFD-1094	UFD-1050	E14C1G58, T03W1G54
UFD-1050	Fabricate 12 Element Container	48.6d	UFD-1045	UFD-1070	U26J1G54
UFD-1070	Mock Up Test Parts	4.0d	UFD-1050	UFD-1260	T04J1G54
Safeguards and Security		0.4d			
UFD-1105	Initiate Engineering Job	0.4d	UFD-1314	UFD-1095	E48W4G56
Criticality Control		2.0d			
UFD-1094	Revision to HFEF Criticality Hazard Control Statement (CHCS)	2.0d	UFD-1093	UFD-1045	E31W2G60
Nuclear Safety		91.8d			
UFD-1090	Author TEV to Address S&S, Crit, Nuc Safety Requirements	17.8d	UFD-0100	UFD-1092	F34GBG56
UFD-1092	Review TEV to Address S&S, Crit, Nuc Safety Requirements	4.0d	UFD-1090	UFD-1093	F34GBG56
UFD-1093	Obtain TEV Approval	0.9d	UFD-1092	UFD-1045, UFD-1094, UFD-1310	F34C6G56
UFD-1100	Perform USQ Screening	1.0d	UFD-1220	UFD-1110, UFD-1120	E63W4G58
UFD-1210	Conduct ALARA Review	4.0d	UFD-1200	UFD-1220	E18H6G56
UFD-1220	Prepare RWP	4.0d	UFD-1210	UFD-1260, UFD-1100	E18H6G56
Operating Procedures		35.0d			
UFD-1160	Revise HFEF-OI-6205 NAC-LWT	18.0d	UFD-1155	UFD-1162	T41U1G56
UFD-1162	Review HFEF-OI-6205 NAC-LWT	3.6d	UFD-1160	UFD-1164	T41U1G56
UFD-1164	Approve HFEF-OI-6205 NAC-LWT	0.9d	UFD-1162	UFD-1170	T41U1G56
UFD-1170	Author LI for In-Cell Fuel Handling	4.0d	UFD-1164	UFD-1172	F30U1G56
UFD-1172	Review LI for In-Cell Fuel Handling	3.6d	UFD-1170	UFD-1174	F30U1G56
UFD-1174	Approve LI for In-Cell Fuel Handling	0.9d	UFD-1172	UFD-1190	
UFD-1190	Walkdown OI & LI to Ensure Process in Place	4.0d	UFD-1174	UFD-1200	F30U1G56
Waste Management & Environmental Impacts		35.8d			
UFD-1095	Validate Environmental Checklist Assupmtions	4.4d	UFD-1105	UFD-1096	S21H5G58
UFD-1096	Revise EC as needed	4.0d	UFD-1095	UFD-1097	S21H5G58



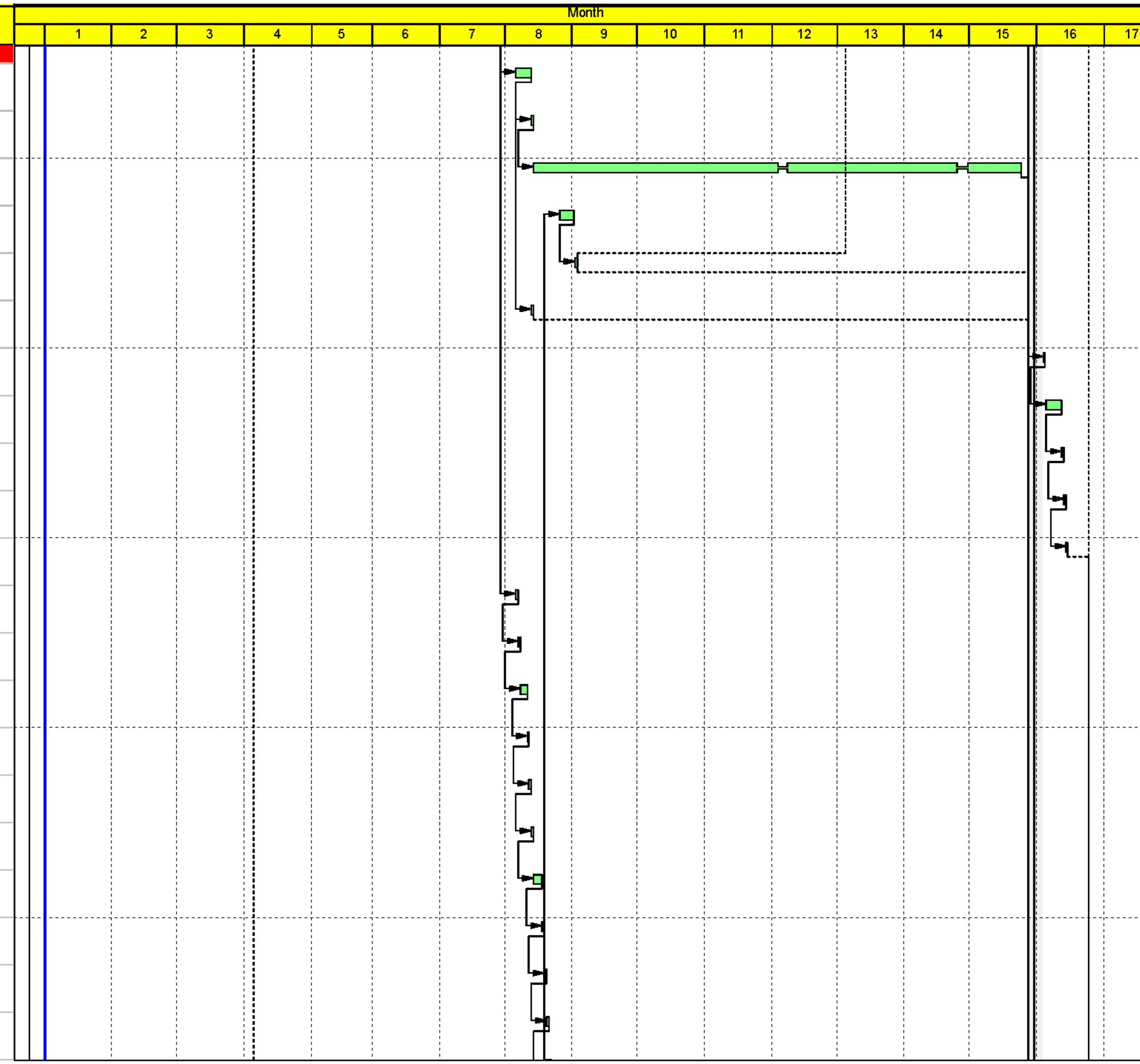
Actual Work
Remaining Work
Critical Remaining Work
Milestone

Activity ID	Activity Description	Orig Dur	Predecessors	Successors	Resource IDs
UFD-1097	Develop APAD for Fuel Receipt	8.9d	UFD-1096	UFD-1098	S21H5G58
UFD-1098	Review APAD for Fuel Receipt	4.0d	UFD-1097	UFD-1099	S21H5G58
UFD-1099	Approve APAD for Fuel Receipt	1.0d	UFD-1098	UFD-1260	S21H5G58
UFD-1310	Develop Waste Disposal Plan	8.0d	UFD-1093	UFD-1312	F34GBG56
UFD-1312	Review Waste Disposal Plan	4.0d	UFD-1310	UFD-1314	F34GBG56
UFD-1314	Approve Waste Disposal Plan	1.0d	UFD-1312	UFD-1260, UFD-1150, UFD-1105,	F34GBG56
HFEF Readiness Activities		55.2d			
UFD-1110	Verify EM, Cranes, Cask Cart, & MSMs Operational @ Windows	0.5d	UFD-1100	UFD-1260	E63W4G58
UFD-1120	Stage 1M Universal Adapter & All In-Cell Parts	1.8d	UFD-1100	UFD-1125	T44U1G54
UFD-1125	Place In Cell 1M Universal Adapter & All In-Cell Parts	0.9d	UFD-1120	UFD-1130	T44U1G54
UFD-1130	Stage 12 Element Container @ 4M	0.9d	UFD-1125	UFD-1140, UFD-1140	T44U1G54
UFD-1140	Stage 12 Element Container @ 17M	1.8d	UFD-1130, UFD-1130	UFD-1260	T44U1G54
UFD-1150	Operational Safety Board Review for RA Path Forward (per MCP-9002)	0.9d	UFD-1314	UFD-1155	F30U1G56
UFD-1155	Resolve Any OSB Concerns	0.9d	UFD-1150	UFD-1160	F34GBG56
UFD-1200	Perform Cask Crew Training & Verify Qualifications	4.0d	UFD-1190	UFD-1210	T41U1G56
Optional Dry Run		95.8d			
UFD-1260	Dry Run of Cask Receipt @ HFEF (Optional)	8.0d	UFD-1140, UFD-1220, UFD-1070,	UFD-1270	T41U1G56, NM80
UFD-1270	Unload Dummy Payload to Storage in HFEF (Optional)	1.8d	UFD-1260	UFD-1280	T44U1G54
UFD-1280	Package & Ship Empty Cask to NAC (Optional)	1.8d	UFD-1270	UFD-1290	T41U1G56
UFD-1290	Perform Readiness Assesment (RA or MSA/CRA)	16.0d	UFD-1280	UFD-1630, UFD-1320	F30U1G56
UFD-1324	Develop SOW for Leasing of NAC LWT Cask for Dry Run (Optional)	4.4d	UFD-1314	UFD-1334	F34GBG56
UFD-1334	Review SOW (Optional)	2.0d	UFD-1324	UFD-1344	F34GBG56
UFD-1344	Approve SOW (Optional)	0.3d	UFD-1334	UFD-1260	F34GBG56
Shipping Support		154.4d			



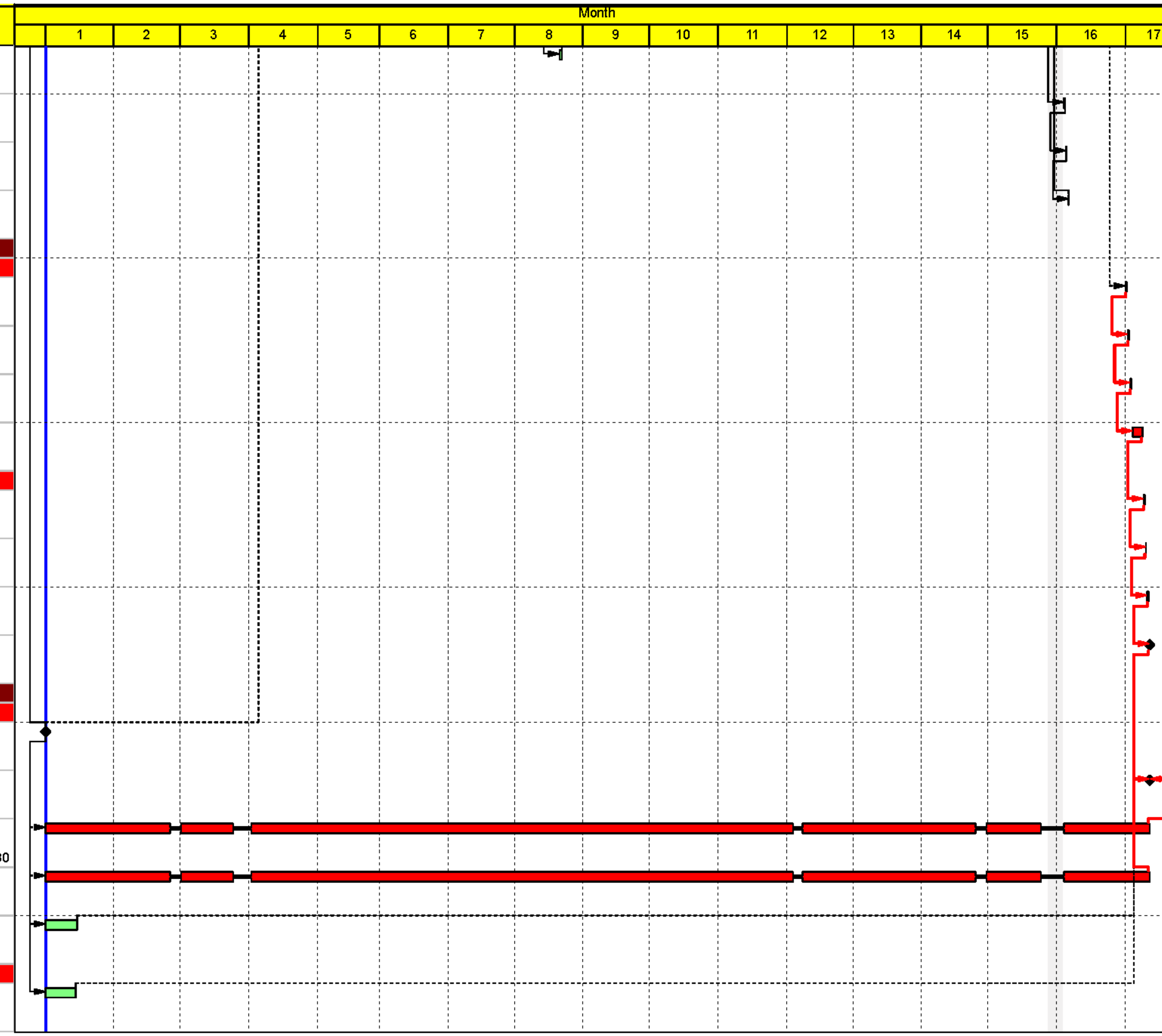
Actual Work
Remaining Work
Critical Remaining Work
Milestone

Activity ID	Activity Description	Orig Dur	Predecessors	Successors	Resource IDs
Shipping Support		154.4d			
UFD-1320	Develop preliminary fuel element information	4.0d	UFD-1290	UFD-1370, UFD-1510	F34GBG56
UFD-1370	Validate exclusive Quality Level Determination for transport task	1.0d	UFD-1320	UFD-1390	P33B3G56
UFD-1390	Transport Planning Support for NAC and North Anna	140.1d	UFD-1370	UFD-1520	P33B3G56
UFD-1440	Support reactor operation personnel & develop tasks/responsibilities for fuel shipments	4.0d	UFD-2000	UFD-1450	E14D2G58, P33B3G56
UFD-1450	Determine cask equipment needs for HFEF use and communicate to NAC	2.0d	UFD-1440	UFD-1520, UFD-2431	P33B3G56
UFD-1510	Record historical data for each selected fuel element	1.0d	UFD-1320	UFD-1520	X19C0G66
UFD-1520	Inspect fuel to verify compliance with fuel loading configurations for shipping	1.0d	UFD-1450, UFD-1510, UFD-1390,	UFD-1550	X19C0G66
UFD-1550	Write inspection report to document fuel inspection results	4.4d	UFD-1520	UFD-1600	X19C0G66
UFD-1600	Review and approve fuel information documents (RSD/App.A)	1.0d	UFD-1550	UFD-1610	E14D2G58, P33B3G56
UFD-1610	Ensure shipment is in compliance with fuel shipping cask specifications	1.0d	UFD-1600	UFD-1620	P33B3G56
UFD-1620	Review fuel loading diagrams/plans and provide comments to NAC	1.0d	UFD-1610	UFD-2266	P33B3G56
UFD-1630	Ensure transmittal of fuel packaging information documents to INL	1.0d	UFD-1290	UFD-1640	F34C6G54
UFD-1640	Obtain and review cask SARP and C of C to ensure compliance	1.0d	UFD-1630	UFD-1670	E48W4G56
UFD-1670	Verify element loading configuration for cask	1.0d	UFD-1640	UFD-1700	P33B3G56
UFD-1700	Review fuel packaging information documents	1.0d	UFD-1670	UFD-1740	P33B3G56
UFD-1740	Verify final fuel shipping information documents	1.0d	UFD-1700	UFD-1800	P33B3G56
UFD-1800	Review Transportation Security Plan and Provide Comments to NAC, EPRI, & Dominion	1.0d	UFD-1740	UFD-1820	X19C0G66
UFD-1820	Obtain current cask and equipment maintenance records	1.0d	UFD-1800	UFD-1830	E48W4G56
UFD-1830	Obtain cask contamination survey from cask owner	1.0d	UFD-1820	UFD-1840	E48W4G56
UFD-1840	Obtain other QA records for ensure compliance with transport requirements	1.0d	UFD-1830	UFD-1850	E48W4G56
UFD-1850	Obtain Form 741 for SNM transfers	1.0d	UFD-1840	UFD-2000	P33B3G56



Actual Work
Remaining Work
Critical Remaining Work
Milestone

Activity ID	Activity Description	Orig Dur	Predecessors	Successors	Resource IDs
UFD-2000	Verify carrier's authorizations	1.0d	UFD-1850	UFD-1440	P33B3G56
UFD-2050	Recieve notification of Readiness to Ship to NRC & INL	1.0d	UFD-2110	UFD-2120	P33B3G56
UFD-2120	Obtain Loading Report/Forms	1.0d	UFD-2050	UFD-2130	P33B3G56
UFD-2130	Obtain copy of compliance record w/ 10CFR71.87 "Routine Determinations" Section	1.0d	UFD-2120	UFD-2170	P33B3G56
Cask Receipt & Return		8.0d			
Cask Receipt		5.0d			
UFD-2266	Recieve Cask/Receipt Surveys	1.0d	UFD-2240, UFD-1620	UFD-2268	U71U1G54, T13H6G54, E48W4G56,
UFD-2268	Unload Cask from ISO Container & Place on Cask Cart	1.0d	UFD-2266	UFD-2270	T44U1G54, T41U1G56, E48W4G56,
UFD-2270	Bag-In Cask	1.0d	UFD-2268	UFD-2272	T41U1G56, E48W4G56, T44U1G54,
UFD-2272	Unload Rods Into Main Cell	2.0d	UFD-2270	UFD-2274	T41U1G56, E48W4G56, T44U1G54
NAC-LWT Return		3.0d			
UFD-2274	Bag-Out Cask	1.0d	UFD-2272	UFD-2276	T13H6G54, T41U1G56, E48W4G56,
UFD-2276	Load Cask Into ISO Container	1.0d	UFD-2274	UFD-2278	T41U1G56, E48W4G56, T44U1G54,
UFD-2278	Prep for Shipment	1.0d	UFD-2276	UFD-2401	T41U1G56, E48W4G56, T44U1G54,
UFD-2401	Transport to Alaron in Pennsylvannia	0.0d	UFD-2278	UFD-0120	
Project Management		303.2d			
Project Managment		303.2d			
UFD-0100	Used Fuel Disposition (UFD) Start Milestone	0.0d		UFD-1300, UFD-2300, UFD-2310,	
UFD-0120	Used Fuel Disposition (UFD) Finish Milestone	0.0d	UFD-1300, UFD-2300, UFD-2310,		
UFD-1300	Project Management	303.2d	UFD-0100	UFD-0120	X19C0G66, A13C0G52, E17Q5G56, NM80
UFD-1305	Project Controls	303.2d	UFD-0100	UFD-0120	P44F2G54
UFD-2300	Develop PEP	9.0d	UFD-0100	UFD-0120	F34GBG56
Quality Assurance		8.9d			
UFD-2310	Develop QAPP	8.9d	UFD-0100	UFD-0120	F34C6G56



Actual Work
Remaining Work
Critical Remaining Work
Milestone