BSC

Study Cover Sheet

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YUCCA MOUNTAIN PROJECT

Preliminary Wet Handling Facility Throughput Study

Informal Study

DOE Contract No.: DE-AC28-01RW12101

Rev.	Date	Reason for Revision	By Print Name and Sign	EGS/Lead Print Name and Sign	PE/RM Print Name and Sign	DEM Print Name and Sign
003	10/31/2007	Reason for Revision: Issued to support LA. This revision includes HI-STAR DPCs and standardized process times. New Gantt chart and model are included to capture changes. Changed operating process to accommodate design and operational changes for STCs and aging overpacks.	J. Monroe-Rammsy 10/31/07	R. Silva 10/31/07	D. Tooker 10/31/07	D. Rhodes 10-31-07
002	03/27/07	Reason for Revision: Facility process has been documented in BFD's and facility layout has stabilized. Better understanding of process times and review of times performed by operations. New Gantt charts and model have been developed to capture changes. The document text has been completely rewritten to capture these substantive changes, and therefore, revision bars have not been used.	J. Monroe-Rammsy 03/27/07	R. Silva 03/27/07	D. Tooker 03/27/07	D. Rhodes 03/27/07
001	05/31/06	Reason for Revision: All throughput calculations in Rev 000 used fuel assembly capacity for PWR DPC as 32 and BWR DPC as 68. However, Assumption 3.2.3 for Rev 000 had fuel assembly capacities listed as 24 and 44 for PWR DPC and BWR DPC respectively. The error has been corrected in this revision and does not affect any results in the study or attachment.	A. Achudume 05/30/06	D. Rhodes 05/30/06	N/A	T. Mulkey 05/31/06
000	05/04/06	Initial Issue	Anthony Achudume 05/03/06	David Rhodes 05/03/06	N/A	Thomas Mulkey 05/04/06

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ACRONYMS

BFD	block flow diagram
BOD	*Basis of Design for the TAD Canister-Based Repository Design Concept*
BWR	boiling water reactor
CRCF	Canister Receipt and Closure Facility
CSNF	commercial spent nuclear fuel
CTM	canister transfer machine
DOE	U.S. Department of Energy
DPC	dual-purpose canister
GA	General Atomics
HLW	high-level (radioactive) waste
MTHM	metric tons of heavy metals
PWR	pressurized water reactor
SFTM	spent fuel transfer machine
SNF	spent nuclear fuel
STC	shielded transfer cask
TAD	transport, aging and disposal canister
TC	transportation cask
WHF	Wet Handling Facility

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1.0 INTRODUCTION

This study describes the development of a preliminary throughput estimate for the Wet Handling Facility (WHF). This study estimates the throughput for the WHF License Application design as of September 2007. This design freeze allowed for the development of the throughput study without having to accommodate for minor updates to the facility design and documentation leading up to the License Application. The preliminary throughput estimate was generated based on the WHF Block Flow Diagrams[1] (BFDs) and general arrangement drawings[2].

As analyzed, the WHF is configured to receive, handle, and repackage bare commercial spent nuclear fuel (CSNF), where each fuel assembly will be handled directly and loaded into a transport, aging and disposal canister (TAD). Truck-based transportation casks containing bare CSNF and rail-based transportation casks containing dual-purpose canisters (DPCs) are the primary waste streams allotted for the WHF (Ref. 6.2.3, Section 5.1.1).

For design flexibility, the WHF will be designed to handle bare CSNF arriving in rail-based transportation casks. Rail transportation casks are not considered to be a primary waste stream. It is presumed that the utilities that can handle and load the relatively large and heavy rail casks have the capability to load TADs; therefore, they do not need to ship CSNF bare but would ship CSNF within TADs. Alternative cases were investigated that included three sizes of rail-based transportation casks containing bare CSNF, where these alternatives were used to assess the sensitivity of the facility to larger capacity bare-fuel transportation casks.

This preliminary study does not investigate throughput for low-volume waste streams. For example, the WHF is able to receive DPCs within aging overpacks that are delivered by a site transporter. Horizontal DPCs delivered from the aging facility on a site-based tractor-trailer can also be handled within the WHF. Neither of these waste streams are modeled. In addition, off normal scenarios involving CSNF which would be processed within the WHF are not specifically modeled or analyzed for their impact on throughput.

A summary of the processes modeled start with the receipt and preparation of the bare CSNF transportation cask or the DPC transportation cask. Receipt and preparation activities include inspection, venting, sampling, and unbolting the casks. For DPCs, the rail-based transportation cask is then transferred to the canister transfer room within the facility where the DPC is loaded into a STC for further processing. The DPCs are moved to a DPC cutting station where the outer lid (if used) and the inner shield lid welds are machined off. The DPC within the STC is placed into the pool and the inner shield lid is removed. The bare-fuel transportation casks are transferred directly from the preparation station to the pool for lid removal. Once the lid is removed from either the bare-fuel transportation cask or the DPC, the bare CSNF is transferred into the in-pool staging racks. (In actuality and outside of this model, the bare CSNF will most likely be transferred directly into a new TAD that has been pre-positioned in the pool; therefore, this model adds conservatism as discussed in Assumption 3.2.4.) Once the transportation cask or DPC is unloaded, the empty transportation cask or empty DPC within the STC is removed from the pool, drained, and prepared for export from the facility. A new TAD within an STC is loaded into the pool and the fuel from the racks is transferred to the TAD. The now loaded TAD is removed from the pool, drained, welded and dried. Once complete, the TAD is transferred to the cask unloading room. The TAD is transferred out of the STC and into an aging overpack and moved out of the facility to either the Canister Receipt and Closure Facility (CRCF) or to the Aging Facility (Ref. 6.2.11).

[1] Block flow diagrams include Revision 00A of the Level 2 and Draft Revision 00Bb of the Level 3 diagrams (Refs. 6.2.11, 6.2.12, 6.2.13, 6.2.14, 6.2.15, 6.2.16, 6.2.17, 6.2.18, 6.2.19, 6.2.20, 6.2.21, 6.2.22, 6.2.23, 6.2.24, 6.2.25, 6.2.26, 6.2.27, and 6.2.28)

[2] Site layout drawing include Revision 000 for the first and second floor and one elevation (Refs. 6.2.6, 6.2.8, 6.2.9 and 6.2.10)

The results of the preliminary throughput estimate are presented in terms of annual transportation cask processing capability, TADs produced and exported from the facility (sent to the CRCF or alternatively to the Aging Facility), and an estimate of total metric tons of heavy metal (MTHM) processed.

The preliminary results and conclusions presented in this study are based on simplifying assumptions (Section 3.2). Through the use of simplifying assumptions, results obtained are believed to be representative of the processing capabilities of the WHF. The calculated throughput rates do not represent exact or final results.

1.1 Purpose and Objectives

The purpose of this *Preliminary Wet Handling Facility Throughput Study* is to estimate the throughput capability of the preliminary WHF design based upon simplifying assumptions. The objective of this throughput estimate is to assist in design development and to provide initial conformance verification that the facility is capable of meeting the assigned processing rates (Criterion 3.1.1).

This study was developed in accordance with *Engineering Studies* and is classified as an informal study (Ref. 6.1.1, Section 2.2) and is within the scope of the contract as specified in the requirements documents (Ref. 6.2.3, Section 2.2.1.2). Per Section 2.1 of the *Engineering Studies* (Ref. 6.1.1) procedure, the results of this informal study are considered preliminary.

1.2 Scope

This preliminary throughput estimate only investigates those operations occurring within the WHF. Processes outside of the WHF (i.e., rail and truck staging, site transporter delivery and export, etc.) may or may not affect the facility throughput capability. To determine WHF throughput capability without assessing outside factors, it is assumed that all processes that are inputs to or outputs from the facility are available on demand. All WHF process inputs, such as loaded transportation casks and new TADs, are assumed to be immediately available when required. All model outputs, such as empty casks and loaded TADs, are assumed to be immediately removed when made ready (see Assumption 3.2.1).

2.0 RESULTS AND CONCLUSIONS

The preliminary results and conclusions presented in this report are based on the simplifying assumptions provided in Section 3.2. Through use of the simplifying assumptions, the results obtained are believed to be representative of the processing capabilities for the WHF design as of September 2007.

While an operations review was performed, operations activities are not wholly addressed or captured in these throughput estimates and may impose increased operational times for each of the processes. This poses a significant risk in the estimation of the throughput. Thus, the calculated throughput rates do not represent exact or final results. The results should be used as preliminary input for design development. Future evaluation should be conducted to ensure the validity of the conclusions.

2.1 Results

The model results are considered optimistic, and per Assumption 3.2.1, outside factors are not represented in the WHF model specifically. While not specifically known, it is anticipated that the outside factors will degrade the performance of the WHF. The primary outside factors include sequencing the delivery of trucks from truck staging, railcars from rail staging, export of TADs within aging overpacks to either the CRCF or Aging Facilities, delivery of empty TADs, and arrival of site transporter from the Receipt Facility and the Aging Facilities.

Table 1 presents a summary of the throughput model results. For full documentation of throughput model results, refer to Section 5.1.

Table 1. Summary of Throughput Model Results

	Model Results		
Scenario	TADs Produced[a]	Transportation Casks[b]	MTHM[c]
Truck Only	36	191-192	309-315
DPC Only	46-47	44-46	410-418
Mix of Truck and DPC	40-52	61-147	363-464
Small, Med, Large Rail Bare CSNF	54-74	60-138	461-627

Notes: [a] See Table 4 [b] See Table 6 [c] See Table 5

Criterion 3.1.1 requires the WHF to be able to process a combined 307 MTHM per year. The results presented in Table 1 show that the WHF meets the throughput requirement for waste streams containing truck only, mix of truck (bare-fuel) and DPC transportation casks, and DPC only cases.

In addition to the 307 MTHM per year requirement, a design goal of 40 TADs per year has been informally established[3]. The results in Table 1 show that the WHF currently does not meet the design goal for a waste stream consisting of a truck-only waste stream.

2.2 Conclusions

A primary purpose for performing throughput analyses is to understand which processes and systems impede the flow of materials through the facility; i.e., which processes are the bottlenecks. The results discussed in Section 5.2 showed that no single piece of equipment is over utilized; however, a bottle neck exists with the preparation station #1 as discussed in Section 5.2.3. The primary impedance to facility throughput is the layout and flow of the objects through the facility—specifically through the preparation station #1. This is visually apparent by reviewing Figure 2 as discussed in the concept of operations in Section 4.2.

Discussed in Section 5.2.1, the secondary impedance to facility throughput is the overhead cranes, which are the primary conveyance through the WHF. To avoid interference between the cranes or spent fuel transfer machine (SFTM), only one crane or SFTM is allowed to operate at a time within a particular zone. No two loaded cranes or SFTM can occupy the same zone or pass through a zone as another loaded crane. Simply, one crane has to wait for the other to complete its job prior to operating. This inability to move across zones and pass-by each other restricts the crane movements and utilization.

2.3 Recommendations for Future Work

The following are recommendations to improve the WHF layout and design (Section 2.3.2), as well as recommendations to improve the fidelity of the model and the veracity of the results (Section 2.3.1).

[3] A BWR TAD contains 44 fuel assemblies. At 0.174 MTHM per assembly (Assumption 3.2.10) for forty BWR TADs equates to approximately 306 MTHM. A PWR TAD contains 21 fuel assemblies. At 0.433 MTHM per assembly (Assumption 3.2.10) for forty PWR TADs equate to approximately 364 MTHM.

2.3.1. Recommendations for Throughput Model Improvement

As the design progresses, re-evaluation of the throughput will be required. Changes to the facility layout and operations are inevitable in this preliminary design phase and will need to be captured in future versions of the throughput model.

For the development of the throughput estimate, the Gantt charts form the basis of the throughput model. Parallel operations within the WHF were captured in the Gantt charts at the third-level of the BFDs. However, the Gantt charts break down each level-three BFD step into numerous individual process steps at the forth-level. Parallel activities are captured at this level but only under the third-level operation. Parallel activities at the forth-level do not span across level-three BFD process steps. By performing future detailed analysis of each operational step, parallel activities at the fourth-level that span across the level-three BFD operations could be discovered and incorporated in future versions of the Gantt charts and subsequent throughput models. While parallel activities at the forth-level will likely have only minor effects on the individual level-three BFD times, the aggregate sum of the small improvements to the process should improve the overall throughput results.

While operations reviewed the WHF Gantt charts, specific and detailed feedback was not received. General, high-level comments were incorporated; however, specific details pertaining to actual process and process times were not fed back for incorporation. The next revision of the throughput evaluation should incorporate specific, detailed operations input, which may impose increased operational times for each of the processes. This imposes risk in the throughput estimation.

To help balance and mitigate risks from operations inputs, future literature searches will continue to be performed to try to further discover published operational times from actual fuel handling operations. The use of these analogs will help establish credibility for the assumed process times captured in the Gantt charts.

Capabilities of the preliminary WHF throughput model can be further utilized or enhanced in the following areas to provide additional information as needed:

Waste Stream Variations

- Perform longer model runs (accounting for backlog)
- Transportation effects (truck, rail, site transporter, and STC variations)

Facility Optimization

- Process sequence variation
- Bottleneck identification

Development of Operational Data

- Better equipment utilization data (e.g., crane, welding equipment, SFTM, canister transfer machine, etc.)
- Cumulative process timing to support worker dose rate determinations
- Capture of detailed operations activities and their effects on process times

Model Fidelity

- Better process differentiation between transportation cask type and the related transportation cask operations, as well as, STC and site transporter operations
- Better process modeling of the horizontal DPCs, such as the MP-187/197 transportation casks (Refs. 6.2.39 and 6.2.40)

- Welding operational differences for pressurized water reactor (PWR) and boiling water reactor (BWR) TADs
- Identification of cask cooling requirements, process times, and frequency of occurrence (Assumption 3.2.30).

2.3.2. Recommendations for Wet Handling Facility Improvement

Discussed in Section 5.2, the use of preparation station #1 has been shown to be the facility bottleneck. The flow of objects through the facility and the location of the preparation, DPC cutting, and welding stations needs to be reevaluated and could potential improve the facility throughput. The circular flow of TADs through the facility is disrupted by the facility layout and by the requirement to export all TADs within an aging overpack. The reevaluation of material flow through facility should include the primary cranes as they are the main conveyance of objects through the facility and have a direct impact on the overall facility throughput.

3.0 STUDY BASES

3.1 Criteria

3.1.1 The WHF shall be designed to be capable of receiving 230 MTHM per year of bare CSNF from legal weight trucks, over-weight trucks and rail based bare fuel casks, as well as, 77 MTHM per year of CSNF in DPCs by rail. In the event that the DOE determines that rail access to the repository site will be unavailable to support system operating conditions and receipt rates, the previous acceptance rates will not apply and will, instead, be based on the availability of truck transportation capability (Ref. 6.2.3, Section 5.2.1.2)

3.1.2 The WHF shall be designed to receive the following transportation cask designs (non-exclusively) (Ref. 6.2.3, Section 5.2.1.1.4):

- GA-4
- GA-9
- NAC-LWT
- NAC-STC
- NAC-UMS
- MP-187
- MP-197
- HI-STAR 100
- TranStor TS-125
- TN-68 TSC
- TAD Transportation Cask

3.1.3 The capacity of the TAD canister shall be either 21 pressurized water reactor (PWR) spent fuel assemblies or 44 boiling water reactor (BWR) spent fuel assemblies (Ref. 6.2.3, Section 33.2.2.3).

3.1.4 The TAD canister shall be designed to facilitate helium leak testing of closure features (Ref. 6.2.3, Section 33.2.2.36-b).

3.1.5 Closure welds shall be used for TAD canister containment in accordance with standard nuclear industry practice (Ref. 6.2.3, Section 33.2.2.36-a).

3.1.6 In accordance with industry standards and regulatory guidance, the TAD canister shall be designed to facilitate the following (Ref. 6.2.3, Section 33.2.2.39):

1. Draining and vacuum drying to remove water vapor and oxidizing material.
2. Filling with helium to atmospheric pressure or greater as required to meet leak test procedural requirements.

3. Sampling of the gas space to verify helium purity.

4. Limiting maximum allowable oxidizing gas concentration within the loaded and sealed TAD canister to 0.20 percent of the free volume in the TAD canister at atmospheric pressure.

3.1.7 The loaded aging overpack shall be designed to be moved to the aging pad via site transporter using a pair of lift beams (e.g., forklift) (Ref. 6.2.3, Section 33.2.4.24).

3.1.8 The WHF shall provide for the removal or retraction of personnel barriers from around the cask while in the preparation areas (Ref. 6.2.3, Section 5.2.2.3.10).

3.2 Assumptions

The preliminary results and conclusions presented in this study are based on the following simplifying assumptions. Through the use of these simplifying assumptions, results obtained are believed to be representative of the processing capabilities of the WHF. The process times and detailed operations are based upon knowledge of the process, basic understanding of process times and understanding of analog processes. Several of the following assumptions are justifications for process times and were reviewed by operations. Some processes within the WHF were undetermined and engineering judgment could not be generally applied. These processes need further analysis to establish reasonable process times. While not inclusive to all processes, those processes requiring further investigation are captured within these assumptions and include the basis for the particular process time.

3.2.1 **Assumption**: On demand delivery conditions were used in the throughput model. All inputs, such as loaded transportation casks and new TADs, were available when required. All outputs, such as empty transportation casks, empty DPCs, and loaded TADs, were removed when ready.

Rationale: The scope of this informal engineering study was limited to the WHF. Processes outside of the WHF (e.g., rail and truck staging, STC movement, aging, remediation activities, etc.) may or may not affect the facility throughput capability. To determine WHF throughput capability without outside factors, it was assumed that all processes that were inputs to or outputs from the facility were available on demand. Therefore, for the scope of WHF only, this assumption is suitable for use in this preliminary engineering study.

Used in: This assumption was used in the development of the throughput model (Attachment I), in the WHF Gantt chart (Appendix A), and is discussed in Section 5.2.

3.2.2 **Assumption**: To estimate the annual throughput capability of the WHF, all calculations were performed using steady state conditions. Ramp-up and ramp-down times, as well as facility startup activities, were not included.

Rationale: Facility operational capability will ultimately be affected by startup activities. However, for study simplification, ramp-up and ramp-down times have not been established and, therefore, were not incorporated.

In addition, facility operational capability is characterized as representing some significant maturity of operations that may not be realized at startup. During initial operations, minor modifications may be made to the facility and/or procedures that do not affect the safety basis of the facility but may increase productivity and subsequent throughput. This assumption is suitable for use in this preliminary engineering study.

Used in: This assumption was used in the development of the throughput model (Attachment I), in the WHF Gantt chart (Appendix A), and is discussed in Section 5.2.

3.2.3 **Assumption**: For the purposes of this preliminary throughput study, facility availability was assumed to be 75 percent. The 25 percent non-availability was used to account for routine maintenance and equipment failures, off-normal operations, and recovery time.

Rationale: The facility was assumed to be available to operate 24 hours a day, 7 days a week. For this version of the throughput study, 75 percent facility availability was assumed. This is equivalent to three months down time per year which could consist of one month planned outage and two months for unplanned outages.

In addition, this throughput study did not simulate failure rates of equipment. Failure modes and effect analyses, subsequent failure rates, and mean time to repair data were assumed to be accounted for in the 25 percent unavailability factor.

As the design progresses and better definition is available for specific equipment types, failure rates and recovery times, system redundancy features, operating procedures, and waste processing requirements, the facility and equipment availability will be reviewed and better quantified. Therefore, this assumption is suitable for use in this preliminary engineering study.

Used in: This assumption was used in the development of the throughput model (Attachment I), and in the WHF Gantt chart (Appendix A).

3.2.4 **Assumption**: All CSNF assemblies are transferred from the transportation cask or DPC to the in-pool racks prior to being placed into a TAD.

Rationale: To reduce in-pool residence time for the TADs and to implement software routines and subsequent logic for the throughput model, an operational philosophy was assumed for the WHF where the facility will receive any type of awaiting transportation cask, regardless of the transportation contents or type, and process that cask type. This is independent of the TAD type within the pool (if any). All fuel from the arriving transportation cask or DPC is conservatively assumed to be transferred to the in-pool storage racks rather than directly to an awaiting TAD. This portion of the model is considered a "Push" model, as the transportation casks are pushed into the facility regardless of type.

Alternatively, the in-pool racks operate on a "Pull" model. That is, the model requests a TAD type (PWR or BWR) based on the rack contents, and not on the incoming waste stream. The logic for requesting a TAD type is based on the quantity of fuel assemblies in either the PWR rack or the BWR rack. The model uses the fuel rack contents to calculate the integer number of TADs that could be created from the two fuel types.

For example, if the model has recently processed two PWR DPCs, one BWR DPC, and three BWR truck casks, then the PWR racks would contain 64 PWR (32×2) fuel assemblies and 95 BWR (68 + 3×9) fuel assemblies. Based on the rack contents, the logic would request a PWR TAD. While there are more BWR fuel assemblies in the rack, there is only enough to create two BWR TADS. Alternatively for this example, there are 68 PWR fuel assemblies, which is enough to create three PWR TADS. Since the fuel racks contain more PWR TADs than BWR TADS, the model requests or "pulls" a PWR TAD for the next loading operation. The purpose for this logic-methodology is two-fold.

First, this methodology reduces in-pool residence time of TADs. It is advantageous to reduce the in-pool residence time to minimize contamination of the external TAD. Prior to loading into the pool, borated water is put into the annular space between a TAD and the STC. A rubber gasket or seal is then inserted in the annulus. This helps prevent any in-pool contaminants that have not been filtered out of the pool water from coming in contact with the TAD exterior. The sides of the TAD are not accessible for washdown or further decontamination. The longer the TAD resides in the pool, the greater the chance that possibly contaminated pool water will infiltrate the rubber gasket and mix with the clean borated water within the annulus. This methodology places a STC/TAD into the pool only if there is enough fuel in the racks to completely load the TAD. Alternately, if the TAD were placed in the pool before a truck cask were delivered, then the TAD would reside in the pool for several truck deliveries before being completely loaded, spanning multiple days. Placing the TAD into the pool only when there is adequate fuel for immediate fuel transfer expedites the TAD loading and subsequent removal from the pool.

Second, this logic-methodology prevents the facility from becoming "locked-up". The software must follow specific "if-then" rules and cannot use any higher-level, cognitive algorithms and is therefore confined by these if-then rules.

If the model logic were set-up to request a TAD canister based on the transportation cask type, then it is feasible that the facility will enter a locked state, which was observed during model development. In this scenario, if a PWR truck cask entered the facility then the model logic would request a PWR TAD. All four fuel assemblies from the PWR truck cask would be transferred to the PWR TAD, and not to the in-pool racks. It requires six PWR transportation casks containing four assemblies each to fill a 21 assembly PWR TAD, with three extra fuel assemblies being placed in the fuel racks at the end of the campaign. However, it is not guaranteed that the next transportation cask in the incoming facility queue is PWR truck cask.

To continue with this example, lets assume that a BWR truck cask is next in line and the PWR TAD within the pool still contains only four fuel assemblies. The nine fuel assemblies within the BWR truck cask must be transferred to the fuel assembly racks as the TAD is of the wrong type. Now, if a BWR DPC is next in the processing queue, all 68 fuel assemblies would be transferred to the rack as well. This string of BWR casks could continue until the entire BWR fuel rack would become full (Assumption 3.2.5). If another BWR truck cask or DPC is in the queue before the PWR TAD is completely filled, then the facility can not process any more fuel and is effectively "locked up". With both the BWR rack full and with a PWR TAD partially full within the pool, the software does not have the capability to correct and recover from this situation.

Designing the software logic to choose the TAD-type based on the quantity of fuel assemblies within the rack, and not on the transportation cask type being processed, allows the TADs to be filled regardless of which type of transportation cask is next and the facility can never enter a locked-state. Therefore, the model is set up to put all fuel assemblies in the rack and "pull" the specific TAD for the process. Thus, all fuel assemblies go to the in-pool rack prior to being loaded into a TAD.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.5 **Assumption**: Once either the PWR or BWR racks contain 132 fuel assemblies, transportation casks are prevented from entering the facility and are held within the rail or truck buffer area.

Rational: Assumption 3.2.4 effectively separated the transportation cask processing from the TAD loading and closure operations. This allows for transportation casks to be processed at the same time as a TAD is being welded and dried—a relatively lengthy process. To prevent the PWR and BWR fuel assembly racks within the pool from exceeding a maximum of 200 fuel assemblies each, transportation casks are not allowed within the facility once either rack reaches 132 fuel assemblies. TAD closure operations are not affected by this logic and will continue to process TADs. Once the number of fuel assemblies within each rack drops below 132, then transportation casks are then allowed to enter the facility.

The cut-off number (132) was selected as it is the rack capacity (200) subtracting one BWR DPC (68). Based on this assumption, the model stops incoming transportation casks from entering once the racks reach 132. It is possible that another cask is currently being processed within the facility. The worst case is that a 68-BWR DPC is being cut-open. The in-pool rack has to have the capacity to handle this situation, and is thus reserved 68 spaces.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.6 **Assumption**: The WHF concept of operations is assumed to be a step-wise, sequential process where items will move from station to station. And, once a station becomes available another item will move into that station. This process allows for multiple truck casks, DPCs, and TADs to be processed simultaneously, significantly improving the parallel operations within the facility.

Rationale: Previous revisions of the WHF throughput engineering studies only allowed a single truck cask or DPC to be processed at a time. For example, a truck cask would enter the facility, be prepared for unloading, move into the pool, fuel unloaded from the cask, the cask moved back to a preparation area, the cask dried and prepared to leave the facility, loaded back onto the same conveyance which brought the cask, and exported from the facility. Only then would another truck cask be able to enter the facility and be processed.

With this revision of the throughput study, the operational philosophy has been changed to a "round-robin" scheduling methodology. With this methodology, more than one transportation cask, DPC, and TAD can be processed simultaneously as each object flows through the facility. In general, this process flows circularly from the conveyance on the east side of the building, to the north side of the building for preparation operations, to the pool on the west for loading/unloading operations, to the southern side for exit and welding operations, and back to the conveyance on the east side.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.7 **Assumption**: The assumed capacity of a truck transportation cask is nine BWR CSNF assemblies or four PWR CSNF assemblies.

Rational: For this study, all truck-based transportation casks are assumed to be either the PWR or BWR variants of the General Atomics (GA) truck casks, referred to as the GA-4 or the GA-9, respectively (Ref. 6.2.30, Section 1.1 and Ref. 6.2.31, Section 1.1). Interestingly, the GA-9 is capable of handling either 4 PWR or 9 BWR CSNF assemblies (Ref. 6.2.31, Section 1.1 and Ref. 6.2.32, Section 1.1), whereas the GA-4 can only handle 4 PWR assemblies.

Per the *Basis of Design for the TAD Canister-Based Repository Design Concept*, referred to as the BOD, (Ref. 6.2.3, Section 5.2.1.1.4), the WHF will also be designed to handle the NAC International Legal Weight Truck (NAC-LWT) transportation cask (Criterion 3.1.2), which can transport either two BWR CSNF assemblies or a single PWR CSNF assembly (Ref. 6.2.34, p. 1.1-1). However, the data[4] from the *2002 Waste Stream Projections Report* (Ref. 6.2.29) for a 10 year old fuel first scenario does not contain any shipments made with a NAC-LWT. This does not preclude the use of a NAC-LWT; but rather, based on the low capacity of the cask type, it is assumed that the NAC-LWT will be a relatively small proportion of the waste stream and is therefore not utilized in this throughput analysis.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

[4] For the data from the *2002 Waste Stream Projections Report* (BSC 2003), see Attachment I, file "Waste Stream Evaluation.xls", tabs "BWR Data Only" and "PWR Data Only"

3.2.8 **Assumption**: Two processing rates were assumed for handling DPC transportation casks—one process time for the HI-STAR 100 and a second process time for all other variants of DPC transportation casks, referred to as a generic DPC. There was no time differentiation in the DPC transportation cask handling processes between the various generic transportation cask types.

Rational: All transportation cask variants required in Criterion 3.1.2 for the DPC waste stream are assumed to be prepared for unloading and exported from the facility utilizing a similar process and timeframe, with exception of the HI-STAR 100. The HI-STAR 100 requires a slightly different process for unloading from the railcar than a generic DPC. In addition, the HI-STAR 100 requires a slightly different process for loading the empty HI-STAR 100 back onto the railcar.

The process time to transfer each of the fuel assemblies out of the respective DPC, either HI-STAR 100 or generic, is captured. For example, a DPC transfer is a single operation and is modeled as such. However, the transfer of the DPC fuel contents (i.e., the CSNF) is modeled individually and accounts for the number of PWR or BWR fuel assemblies. It is the transportation cask preparation and handling process that is generically modeled as an assumed cask (Table 2). Until specific operational sequences, cask quantities (waste stream), and process times are established for each transportation cask type, this assumption is suitable for use in this preliminary throughput study.

Table 2. DPC Transportation Cask Information

[a]DPC Transport Cask	Max Capacity		Number of Lid Bolts (Inner/Outer)	Number of Lids	Impact Limiter Bolts (Per Impact Limiter)
	BWR	PWR			
[1]MP-187	0	24	36	1	12
[2]MP-197	61	0	48	1	12
[3]HI-STAR 100	68	32	54	1	10
[4]NAC-STC	0	36	36/42	2	16
[5]NAC-UMS	56	24	48	1	16
[6]TS-125 (TranStor)	74	21	60	1	12
[7]TN-68	68	0	48	1	[b]13
Assumed Cask	**68**	**32**	**48**	**1**	**16**

Notes: [a] Partial list as specified in Criterion 3.1.2
[b] Impact limiters are attached using 13 individual Tie Rods. See Ref. 6.2.38, Drawings 972-71-2 and 972-71-3

References:[1] Ref. 6.2.39, pp. 1.1-3, 1.1-4, and General Arrangement Sheet 1
[2] Ref. 6.2.40, Dwgs.1093-71-1, 1093-71-2, 1093-71-3, 1093-71-11.
[3] Ref. 6.2.33, pp. 1.1-1, and Drawings. 3913 Sheet 5 and C1765 Sheet 5
[4] Ref. 6.2.35, pp. 1.1-1, 1.1-2, 1.2-5, 1.2-6, 1.2-9
[5] Ref. 6.2.36, pp. 1.1-1, 1.2-4
[6] Ref. 6.2.2, pp. 1.2-5, and Drawings. FS-200 Sheets 2 and 3
[7] Ref. 6.2.38, Drawings 972-71-1 through 972-71-10

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.9 **Assumption**: Estimated process times, as presented in the Gantt charts (Appendix A), were assumed to be reasonable for the stated processes.

Rationale: A formal time and motion study for the CSNF processing within the WHF was not performed. The process times and detailed operations are based upon knowledge of the process, basic understanding of process times and understanding of analog processes. It is anticipated that the processing times and steps will be further defined and reviewed as the facility design matures, and will be subsequently incorporated into future revisions of the facility throughput model.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.10 **Assumption**: The average MTHM per PWR and BWR fuel assembly is 0.433 and 0.174, respectively.

Rationale: The actual MTHM per fuel assembly varies. The average MTHM per fuel assembly is calculated from the data provided with the *2002 Waste Stream Projections Report* (Ref. 6.2.29, Section 3.2 and Table 2) for the 70,000 MTHM case where the 10-year old fuel is sent to the repository first. This data is found in (Attachment I), Excel file "Waste Stream Evaluation", Tabs "PWR Data Only" and "BWR Data Only".

Used in: This assumption was used in the estimation of MTHM for Table 5 calculated from the throughput results presented in Attachment I.

3.2.11 **Assumption**: Personnel Barriers are not removed within the WHF.

Rationale: Currently, the WHF is required to have the provision to remove personnel barriers (Criterion 3.1.8). However, the specific location where they are to be removed has been in debate, either within the WHF or another location within the repository operations area, such as the security station. The current operational philosophy is to have all personnel barriers removed at the security station and not within the WHF. Until a definitive decision is made for the location where personnel barriers are to be removed, it is reasonable to assume that they will be removed at the security station.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.12 **Assumption**: All casks are washed prior to entering the WHF.

Rationale: Currently, there is no formally defined location where STCs and transportation casks will be washed. Washing is required to remove the majority of road dirt from the external surfaces of the respective cask, which will help prevent the introduction of dirt or other contaminants into the pool environment. Currently, this wash-down is expected to occur somewhere outside of the WHF, rather than within the decontamination pit.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.13 **Assumption**: New TADs that will be loaded with CSNF within the WHF are brought into the facility by means of an STC. Once the loaded and welded TAD is transferred to an aging overpack, the empty STC is sent out of the WHF to the Warehouse and Non-Nuclear Receipt Facility for loading with another new TAD.

Rationale: At the time of development for this version of the throughput study, the use of STCs was undergoing reevaluation. A design change required that all loaded TADs exit the facility through aging overpacks. However, it was unclear if the STC, which was used during the preparation, loading, and closure of the TAD canister would be allowed to leave the facility. For use in this throughput only, it was assumed that a STC loaded with a new TAD or an unloaded STC could enter and leave the facility with appropriate contamination surveys.

Used in: This assumption was discussed in Section 4.2, used in the development of the throughput model (Attachment I), and used in the WHF Gantt charts (Appendix A).

3.2.14 **Assumption**: The universally used STC has 48 lid bolts that require 5 minutes each to install, 3 minutes each to remove.

Rationale: The NAC-UMS Storage System, which is similar in size and function to a TAD based STC, utilizes 48 Bolts (2 inches in diameter x 8.5 inches long) weighing approximately 30 pounds each (Ref. 6.2.36). Thus to remove each bolt, it will take approximately 3 operators 3 minutes each to remove–one person operating the impact wrench, one person to support and catch the bolt, and a third person to stack the bolts on the rack. Thus to remove all STC lid bolts, it will take

$$3 \text{ min} \times 48 \text{ bolts} = 144 \text{ minutes} = 2.4 \text{ hours} \qquad \text{(Eq. 1)}$$

To install the STC lid bolts it will take approximately 3 operators, 3 minutes each to run-in the bolt, and two minutes each to torque the bolts to specification and torque pattern. Thus to install all lid bolts, it will take:

$$5 \text{ min} \times 48 \text{ bolts} = 240 \text{ minutes} = 4 \text{ hours} \qquad \text{(Eq. 2)}$$

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.15 **Assumption**: The universally used STC will require only 4 lid bolts when an STC is moved within the facility, where each bolt requires 5 minutes to install, 3 minutes to remove, or 5 minutes to install or remove underwater.

Rationale: To prevent fuel ejection from an off-normal tip-over/drop event, it is assumed that four lid bolts will prevent the lid from opening and ejecting fuel assemblies.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.16 **Assumption**: The universally used STC will have a permanent lid lifting device either built into or attached to the STC lid.

Rationale: The STC is not yet designed. The operations require the STC lid to be removed and installed by a crane and grapple; thus, the lid will require a lid lifting device. While the specification for the Aging Overpack specifically requires a standardized lifting fixture (Ref. 6.2.3, Section 33.2.4.6), it is assumed that a similar requirement will be imposed upon the STC design.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.17 **Assumption**: There will be materials accountability performed concurrently with CSNF transfer.

Rationale: While not specifically identified on the WHF BFDs, a material accountability will be performed. Based on operations input, an underwater video camera mounted to the fuel transfer machine will be used by an operator to view and record the serial numbers of each submerged fuel assembly and its location within a transportation cask, fuel rack, or its final TAD location. A secondary, independent check of the material inventory will be performed concurrently by quality insurance personnel who will verify the material accountability from the prerecorded video tapes.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.18 **Assumption**: DPC cutting occurs dry, within a preparation area, and with the internals flooded such that the fuel is covered with water, and is not performed underwater within the pool.

Rationale: A DPC cutting engineering study concluded that a partially dry approach to opening DPCs would be the most suitable method (Ref. 6.2.1, Section 2.1.1) and is captured in the BOD (Ref. 6.2.3, Section 5.2.1.3). This approach would involve performing all DPC preparation and cutting operations in a dry environment within a preparation area with the internals flooded such that the fuel is covered with water prior to breaching the DPC. Once opened, the DPC is transferred with the shield plug still in place into the pool for shield plug removal and fuel transfer. While this design change is documented in a study, it is assumed to be adopted as the design approach per the BOD. This assumption is suitable for use in this preliminary study.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.19 **Assumption**: DPC Cutting requires the removal of two lids and a shield plug.

Rationale: The specific designs of the DPCs vary. The *Dual Purpose Canister Opening Study* investigated the various DPC designs and documented a summary of the DPC design information (Ref. 6.2.1, Table A-2). Based on this information, the bounding case DPC utilizes an outer lid, an inner lid, and a shield plug. All three require removal prior to unloading CSNF from the DPC.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.20 **Assumption**: The DPC cutting process follows a general sequence that includes a series of basic steps required to sample, vent and open a DPC. The basic methodology for opening a DPC is listed as follows:

1. Remove STC Lid
2. Set-up DPC cutting machine to cut DPC outer lid
3. Cut DPC outer lid
4. Remove DPC outer lid
5. Set-up DPC cutting machine to cut siphon and vent port covers
6. Remove siphon and vent port covers
7. Connect hoses to siphon and vent ports
8. Sample atmosphere inside DPC and cool, if necessary
9. Fill DPC with water
10. Set-up DPC cutting machine to cut DPC inner lid
11. Cut DPC inner lid
12. Remove DPC inner lid
13. Install DPC shield plug lifting device
14. Install STC lid
15. Place DPC/STC into the pool
16. Remove STC lid
17. Lift DPC shield plug
18. Cut DPC siphon tube
19. Remove DPC shield plug

It should be noted that these steps are generic and in reality will vary depending on the type of DPC being cut as not all DPCs have an inner lid.

Rationale: This information is based on the *Dual Purpose Canister Opening Study* (Ref. 6.2.5, Section 4), which researched various DPC opening methods, including those proposed by DPC manufacturers and documented in their respective Safety Analysis Reports.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.21 **Assumption**: The process to machine off the weld areas of a typical inner and outer DPC lid is assumed to be 12 hours.

Rationale: The DPC lids are austenitic stainless steel (typical for SS-304L and SS-316L). The milling machine is assumed to be an end mill (Ref. 6.2.1, Section 2.3.3) utilizing a high-speed steel cutter that is a diameter of 1.0 inch with a 3-tooth, 20-degree helix angle tool profile. This milling machine is assumed to operate at a milling depth of 0.250 inches and a speed of 210 rpm. Based on the tabular data from the *Machinery's Handbook* (Ref. 6.2.37, Table 15a), the recommended feed rate is 0.003 inches per tooth and average cutting speed of 55 ft/min for high-speed steel cutters (Ref. 6.2.37, Table 13). High-speed steel cutters where chosen, rather than carbide tip tools, to be conservative as the cutting operations will be performed without any liquid cooling or lubrication. While DPCs vary in size, it is assumed the weld diameter is 70 inches in diameter. In addition, it is assumed that the weld depth that needs to be machined is 1 inch deep for the outer lid and ½ inch deep for the inner lid. To calculate the feed rate, the equation specified in the *Machinery's Handbook* (Ref. 6.2.37, p. 1041) is used:

$$f_m = f_t n_t N \qquad \text{(Eq. 3)}$$

Where:

f_m = milling machine feed rate in inches per minute

f_t = feed in inches per tooth

n_t = number of teeth in the milling cutter

N = spindle speed of the milling machine in revolutions per minute (rpm). N is found using the cutting speed (V) and the tool diameter (D):

$$N = \frac{12V}{\pi D} = \frac{12\,{}^{\text{in}}\!/_{\text{ft}} \cdot 55\,{}^{\text{ft}}\!/_{\text{min}}}{\pi \cdot 1\,\text{in}} = 210.1\,{}^{\text{rev}}\!/_{\text{min}} \qquad \text{(Eq. 4)}$$

Substituting back into the feed rate equation from above:

$$f_m = 0.003\,{}^{\text{in}}\!/_{\text{tooth}} \times 3\text{ teeth} \times 210.1\,{}^{\text{rev}}\!/_{\text{min}} = 1.89\,{}^{\text{in}}\!/_{\text{min}} \qquad \text{(Eq. 5)}$$

To calculate the time for one pass of the cutter head:

$$\frac{\pi \times 70\text{in}}{1.89\,{}^{\text{in}}\!/_{\text{min}}} = 116.3\,\text{min} \cong 120\,\text{min} \qquad \text{(Eq. 6)}$$

The number of passes required is determined by the assumed cutting depth of 0.25 inches for a total depth of 1.0 inch, or four passes of the cutter head. Therefore, the total time to perform the outer lid cutting is:

$$120\,\text{min} \times 4\,\text{passes} = 480\,\text{min} = 8\,\text{hr} \qquad \text{(Eq. 7)}$$

Similarly, the total time to perform the 0.50 inch thick inner lid cutting of two 0.25 inch passes is:

$$120\,\text{min} \times 2\,\text{passes} = 240\,\text{min} = 4\,\text{hr} \qquad \text{(Eq. 8)}$$

This results in a total time of 12 hours to open the inner and outer lids of the DPCs.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.22 **Assumption**: The process to fill the TAD with borated water will take approximately 25 minutes.

Rationale: TAD volume is specified in the BOD (Ref. 6.2.3, Section 33.2.2.1) with a maximum outside length of 212 inches and a diameter of 66.5 inches. Ignoring the TAD wall thickness, this equates to a free volume of:

$$\frac{\pi d^2}{4} \times L = \frac{\pi (66.5\,\text{in})^2}{4} \times 212\,\text{in} = 736{,}324\,\text{in}^3 = 3{,}188\,\text{gal} \qquad \text{(Eq. 9)}$$

The piping, pressure, and runs are not known for this application. It can be assumed that a dedicated filling pipe could supply water at 150 gallons per minute. Thus, solving for the filling time:

$$\frac{3{,}188\,\text{gal}}{150\,\text{gal}/\text{min}} = 21.5\,\text{min} \cong 25\,\text{min} \qquad \text{(Eq. 10)}$$

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.23 **Assumption**: The process to fill the STC annulus with borated water, as specified in the WHF BFD (Ref. 6.2.22, Block 3.1.1), will take approximately 25 minutes.

Rationale: Similar to Assumption 3.2.22, the filling of the annulus between the STC and the TAD can be found by subtracting the TAD volume from the free volume of the STC. The flow rate in this assumption is significantly reduced as the annular space between the TAD outer diameter and the STC inner diameter is assumed small. Thus, a relatively low flow rate will be used, nominally 10 gallons per minute.

The STC dimensions are currently unknown, but are assumed to be slightly larger than the TAD dimensions. Thus, assume an STC volume of 215 inches long and a diameter of 68.5 inches. This equates to a volume of:

$$\frac{\pi d^2}{4} \times L = \frac{\pi (68.5\,\text{in})^2}{4} \times 215\,\text{in} = 492{,}336\,\text{in}^3 = 3{,}430\,\text{gal} \qquad \text{(Eq. 11)}$$

TAD volume is specified in the BOD (Ref. 6.2.3, Section 33.2.2.1) with a maximum outside length of 212 inches and a diameter 66.5 inches. This equates to a free volume of:

$$\frac{\pi d^2}{4} \times L = \frac{\pi (66.5\,\text{in})^2}{4} \times 212\,\text{in} = 736{,}324\,\text{in}^3 = 3{,}188\,\text{gal} \qquad \text{(Eq. 12)}$$

Subtracting the TAD volume from the STC and assuming a flow-rate of 10 gallons per minute provides the free volume required to be filled in a specific period of time.

$$\frac{3{,}430\,\text{gal} - 3{,}188\,\text{gal}}{10\,{}^{gal}\!/_{\min}} = 24.2\min \cong 25\min \qquad \text{(Eq. 13)}$$

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.24 **Assumption**: TAD welding and non-destructive testing/examination require 6 hours to complete.

Rationale: TAD welding involves the welding of two lids with non-destructive testing/examination of each lid. The welding is assumed to be a three pass weld operating at 3 inches per minute. A setup of the weld-head is required prior to each pass requiring approximately 10 minutes, which is based on vendor provided video of a similar welding operation.

$$\frac{\pi \times 66.5in \times 3passes}{3\,{}^{in}\!/_{\min}} = 208.9\min \cong 210\min = 3.5hr \qquad \text{(Eq. 14)}$$

Including the weld prep prior to each of the three weld passes, the total time is 240 minutes (4 hours) per lid.

The non-destructive testing/examination equipment and process time is currently unknown. For this study, it is assumed the non-destructive testing/examination requires 120 minutes (2 hours) to perform with a 30 minute equipment setup. The Gantt chart accounts for the additional process time for subsequent setup and tear-down of both the weld equipment and the non-destructive testing/examination equipment (See Attachment I)

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.25 **Assumption**: TAD drying is based on a vendor provided process and requires approximately 2,280 minutes (38 hours).

Rationale: The TAD drying process is based on the Holtec International process. Based on this vendor information, typical drying times are from 16 to 38 hours per canister, depending on the heat load of the canister and the operational practices of the site (see Appendix B). The more conservative 38 hour process is used in this study. Until definitive data is available, this assumption is suitable for use.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.26 **Assumption**: All incoming railcars and tractor-trailers will be chocked but not leveled or tied-down to the facility floor.

Rationale: Currently, operational procedures are not developed for the handling, loading, and offloading of railcars and tractor-trailers within the WHF. The naval cask handling process requires leveling and tie-down of the railcar prior to upending the naval transportation cask. However, nuclear power industry observations and benchmarking has shown that leveling and tie-down of railcars and truck-trailers is not required. The GA-9 safety analysis report (Ref. 6.2.32, pp. 7.1-1 to 7.1-2) states that the trailer could either 1) have the brakes set and the wheels chocked or 2) allow the trailer to move under the load. Observations from Sharron Harris Nuclear Power Plant applied the brakes and chocked the wheels of the railcar prior to offloading their transportation cask. Discussions with operators at Edward Hatch Nuclear Power Plant allowed the railcar to move under the load as they offloaded the Holtec HI-STAR 100 transportation casks. Per the safety analysis report, the method used is determined by the crane capability within the facility handling the cask.

The assumed operation of tying down the railcar or trailer will not be implemented, but rather simply applying the brakes and chocking the wheels. Thus this is assumed that two operators will perform this duty in 10 minutes. Until specific operational procedures are established for each transportation cask type used in the WHF, this assumption is reasonable.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.27 **Assumption**: All grapple and yoke change outs require 15 minutes to remove from an overhead crane and 15 minutes to install onto an overhead crane.

Rationale: Currently, there is not enough detailed information available to know the exact process for removing a grapple or yoke from an overhead crane. It is assumed that the process will involve removing safety bolts and sliding out a primary kingpin (See Figure 1 as an example of a typical yoke change out as performed at the Maine Yankee Nuclear Power Plant). A similar, reverse operation will be required to install the king pin and any safety bolts. Until a specific process is known, all grapple changes are assumed to require 15 minutes to disconnect and 15 minutes to reconnect.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

Figure 1. Typical Yoke Change Out

3.2.28 **Assumption**: The process for handling a rail-based PWR or BWR bare-fuel transportation casks is assumed to be the same as for truck-based transportation casks.

Rationale: All rail-based transportation cask variants are assumed to be prepared for unloading and exported from the facility utilizing a similar process and timeframe as the truck-based transportation casks. This does not include the transfer of the fuel assemblies from the rail casks, which are assumed to contain 32 PWR or 68 BWR fuel assemblies each.

For example, the handling of the rail-based or truck-based transportation casks follow similar operational steps. However, the transfer of the fuel contents (i.e., the CSNF) is modeled individually and accounts for the number for the PWR or BWR fuel assemblies. It is the transportation cask preparation and handling process that is generically modeled. Until specific operational sequences, cask quantities (waste stream), and process times are established for each transportation cask type, this assumption is suitable for use in this preliminary throughput study.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.29 **Assumption**: Canister Transfer Machine movements will require 5 minutes.

Rationale: The distance to travel between the unloading and loading ports is slightly less than approximately 60 feet (Ref. 6.2.7). Maximum trolley speed shall be limited by design to a nominal 20 feet per minute (Ref. 6.2.4). Additionally, this operating speed of 20 feet per minute for the movement of the critical load is less than the recommended slow bridge speed of 40 feet per minute for a 300 to 499 ton load per NOG-1 (Ref 6.2.1, Table 5332.1-1). While the assembly weight of the canister transfer machine is 500 tons (Ref. 6.2.37), where the crane load, a loaded TAD canister (Ref. 6.2.3, Section 33.2.2.2) and the trolley shield bell assembly is assumed to be approximately 200 tons, depending on the shielding materials

Also, it is assumed that the CTM will require 30 seconds to accelerate and 30 seconds to decelerate from the operating speed of 20 feet per minute. The distance traveled by the bridge during its acceleration and deceleration can be found as:

$$\frac{1}{2}a \cdot t^2 = \frac{1}{2}\left(40\ {}^{ft}\!\!\diagup_{min^2}\right)(0.5\,min)^2 = 5\,ft \qquad \text{(Eq. 15)}$$

The total distance required to travel at the full operating speed of 20 feet per minute is:

$$60\,ft - (2 \times 5\,ft) = 50\,ft \qquad \text{(Eq. 16)}$$

The time required to travel the 50 feet at 20 feet per minute is 2.5 minutes. Adding the acceleration and deceleration time to the travel time, a total of 3.5 minute is required. After the load has stopped, minor swinging-oscillations of the canister load will occur. It is assumed that one minute is required for the natural dampening of these oscillations. Therefore, the total time required is 4.5 minutes. This value is simply rounded to 5 minutes for the CTM movement.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.30 **Assumption**: Transportation cask cooling is not accounted for in the throughput estimates.

Rationale: Transportation casks contents may be too thermally hot to allow for the introduction of borated water as part of the cask preparation and unloading activities. Cask cooling may be required, however, the method for cask cooling is undefined and subsequent process times can not be estimated. In addition, the frequency for cask cooling can not be quantified without a better understanding of the waste stream thermal properties and criteria for cask cooling. Until further definition of cask cooling is developed, transportation cask cooling is not accounted for in the throughput estimates and may degrade the performance of the facility.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.31 **Assumption**: Shield doors used in the WHF take 5 minutes to open and close.

Rationale: Some shield doors in the WHF weigh upwards of 300 tons with a travel of approximately 20 feet (Ref. 6.2.6). The mass of these doors limits the speed in which these doors can move. Engineering judgment has been used to determine the 5 minute time frame. This time can be considered reasonable for the preliminary analysis.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.2.32 **Assumption**: Manpower will be sufficient to support all operational phases based on the WHF operating on the operational work week schedule. This assumption includes sufficient personnel to support activities required to be performed concurrently identified in this throughput.

Rationale: When a facility is designed, startup, operation, and maintenance personnel to support these functions are factored into the design once the operation and maintenance schedule has been identified for a facility.

Used in: This assumption was used in the development of the throughput model (Attachment I) and in the WHF Gantt chart (Appendix A).

3.3 Methodology

The preliminary throughput estimate was generated based on the WHF BFDs[5] and general arrangement drawings[6]. The diagrams were used to formulate the high-level sequence of events for the receipt, unloading, and packaging of waste forms. Once the high-level processes and logic were captured in the WHF Gantt charts, a detailed process was defined for each high-level process step (See WHF Gantt charts in Attachment I and as summarized in Appendix A). The detailed WHF processes were represented as discrete process steps, where process times were estimated (Assumption 3.2.9) and step-wise logic formulated. The discrete processes were also assigned appropriate resources, such as cranes, the canister transfer machine, drying equipment, DPC cutting equipment, SFTM, weld stations, etc.

Once the detailed process steps and subsequent logic were captured in the Gantt chart, then the processes, times, and logic were represented in a process modeler. The process modeling software (SimCAD™ Pro) is a deterministic, discrete, and local simulation tool that is more robust than a Gantt chart, especially in modeling complex, logic-driven systems. This discrete process modeler does not rely on a mathematical model with an underlying equation. Although the model is represented formally, individual objects and resources in the model are represented directly (rather than by their density, concentration, or formula). Each model process and resource possesses an internal state and conforms to a set of behaviors or rules. The specified process determines how the object is updated from one time-step to the next within the model environment.

3.4 Use of Computer Software

Software tools used to develop this non-quality affecting engineering study are applied in scoping determinations and used to assess the feasibility of the Nuclear Facility in meeting throughput requirements; and therefore, are classified as Level 2 usage and are not required to be qualified per IT-PRO-0011, *Software Management* (Ref. 6.1.2, Attachment 12).

The process simulation software used for this throughput model is SimCAD™ Pro 8.0 Build-1371. Standard functions of SimCAD™ Pro were used to model the WHF processes. The SimCAD™ Pro files are contained on a compact disc (Attachment I).

Standard functions of Microsoft Excel™ for Windows, Version 2003 SP3 (Build 11.8169.8172), were used in this study to display results in a tabular form and as inputs to the SimCAD™ Pro model. The Microsoft Excel™ files are contained on a compact disc (Attachment I).

[5] Block flow diagrams include Revision 00A of the Level 2 and Draft Revision 00Bb of the Level 3 diagrams (Refs. 6.2.11, 6.2.12, 6.2.13, 6.2.14, 6.2.15, 6.2.16, 6.2.17, 6.2.18, 6.2.19, 6.2.20, 6.2.21, 6.2.22, 6.2.23, 6.2.24, 6.2.25, 6.2.26, 6.2.27, and 6.2.28)

[6] Site layout drawing include Revision 000 for the first and second floor and one elevation (Refs. 6.2.6, 6.2.7 6.2.8, 6.2.9 and 6.2.10)

Standard functions of Microsoft Office Project™ Professional 2003 SP3 (Build 11.3.2007.1529.15), was used in this study to determine the waste form processing times and for validating the SimCAD™ Pro model. The Microsoft Project™ files are contained on a compact disc (Attachment I) and are summarized in Appendix A.

4.0 DESCRIPTION OF ALTERNATIVES CONSIDERED

This preliminary throughput study investigated a single preliminary facility layout, as documented in the WHF BFDs and general arrangement drawings. However, twelve different waste streams were analyzed, as shown in Table 3 and further described in Section 4.1. The waste streams were created to saturate the WHF throughput model; and thereby, estimating maximum throughput for the particular waste stream (Assumptions 3.2.1 and 3.2.2). This maximum throughput is considered optimum, as any external or process delays will degrade the throughput from this optimum.

Table 3 shows the composition of each waste stream case by quantity of transportation casks per type. While some waste streams were arbitrarily selected, most were selected to test the sensitivity of the WHF's throughput to changes in waste stream.

Table 3. Waste Streams Cases by Transportation Cask Type

	Waste Stream Case – Transportation Cask											
	1	2	3	4	5	6	7	8	9	10	11	12
Waste Stream Type	Avg	Peak	DPC Only	DPC Only	Truck Only	Truck Only	Mix	Mix	Mix	Sm. Rail	Med. Rail	Lg. Rail
Truck PWR	72	145	-	-	152	130	140	100	60	-	-	-
Truck BWR	23	55	-	-	48	70	44	22	14	-	-	-
Rail PWR DPC	12	27	160	118	-	-	11	62	100	-	-	-
Rail PWR HI-STAR	1	2	16	12	-	-	1	6	10			
Rail BWR DPC	2	9	23	67	-	-	4	10	16	-	-	-
Rail BWR HI-STAR	-	-	1	3	-	-	-	-	-			
Rail PWR	-	-	-	-	-	-	-	-	-	154	154	154
Rail BWR	-	-	-	-	-	-	-	-	-	83	83	83
Total	110	238	200	200	200	200	200	200	200	237	237	237

4.1 Waste Stream Cases

For each waste stream case shown in Table 3, the specific delivery rate to the repository is a uniform distribution. Using Case 5 as an example, if there were 152 PWR truck casks allocated to be delivered within the waste stream case, then the delivery would be uniformly spread across 75 percent of the year (Assumption 3.2.3).

$$\frac{\left(365\text{ days}\times 24\,{}^{\text{hr}}\!/\!_{\text{day}}\times 60\,{}^{\text{min}}\!/\!_{\text{hr}}\right)\times 75\%}{152\text{ casks}}=\frac{394{,}200\text{ min}}{152\text{ casks}}=2{,}593\,{}^{\text{min}}\!/\!_{\text{cask}} \qquad \text{(Eq. 17)}$$

Thus, there would be a PWR truck cask arriving every 2,593 minutes, or 43.2 hours. This receipt methodology is applied to each of the transportation cask types for the particular waste stream. By following the same formula as above for the waste stream Case 1 (Table 3), there will be a total of 72 PWR truck casks each arriving every 91 hours, 23 BWR truck cask each arriving every 286 hours, 13 PWR DPC rail casks (HI-STAR and generic) each arriving every 505 hours, and a

2 BWR DPC rail casks each arriving every 3,285 hours. This delivery methodology for the repository is applied to all waste stream cases.

4.1.1. Case 1 and 2 – 2002 Waste Stream Case

The waste stream for Cases 1 and 2 are based on the data provided in the *2002 Waste Stream Projections Report* (Ref. 6.2.29). The waste stream used has been out of the reactor a minimum of 10 years and the youngest fuel is delivered first, referred to as the 10-YFF case. The data from this case was analyzed to estimate a likely delivery to the WHF. The 10-YFF case data[7] was analyzed by using a pivot table to extract the total number of cask deliveries by type and by year of delivery. From this data, two cases were determined, an average and a peak—Cases 1 and 2, respectively. The average case simply takes the average number of PWR and BWR transportation casks to be delivered over the entire delivery period. The peak extracts the years where the number of transportation casks deliveries are the greatest. For example, the peak case shows that 145 PWR truck casks are to be delivered in year 5 and that 55 BWR truck casks are to be delivered in year 6. Thus, the peak case (Case 2) extracts the maximum delivery regardless of the year of delivery. For Case 1, the percentage split of transportation casks delivered to the repository is 77 percent PWR and 23 percent BWR. For Case 2, the percentage split is 73 percent PWR and 27 percent BWR.

4.1.2. Case 3 – PWR/BWR Split for DPC

Case 3 is a DPC only case where the total number of DPCs delivered is arbitrarily set at 200. This is significantly more DPCs than expected within a year, but as discussed above was purposely set high to saturate the WHF throughput model; and thereby, estimate the maximum throughput for the particular waste stream (Assumptions 3.2.1 and 3.2.2).

The split between PWR and BWR DPCs was determined by examining the 10-YFF case data, as discussed in Case 1-2 above. In addition, the percentage split for HI-STAR DPCs for both PWR and BWR waste streams was determined. For the entire delivery schedule, 88 percent of the DPCs to be delivered are PWR and 12 percent are BWR. Assuming 200 DPCs to be delivered in a particular year equates to 176 PWR and 24 BWR DPCs. Of the 176 PWR DPCs, 16 are HI-STAR PWR DPCs resulting in 160 standard DPCs. Thus, for PWR DPCs, approximately nine percent are HI-STAR PWR DPCs. And, of the 24 BWR DPCs, 1 is a HI-STAR BWR DPC resulting in 23 standard DPCs. Again, for BWR DPCs, approximately four percent are HI-STAR BWR DPCs.

4.1.3. Case 4 – Arbitrary PWR/BWR Split for DPC

Like Case 3 above, Case 4 is a DPC only case where the total number of DPCs delivered is set at 200 to saturate the model. The split between PWR and BWR was slightly modified to 65 percent PWR and 35 percent BWR to help identify any sensitivity to fuel type within a waste stream and its effects on total throughput. A similar percentage of standard and HI-STAR DPCs is made.

4.1.4. Case 5 – PWR/BWR Split of Truck Transportation Casks

Case 5 is a truck cask only case where the total number of truck casks delivered is once again arbitrarily set at 200. Like the previous cases, this is significantly more truck casks than expected within a year, but as discussed above was purposely set high to saturate the WHF throughput model; and thereby, estimating maximum throughput for the particular waste stream (Assumptions 3.2.1 and 3.2.2).

[7] See Attachment I, Excel File "Waste Stream Evaluation", Tab "B_YFF10-Casks"

The split between PWR and BWR truck casks was determined by examining the 10-YFF case data, as discussed in Case 1-2 above. For the entire delivery schedule, 76 percent of the truck casks to be delivered are PWR and 24 percent are BWR. Assuming 200 truck casks to be delivered in a particular year equates to 152 PWR and 48 BWR DPCs.

4.1.5. Case 6 – Arbitrary PWR/BWR Split of Truck Transportation Casks

Like Case 5 above, Case 6 is a truck cask only case where the total number of truck casks delivered is set at 200 to saturate the model. The split between PWR and BWR was slightly modified to 65 percent PWR and 35 percent BWR to help identify any sensitivity to fuel type within a waste stream and its effects on total throughput.

4.1.6. Cases 7 through 9 – Truck and DPC Sensitivity Studies

Cases 3-4 and 5-6 show the boundaries of the waste streams to help identify sensitivities in the throughput to changes in the waste stream. While Cases 3-4 were DPC only and Cases 5-6 were truck cask only, Cases 7 through 9 were set up to vary the mix of DPCs and truck casks from one extreme to the other. Waste stream Case 7 starts with a heavy proportion of truck casks and a light proportion of DPCs. Case 8 blends the number of truck casks and DPCs. Case 9 has a heavy proportion of DPC and a light proportion of truck casks.

4.1.7. Cases 9 through 12 – Small, Medium, and Large Bare Fuel Rail Casks

Cases 9 through 12 were developed specifically to determine the effects on throughput by using bare-fuel transportation casks that contained more fuel assemblies per cask than a standard truck cask, which is a more efficient mode of operation as it requires less cask handling per TAD. Based on input from the Total System Model group, these rail cask sizes are the same size casks used in their respective throughput cases. The three cases are the small, medium and large casks that contain 8/20, 18/42, and 32/68 PWR/BWR fuel assemblies per cask, respectively.

4.2 Operations Concept

As discussed in Assumption 3.2.6, the concept of operations for the WHF has been modified for this throughput study to represent a round-robin scheduling methodology. The operations are assumed to be a step-wise, sequential process where objects (transportation casks, STCs, DPCs, etc.) will move from station to station. And, once a station becomes available another item will move into that station. This process allows for multiple truck casks, DPCs, and TADs to be processed simultaneously, significantly improving the parallel operations within the facility.

The process flow for these three items (truck casks, DPCs, and TADs)[8] is each shown separately in Figure 2. In general, this process flows circularly from the conveyance on the east side of the building, to the north side of the building for preparation operations, to the pool on the west for loading/unloading operations, to the southern side for exit and welding operations, and back to the conveyance on the east side.

While any order or number of objects can be processed, a summary-level example of how this circulatory flow works with the round-robin scheduling can be described with a couple of truck-based transportation casks, a couple of TADs, followed by a couple of DPCs.

1. A truck cask arrives on its conveyance in the east side of the pool room.
2. The truck cask is moved from its conveyance to preparation station #1 (operation TC-1 shown on Figure 2) and the conveyance is moved out of the facility.

[8] For bounding purposes, a secondary rail-based waste stream is investigated in this throughput study but is not considered a primary waste stream and subsequently its operational flow is not shown in Figure 2.

3. A second truck cask is moved into the facility on its conveyance.

4. Once prepared for unloading, the first truck cask is moved to the pool (TC-2). Once in the pool and the overhead crane is free, the second truck cask is moved into the preparation station (TC-1). There are now two truck casks within the facility, one in the pool being unloaded and one in the preparation station #1. The conveyance for the second truck cask is moved out of the facility while truck cask 1 is being unloaded and truck cask 2 is being prepared.

5. The next incoming object is an empty TAD within an STC (Assumption 3.2.13). As the conveyance brings in the STC/TAD, the unloaded truck cask 1 is moved from the pool to preparation station #2 (TC-3), truck cask 2 is moved from preparation station #1 to the pool (TC-2), and then the incoming STC/TAD is moved from its conveyance to preparation station #1 (TAD/STC-1). At this point in time, there are three simultaneous operations occurring—one in preparation station #1, one in the pool, and one in preparation station #2.

6. In order for the round-robin process to continue, the truck cask in preparation station #2 must be moved to its conveyance (TC-4) and removed from the facility. This will open preparation station #2 for the next operation, which is moving truck cask 2 out of the pool and into preparation station #2 (TC-3). This in turn, opens up the pool so that the TAD/STC 1 can be moved from preparation station #1 to the pool (TAD/STC-2).

7. While truck cask 2 and TAD/STC-1 is being moved and truck cask 1 is now out of the facility, the second STC/TAD is brought into the facility and moved to preparation station #1 (TAD/STC-1). Once again, there are three simultaneous operations occurring—TAD/STC 2 in preparation station #1, TAD/STC 1 in the pool being loaded, and truck cask 2 in preparation station #2.

8. Truck cask 2 is moved from preparation station #2 to its conveyance, which was brought into the facility. Once the truck cask is moved out of the facility, the DPC is moved into the facility within a rail-transportation cask (RC) on a railcar. Meanwhile, TAD/STC 1 is moved from the pool to the TAD closure station (TAD/STC-3), which opens up the pool to move TAD/STC 2 from the preparation station to the pool (TAD/STC-2).

9. Then, DPC 1 is moved from the conveyance to the preparation station #1 (DPC/RC-1).

    a. The DPC requires transfer from its rail-based transportation cask to a DPC-STC for in-facility handling. Once prepared, the DPC and its rail-based transportation cask is moved into the cask transfer room (DPC/RC-2) where the rail-based transportation cask lid is removed and the DPC is pulled up into the bell of the canister transfer machine. The rail-based transportation cask lid is the placed back onto the cask, and the empty cask is moved back to the preparation station #1 (RC-3).

    b. The transportation cask is then prepared for exit and moved back to its railcar (RC-4).

    c. Once the railcar with the empty rail-based transportation cask is removed from the facility, a STC is brought into the facility and is moved to preparation station #1 (STC-5) and prepared for DPC loading.

    d. The STC is moved into the cask unloading room under the cask transfer port (STC-6). The lid of the STC is removed and the DPC is loaded into the STC. The lid is replaced on the STC and the DPC/STC is moved back to preparation station #1 (DPC/STC-7).

    e. At this point the DPC/STC is ready for cutting and is moved from preparation station #1 to the DPC cutting station (DPC/STC-8).

LEGEND

TAD-#	Primary TAD Process
STC-#	Secondary TAD Process
DPC/Cask-#	Primary DPC Process
Cask-8	Secondary DPC Process
TC-1	Primary TC Process

ACRONYMS

AO	Aging Overpack
DPC	Dual-Purpose Canister
RC	Rail Cask
STC	Shielded Transfer Cask
TAD	Transport, Aging, and Disposal
TC	Truck Cask

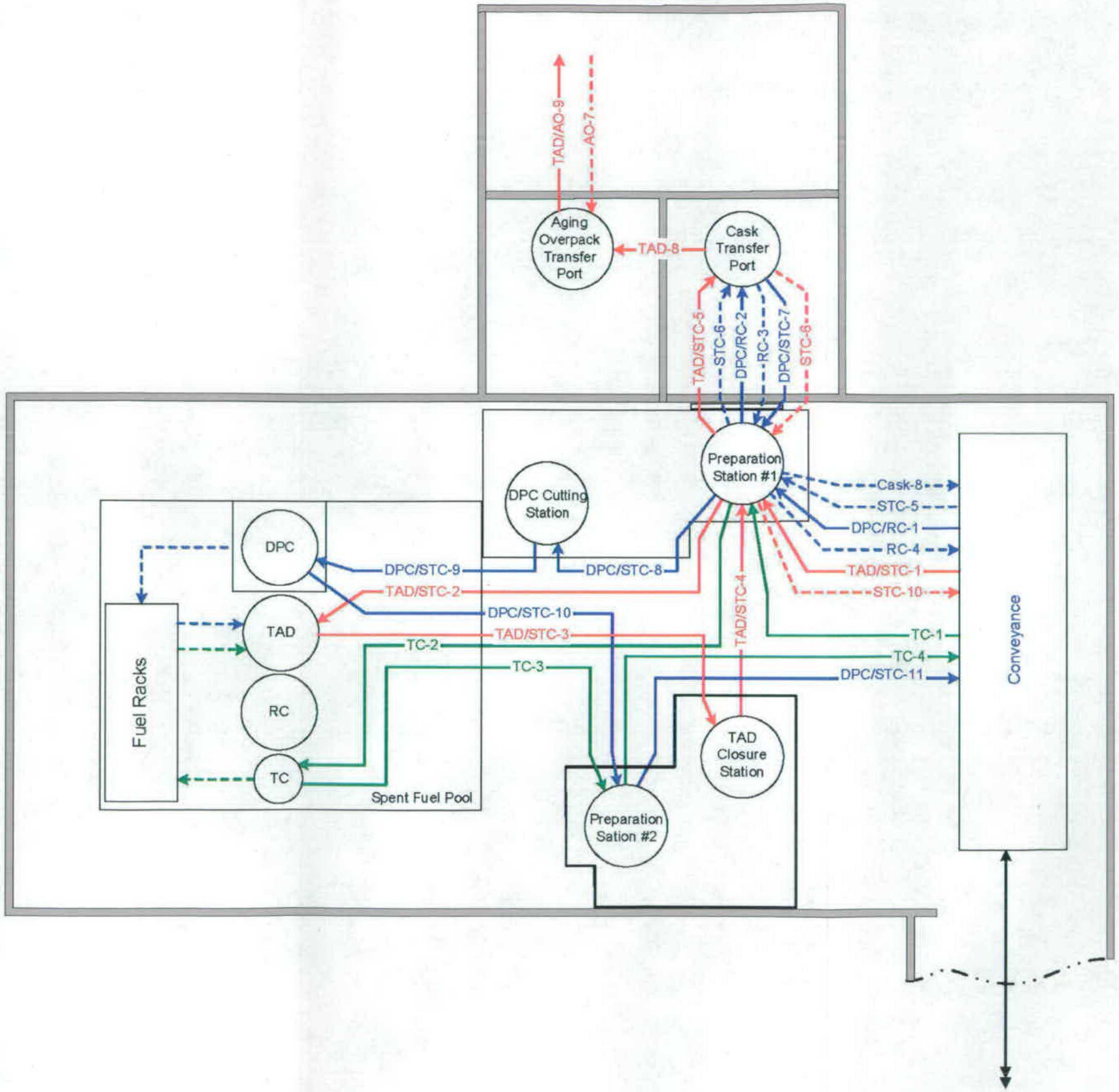

Figure 2. Summary WHF Process Flow

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10. The preparation station #1 is now available; and in this example, a second DPC is in the queue for processing within the facility. However, the preparation station #1 must not become occupied as TAD/STC 1 is nearing completion of the welding operations. Rather than allowing DPC 2 to enter the facility, the TAD/STC 1 is allowed to complete its welding operation and preparation station #1 remains idle.

11. Once complete with welding, the TAD/STC 1 is transferred from the TAD closure station to preparation station #1 (TAD/STC-4). At this point, the TAD must be transferred out of the STC and placed into an aging overpack for transfer to either the Aging Facility or to the Canister Receipt and Closure Facility.

    a. The TAD/STC 1 is moved under the cask transfer port of the cask transfer room (TAD/STC-5).

    b. The lid of the STC is removed and the lid of an awaiting aging overpack (AO-7) is removed and staged within the canister transfer room.

    c. The TAD is raised into the bell of the canister transfer machine. The CTM slews over to the aging overpack transfer port and lowers the TAD into the aging overpack (TAD-8).

    d. Once the TAD is in the aging overpack, the CTM retrieves the aging overpack lid and places the lid onto the aging overpack, and then the aging overpack is moved out of the facility (TAD/AO-9).

    e. Once the lid is on the aging overpack, the STC lid is retrieved and placed back onto the now-empty STC, simultaneously with the aging overpack being moved out.

    f. The empty STC is moved to the preparation station #1 (STC-6).

12. Once prepped for exit, the empty STC is then moved to the conveyance (STC-10), which frees up preparation station #1. At this point in time, 1) there is TAD/STC-2 in the TAD closure station, 2) DPC/STC 1 in the DPC cutting station, and 3) DPC/RC 2 in the queue to enter the facility. Both the pool and the preparation station #1 are idle.

13. Once complete with cutting operations, DPC/STC 1 is moved into the pool for unloading operations (DPC/STC-9). Now both the preparation station #1 and the DPC cutting station is idle.

14. With TAD/STC 2 finishing welding and DPC/RC 2 in the entrance queue, the model must make the decision of which object to place into preparation station #1. TADs have been set as the priority for the model, as processing TADs has a direct affect on MTHM processed and number of TADs created. Therefore, DPC/RC 2 is still forced to wait as TAD/STC 2 finishes welding and preparation station #1 remains idle.

15. While waiting for welding to finish, DPC/STC 1 is able to move from the pool to preparation station #2 (DPC/STC-10).

16. Once complete, the TAD/STC 2 is moved from the TAD closure station to preparation station #1 and follows the same process as described in step 11, above.

17. After the TAD is loaded into an aging overpack and the empty TAD-STC exits the facility, the DPC/RC 2 waiting in the queue is permitted to enter the facility for processing.

This round-robin process continues to receive and process truck casks, DPCs, and TADs in a continuous, circular operation maximizing the use of the preparation, cutting, and welding stations.

5.0 EVALUATION OF ALTERNATIVES

5.1 Throughput Results

This WHF throughput model processed the maximum possible transportation casks and DPCs (based on the waste stream case) per year, which results in the maximum theoretical throughput. The throughput results are presented in total number of TADs exported from the facility (Table 4), the estimated MTHM for those TADs (Table 5), and the number of transportation casks received for processing within the WHF (Table 6).

As expected, the total number of TADs produced per year varied by the type and makeup of input waste stream. The truck-only waste streams produced significantly less TADs per year at 36. The DPC-only waste stream produced 46-47 TADs per year. The rail, bare-fuel only waste stream produced the theoretical maximum throughput at 54-74 TADs per year.

Table 4. Throughput in Terms of TADs Produced

	Waste Stream Case											
	1	2	3	4	5	6	7	8	9	10	11	12
Waste Stream Type	**Avg**	**Peak**	**DPC Only**	**DPC Only**	**Truck Only**	**Truck Only**	**Mix**	**Mix**	**Mix**	**Sm. Rail**	**Med. Rail**	**Lg. Rail**
PWR	34	33	40	40	27	23	35	46	47	33	45	42
BWR	13	7	7	6	9	13	7	6	5	21	26	32
Total	47	40	47	46	36	36	42	52	52	54	71	74

Source: Attachment I, Excel File "Sumary-output.xls", Tab "Results"

Based on the number of TADs produced per year, an estimate for the annual MTHM can be determined by multiplying the respective TAD capacity by the MTHM per fuel assembly. As discussed in Assumption 3.2.10, the average MTHM per PWR and BWR fuel assembly is 0.433 and 0.174, respectively.

$$MTHM_{PWR} = 21\,{}^{Assy}\!/_{TAD} \times 0.433\,{}^{MTHM}\!/_{Assy} = 9.093\,{}^{MTHM}\!/_{TAD} \qquad \text{(Eq. 18)}$$

-OR-

$$MTHM_{BWR} = 44\,{}^{Assy}\!/_{TAD} \times 0.174\,{}^{MTHM}\!/_{Assy} = 7.656\,{}^{MTHM}\!/_{TAD} \qquad \text{(Eq. 19)}$$

To provide an estimate for throughput in terms of MTHM per year, the TAD quantities from Table 4 are multiplied by the MTHM per TAD resulting in the values in Table 5.

Table 5. Throughput in Terms of MTHM for Commercial SNF

	Waste Stream Case											
	1	2	3	4	5	6	7	8	9	10	11	12
Waste Stream Type	**Avg.**	**Peak**	**DPC Only**	**DPC Only**	**Truck Only**	**Truck Only**	**Mix**	**Mix**	**Mix**	**Sm. Rail**	**Med. Rail**	**Lg. Rail**
PWR	309	300	364	364	246	209	309	418	427	300	409	382
BWR	100	54	54	46	69	100	54	46	38	161	199	245
Total	409	354	418	410	315	309	363	464	445	461	608	627

Note: Average MTHM per assembly is based on Assumption 3.2.10.

As shown in Table 5, the 307 MTHM per year requirement (Criterion 3.1.1) was met for all cases, where the 307 MTHM is combined from 230 MTHM per year of bare CSNF from legal weight trucks, over-weight trucks and rail based bare fuel casks, and 77 MTHM per year of CSNF in DPCs by rail.

The throughput in terms of the transportation casks received is presented in Table 6, below.

Table 6. Throughput in Terms of Transportation Casks Processed

	Waste Stream Case											
	1	2	3	4	5	6	7	8	9	10	11	12
Waste Stream Type	**Avg.**	**Peak**	**DPC Only**	**DPC Only**	**Truck Only**	**Truck Only**	**Mix**	**Mix**	**Mix**	**Sm. Rail**	**Med. Rail**	**Lg. Rail**
Truck PWR	71	73	-	-	145	124	106	38	18	-	-	-
Truck BWR	27	23	-	-	47	67	27	9	6		-	-
Rail PWR DPC	14	12	34	26	-	-	9	25	30	-	-	-
Rail PWR HI-STAR DPC	1	1	5	16	-	-	4	4	4	-	-	-
Rail BWR DPC	5	2	4	3	-	-	1	3	3	-	-	-
Rail BWR HI-STAR DPC	-	-	1	1	-	-	-	-	-	-	-	-
Rail PWR	-	-	-	-	-	-	-	-	-	90	55	37
Rail BWR	-	-	-	-	-	-	-	-	-	48	29	23
Total	118	111	44	46	192	191	147	79	61	138	84	60

Source: Attachment I, Excel File "Sumary-output.xls", Tab "Results"

The throughput simulation model continues to process right up to the end of the year (see Assumption 3.2.3). Any transportation casks being prepared for processing are counted as a cask received, but there may not have been enough time to fully process and unload the cask contents at the end of the year's time. Also, fuel assemblies reside in the pool racks at the end of the year, and subsequently are not accounted for in the MTHM calculations as they are not processed into TADs.

5.2 Resource Utilization and Optimization

A primary purpose for performing throughput analyses is to understand which processes and systems impede the flow of materials through the facility. When investigating throughput, a rule of thumb is used to determine if any one resource is saturated; that is, the rule of thumb is used to determine if a crane, trolley, weld cell, or any other arbitrary resource is being over-utilized and thereby impeding throughput. Typically, a process becomes saturated between 65 and 85 percent utilization. Table 7 shows the resource utilization for the primary cranes, canister transfer machines, and weld cells.

A first review of the utilization results shows that no single resource is overloaded. This indicates that no single piece of equipment is over utilized. Therefore, some other factor is impeding the flow of materials through the facility rather than a single resource. Three items are discussed below, Crane Utilization, the use of Preparation Station #1, and bare-fuel rail casks.

Table 7. Percent Utilization of Primary Equipment

	Waste Stream Case (%)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Equipment or Resource	**Avg.**	**Peak**	**DPC Only**	**DPC Only**	**Truck Only**	**Truck Only**	**Mix**	**Mix**	**Mix**	**Sm. Rail**	**Med. Rail**	**Lg. Rail**
Auxiliary Pool Crane	9.61	8.84	4.30	4.34	14.29	14.37	11.35	6.99	5.56	11.5	8.52	6.99
CTM Maintenance Crane	0.69	0.52	1.52	1.54	-	-	0.49	1.07	1.27	-	-	0.00
Canister Transfer Machine	16.07	12.08	35.54	35.33	0.84	0.85	11.60	24.31	28.37	1.31	1.65	1.74
Cask Handling Crane	24.88	22.87	14.15	14.52	34.32	35.13	28.81	19.94	16.76	29.35	23.84	21.44
Cask Prep Area	14.93	13.05	13.73	14.2	15.34	15.55	15.39	14.81	14.26	14.42	13.20	12.10
Cask Transfer Trolley	17.22	13.88	27.41	27.74	7.34	7.40	14.19	22.57	24.84	8.88	10.18	10.22
DPC Cutting Jib Crane	4.86	3.65	10.63	10.71	-	-	3.16	7.54	8.71	-	-	0.00
DPC Cutting Machine	7.24	5.43	15.82	15.91	-	-	4.72	11.21	13	-	-	0.00
DPC Cutting Station	9.08	6.80	19.83	19.98	-	-	5.93	14.06	16.28	-	-	0.00
Entrance Vestibule Crane	8.70	8.06	3.50	3.27	13.51	13.62	10.53	5.94	4.61	9.91	5.97	4.34
Mobile Access Platform	15.88	14.64	6.98	7.26	24.08	24.32	19.14	11.36	9.00	18.48	12.26	9.53
NDE Equipment	11.39	9.69	11.46	11.46	8.85	8.87	10.17	12.60	12.60	13.02	17.19	17.61
Pool Area	32.85	29.03	24.87	24.49	38.17	39.39	34.41	29.06	26.40	37.97	36.66	35.94
Prep Station #1	30.10	26.06	30.52	31.13	29.90	29.99	30.80	30.21	29.72	25.71	20.83	18.15
Prep Station #1 Jib Crane	10.39	8.39	17.22	17.49	4.38	4.36	8.55	13.72	15.06	5.31	6.13	6.09
Prep Station #2	4.69	4.36	2.93	3.02	6.64	6.77	5.48	3.74	3.26	4.86	2.97	2.10
Prep Station #2 Jib Crane	0.53	0.41	1.15	1.20	-	-	0.36	0.86	0.98	-	-	0.00
SFTM	9.54	7.70	9.92	9.60	7.21	7.74	8.01	9.76	9.72	11.77	15.61	17.08
TAD Canister Welding Machine	18.11	15.40	18.26	18.23	14.08	14.11	16.19	20.02	20.03	20.70	27.33	28.01
TAD Closure Jib Crane	20.03	17.02	20.00	19.96	15.71	15.73	17.89	22.15	22.17	23.1	30.5	31.23
TAD Closure Station	20.00	17.02	20.15	20.12	15.55	15.60	17.89	22.12	22.15	22.92	30.17	30.94
Transportation Cask Vestibule (Entrance Vestibule)	19.1	17.59	8.97	9.11	28.48	28.65	22.92	13.78	11.20	21.51	13.9	10.62

Source: Attachment I, Excel File "Results.xls"

5.2.1. Preparation Station Review

Preparation station #1 has been allocated multitude of tasks. Primarily, this station prepares the incoming truck transportation casks, rail-based DPC transportation casks, and new TADs. Also, this preparation station assists in the transfer of DPCs from their respective transportation cask into its STC for further processing within the WHF. As introduced in Assumption 3.2.6 and further described in the concept of operations (Section 4.2), the WHF general process flows circularly from the conveyance on the east side of the building, to the north side of the building for preparation operations, to the pool on the west for loading/unloading operations, to the southern side for exit and welding operations, and back to the conveyance on the east side.

However, this circular process flow is interrupted by a loaded and welded TAD, as is shown in Figure 2. The current concept of operations for the WHF is that all TADs exit the facility within aging overpacks. Aging overpacks are loaded by the canister transfer machine, located north of preparation station #1. Once welding operations are complete, the loaded and welded TAD is transferred within its STC back to preparation station #1. Preparation station #1 must be available to the TAD, otherwise the facility would become blocked and not be able to further process—essentially locking up the facility. Therefore, the preparation station is not allowed to accept any incoming objects when the TAD closure operations are approximately 50 percent complete. This ensures that the preparation station is available to the loaded and welded TAD. The consequence is that the preparation station remains idle for long periods of time, as is shown by the low utilizations in Table 7, above

The requirement for TADs to exit the facility within aging overpacks should be reviewed as it requires the material flow through the facility to crisscross. Alternatively, improved process flow should be evaluated to reduce or eliminate otherwise conflicting process flows.

5.2.2. Crane Utilization Review

Reviewing the facility layout drawings (Refs. 6.2.6, 6.2.7 and 6.2.8) and the concept of operation (Section 4.2 and Figure 2), overhead cranes are the primary conveyance through the WHF. The three primary cranes are the cask handling crane, the auxiliary pool crane, and the entrance vestibule crane. The cask handling crane and the auxiliary crane have operating envelopes that span the entire cask preparation area (including the pool area) and a portion of the transportation cask vestibule. The cask preparation area is divided into two zones—the pool area and the preparation area. The entrance vestibule crane spans both the transportation cask vestibule and the preparation area of the cask preparation area. In addition, there is a SFTM that operates exclusively over the pool area.

To avoid interference between the cranes or SFTM, only one crane or SFTM is allowed to operate at a time within a particular zone, which is either within the pool area, the preparation area, or the entrance vestibule area. Because the auxiliary pool crane operates on the same crane rail as the cask handling crane, neither crane can pass by the other. No two loaded cranes can occupy or pass through the same zone as another crane.

Simply, one crane has to wait for the other to complete its job prior to operating. This inability to move across zones and pass-by each other significantly restricts the crane movements, which is the primary conveyance through the WHF. These restrictions are apparent in the overall low utilizations shown in Table 7 as each piece of equipment is waiting on another to complete its job so that it can operate. Thus, the low throughput in the WHF can be primarily attributed to the crane and facility layout as well as the poor material flow planning.

5.2.3. Bare-Fuel Rail Cask Review

Similar to DPC operations, rail-based bare-fuel transportation casks contain more fuel per cask than a similar truck cask. As discussed in Section 4.1.7, three different bare-fuel rail casks were used as input to the model—small casks containing either 8 PWR or 20 BWR fuel assemblies, a medium cask containing either 18 PWR or 42 BWR, and a large casks containing 32 PWR or 68 BWR fuel assemblies per cask, respectively. The cask handling operations were performed using the same process as the truck casks, but due to their increased capacity require less transportation casks to fill a TAD. Therefore, for these cases the primary bottleneck is TAD closure and the respective exit through preparation station #1. The higher utilizations in the SFTM and TAD closure station reflect this (Table 7).

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6.3 Design Constraints

None

6.4 Design Outputs

This engineering study will be utilized by management to assess the adequacy of the WHF design in meeting throughput expectations and/or requirements. This study may also be used to support bounding assumptions for transportation cask quantities, TAD quantities, and various other throughput related assumptions.

7.0 APPENDICES

APPENDIX A -
WHF SUMMARY GANTT CHART

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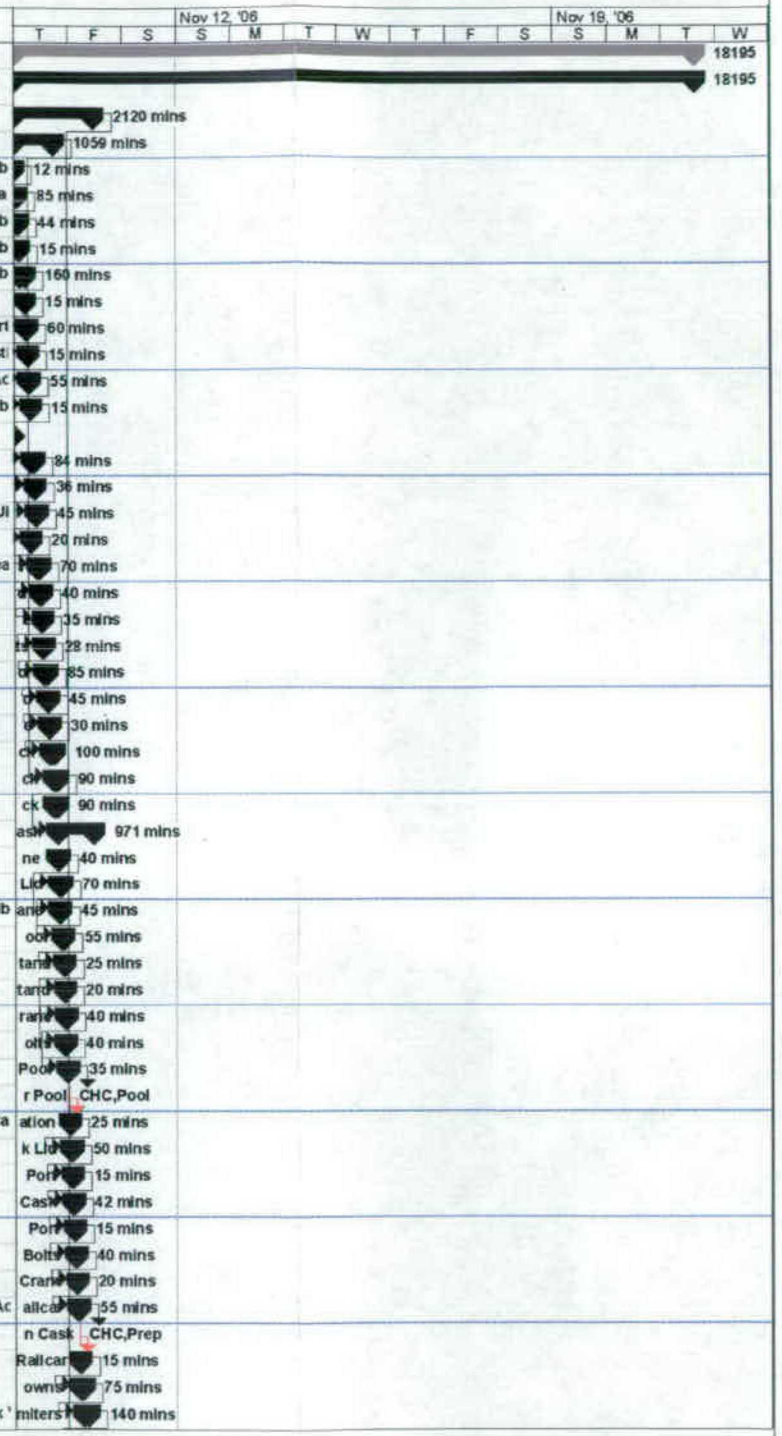
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
0		Wet Handling Facility (WHF) PWR/BWR TC Throughput	18195 mins				
1		*TC PWR TAD (in GA-4 Truck Cask)*	18195 mins				
2		Cask 1	2120 mins		347		
3	1.1	Receive Transportation Cask with SNF Assemblies	1059 mins		183		
4	Not in BFD	Receive Cask Pedestal	12 mins		11	EV	Transportation Cask Vestibule (Entrance Vestib
11	1.1.25	Install Cask Pedestal in Cask Transfer Trolley	85 mins	4	30	CHC,PS1,CTT	Cask Handling Crane,Preparation Station #1,Ca
30	1.1.1	Park Tractor/Railcar with Transportation Cask in Receipt Area	44 mins	11	53	EV	Transportation Cask Vestibule (Entrance Vestib
53	1.1.2	Move and Secure Platform into Position Around Tractor/Railcar	15 mins	30	56	EV,MAP	Transportation Cask Vestibule (Entrance Vestib
56	1.1.10	Remove and Store Impact Limiters and Personnel Barriers	160 mins	53	81	EV,MAP,EVC	Transportation Cask Vestibule (Entrance Vestib
79	NOT in BFD	Prepare CHC (CHC = Cask Handling Crane)	15 mins		81	CHC	Cask Handling Crane
81	1.1.11	Remove Tie Downs	60 mins	79,56	85	CHC,Prep,EV,MAP	Cask Handling Crane,Cask Prep Area,Transport
85	1.1.12	Upend Transportation Cask	15 mins	81	87	CHC,EV	Cask Handling Crane,Transportation Cask Vesti
87	1.1.13	Move Transportation Cask to Preparation Station #1 or #2	55 mins	85	96,126	CHC,Prep,MAP,PS1	Cask Handling Crane,Cask Prep Area,Mobile Ac
96	NOT in BFD	Remove and Store Platforms	15 mins	87	101	EV,MAP	Transportation Cask Vestibule (Entrance Vestib
99	1.1.14	Cool Cask Interior as Required	0 mins				
101	1.1.15	Vent Transportation Cask and Fill Borated Water	84 mins	96	115	PS1	Preparation Station #1
115	1.1.16	Remove Lid Bolts Leaving a Minimum of Four in Place	36 mins	101	119	PS1	Preparation Station #1
119	1.1.17	Attach Lid Lifting Device on Transportation Cask Lid	45 mins	115	129	PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
126	NOT in BFD	Prepare CHC	20 mins	87	129	CHC,Prep	Cask Handling Crane,Cask Prep Area
129	1.1.18	Move Transportation Cask to Staging Shelf in Pool	70 mins	126,119	137	CHC,Prep,Pool,PS1	Cask Handling Crane,Cask Prep Area,Pool Area
137	1.1.19	Wash Cask Handling Yoke over Pool and Place onto Stand	40 mins	129	142	CHC,Pool	Cask Handling Crane,Pool Area
142	1.1.20	Attach Pool Yoke Lift Adapter and Pool Cask Handling Yoke to Cask Ha	35 mins	137	146	CHC,Pool	Cask Handling Crane,Pool Area
146	1.1.21	Remove Remainder of Transportation Cask Lid Bolts	28 mins	142	150	Pool	Pool Area
150	1.1.22	Move Transportation Cask to Position in Bottom of Pool	85 mins	146	159	CHC,Pool	Cask Handling Crane,Pool Area
159	NOT in BFD	Clean Up and Move CHC to Yoke Stand	45 mins	150	165	CHC,Pool	Cask Handling Crane,Pool Area
165	NOT in BFD	Prepare Aux. Crane	30 mins	159	170	APC,PS1	Auxiliary Pool Crane,Preparation Station #1
170	1.1.23	Remove Transportation Cask Lid to Rack	100 mins	165		APC,Pool	Auxiliary Pool Crane,Pool Area
183	2.1	Move SNF Assemblies from TC to Rack	90 mins	3	192		
184	2.1.2	Move SNF Assemblies into Storage Rack	90 mins			SFTM,Pool	Spent Fuel Transfer Machine,Pool Area
192	1.2	Export Unloaded Transportation Cask	971 mins	183			
193		Prepare Aux Crane	40 mins		198,209	APC	Auxiliary Pool Crane
198	1.2.1	Install Transportation Cask Lid	70 mins	193	214	APC,Pool	Auxiliary Pool Crane,Pool Area
209	NOT in BFD	Prepare Cask Handling Crane	45 mins	193	214	EV,CHC	Transportation Cask Vestibule (Entrance Vestib
214	1.2.2	Lift Transportation Cask To Staging Shelf in Pool	55 mins	198,209	223	CHC,Pool	Cask Handling Crane,Pool Area
223	1.2.3	Wash Cask Pool Handling Yoke over Pool and Place onto Stand	25 mins	214	227,236	CHC	Cask Handling Crane
227	1.2.4	Place Pool Yoke Lift Adapter onto Stand	20 mins	223	231	CHC	Cask Handling Crane
231	1.2.5	Attach Cask Handling Yoke to Cask Handling Crane	40 mins	227	240	CHC	Cask Handling Crane
236	1.2.6	Bolt Transportation Cask Lid with at Least Four Bolts	40 mins	223	240	Pool	Pool Area
240	1.2.7	Lift Transportation Cask Out of Pool	35 mins	231,236	245	CHC,Pool	Cask Handling Crane,Pool Area
245	1.2.8	Wash Lifting Yoke and Exterior of Transportation Cask Over Pool	30 mins	240	246	CHC,Pool	Cask Handling Crane,Pool Area[50%]
246	1.2.9	Move Transportation Cask to Preparation Station	25 mins	245	250	CHC,PS1,Prep	Cask Handling Crane,Preparation Station #1,Ca
250	1.2.10	Remove Lid Lifting Device from Transportation Cask Lid	50 mins	246	259	PS1,Prep	Preparation Station #1,Cask Prep Area
259	1.2.11	Open Transportation Cask Drain Port	15 mins	250	263	Prep,PS1	Cask Prep Area,Preparation Station #1
263	1.2.12	Drain Transportation Cask	42 mins	259	269	Prep,PS1	Cask Prep Area,Preparation Station #1
269	1.2.13	Close Transportation Cask Drain Port	15 mins	263	273	Prep,PS1	Cask Prep Area,Preparation Station #1
273	1.2.14	Install Remainder of Transportation Cask Lid Bolts	40 mins	269	275	Prep,PS1	Cask Prep Area,Preparation Station #1
275	1.2.15	Engage Transportation Cask with Cask Handling Crane	20 mins	273	278	CHC	Cask Handling Crane
278	1.2.25	Move Transportation Cask to Tractor/Railcar	55 mins	275	285	CHC,Prep,MAP,PS1	Cask Handling Crane,Cask Prep Area,Mobile Ac
285	1.2.26	Downend Transportation Cask	10 mins	278	286	CHC,Prep	Cask Handling Crane,Cask Prep Area
286	1.2.27	Move and Secure Platform into Position around Tractor/Railcar	15 mins	285	289		
289	1.2.28	Install Tie Downs	75 mins	286	295	MAP	Mobile Access Platform
295	1.2.29	Install Impact Limiters	140 mins	289	314	EVC,EV,MAP	Entrance Vestibule Crane,Transportation Cask '



Project: Wet Handling Facility (WHF) P
Date: Wed 10/31/07

Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | External Milestone | External Milestone | Deadline

Sheet 1

Figure A-1. Summary WHF Gantt Chart – Sheet 1

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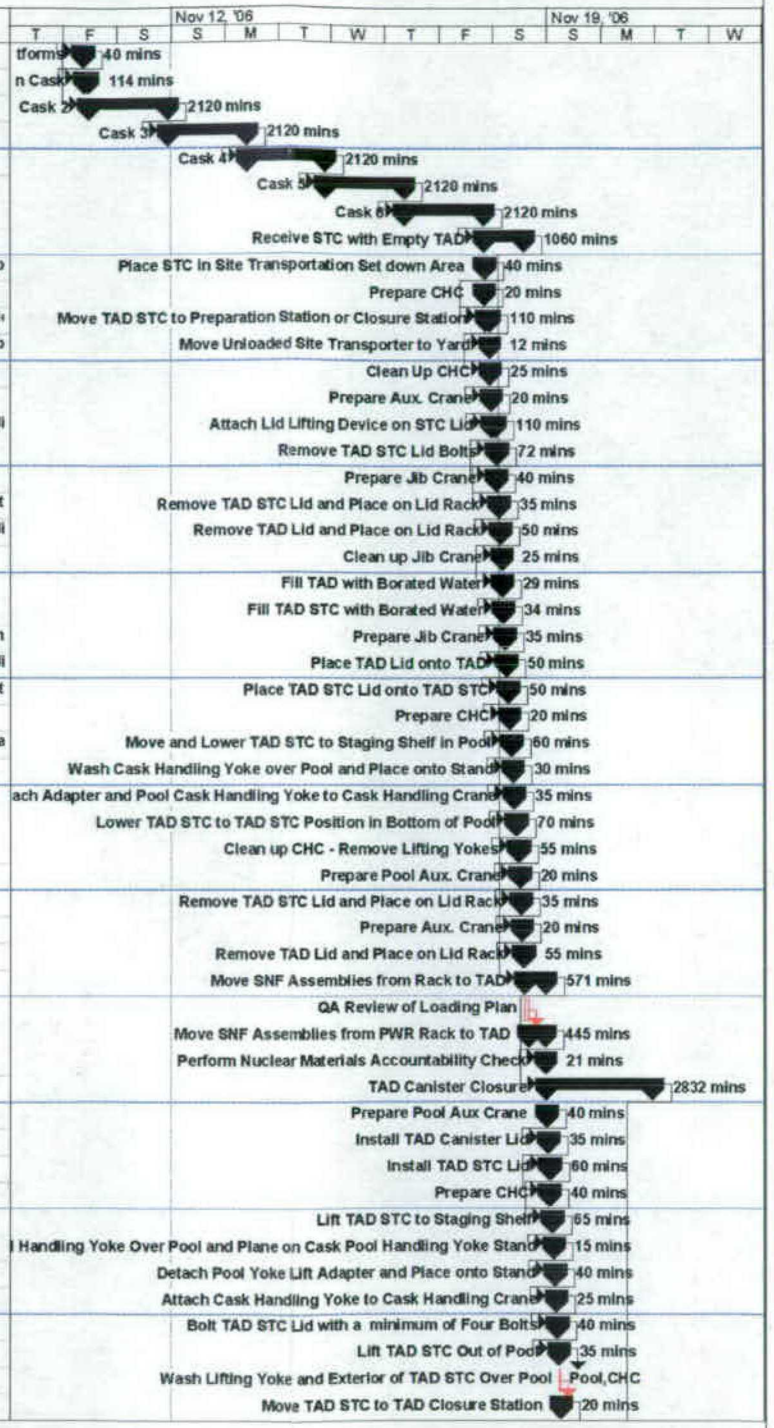
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
314	1.2.30	Remove Platforms	40 mins	295	317	MAP	Mobile Access Platform
317	NOT in BFD	Exit Tractor/Trailer with Empty Transportation Cask	114 mins	314			
347		Cask 2	2120 mins	2	692		
692		Cask 3	2120 mins	347	1037		
1037		Cask 4	2120 mins	692	1382		
1382		Cask 5	2120 mins	1037	1727		
1727		Cask 6	2120 mins	1382	2072		
2072	1.3	Receive STC with Empty TAD	1060 mins	1727	2225		
2073	1.3.1	Place STC in Site Transportation Set down Area	40 mins		2084	EV	Transportation Cask Vestibule (Entrance Vestib
2081	Not in BFD	Prepare CHC	20 mins		2084	Prep,CHC	Cask Prep Area,Cask Handling Crane
2084	1.3.2	Move TAD STC to Preparation Station or Closure Station	110 mins	2081,2073	2093,2100	CHC,Prep,PS2	Cask Handling Crane,Cask Prep Area,Preparati
2093	NOT in BFD	Move Unloaded Site Transporter to Yard	12 mins	2084		EV	Transportation Cask Vestibule (Entrance Vestib
2100	NOT in BFD	Clean Up CHC	25 mins	2084	2104	CHC,Prep	Cask Handling Crane,Cask Prep Area
2104	NOT in BFD	Prepare Aux. Crane	20 mins	2100	2107	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
2107	NOT in BFD	Attach Lid Lifting Device on STC Lid	110 mins	2104	2115,2117	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
2115	1.3.3	Remove TAD STC Lid Bolts	72 mins	2107	2122	PS2	Preparation Station #2
2117	NOT in BFD	Prepare Jib Crane	40 mins	2107	2122	PS2 JC	Preparation Station #2 Jib Crane
2122	1.3.4	Remove TAD STC Lid and Place on Lid Rack	35 mins	2115,2117	2129	PS2 JC,PS2	Preparation Station #2 Jib Crane,Preparation St
2129	1.3.5	Remove TAD Lid and Place on Lid Rack	50 mins	2122	2141,2137	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
2137	NOT in BFD	Clean up Jib Crane	25 mins	2129	2155	PS2 JC	Preparation Station #2 Jib Crane
2141	1.3.6	Fill TAD with Borated Water	29 mins	2129	2145	PS2	Preparation Station #2
2145	1.3.7	Fill TAD STC with Borated Water	34 mins	2141	2149	PS2	Preparation Station #2
2149	NOT in BFD	Prepare Jib Crane	35 mins	2145	2153	Prep,PS2 JC	Cask Prep Area,Preparation Station #2 Jib Cran
2153	1.3.8	Place TAD Lid onto TAD	50 mins	2149	2161	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
2161	1.3.9	Place TAD STC Lid onto TAD STC	50 mins	2153	2169	PS2 JC,PS2	Preparation Station #2 Jib Crane,Preparation St
2169	NOT in BFD	Prepare CHC	20 mins	2161	2172	CHC,Prep	Cask Handling Crane,Cask Prep Area
2172	1.3.10	Move and Lower TAD STC to Staging Shelf in Pool	60 mins	2169	2180	CHC,Prep,Pool,PS2	Cask Handling Crane,Cask Prep Area,Pool Area
2180	1.3.11	Wash Cask Handling Yoke over Pool and Place onto Stand	30 mins	2172	2184	CHC,Pool	Cask Handling Crane,Pool Area
2184	1.3.12	Attach Long Reach Adapter and Pool Cask Handling Yoke to Cask Handling	35 mins	2180	2188	CHC,Pool	Cask Handling Crane,Pool Area
2188	1.3.13	Lower TAD STC to TAD STC Position in Bottom of Pool	70 mins	2184	2197	CHC,Pool	Cask Handling Crane,Pool Area
2197	NOT in BFD	Clean up CHC - Remove Lifting Yokes	55 mins	2188	2203	CHC	Cask Handling Crane
2203	NOT in BFD	Prepare Pool Aux. Crane	20 mins	2197	2206	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
2206	1.3.14	Remove TAD STC Lid and Place on Lid Rack	35 mins	2203	2213	APC,Pool	Auxiliary Pool Crane,Pool Area
2213	NOT in BFD	Prepare Aux. Crane	20 mins	2206	2216	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
2216	1.3.15	Remove TAD Lid and Place on Lid Rack	55 mins	2213		APC,Pool	Auxiliary Pool Crane,Pool Area
2225	2.1	Move SNF Assemblies from Rack to TAD	571 mins	2072	2235		
2226	NOT IN BFD	QA Review of Loading Plan	105 mins		2227		
2227	2.1.1	Move SNF Assemblies from PWR Rack to TAD	445 mins	2226	2233	Pool,SFTM	Pool Area,Spent Fuel Transfer Machine
2233	NOT IN BFD	Perform Nuclear Materials Accountability Check	21 mins	2227			
2235	4.1	TAD Canister Closure	2832 mins	2225	2495		
2236	NOT IN BFD	Prepare Pool Aux Crane	40 mins		2241	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
2241	4.1.1	Install TAD Canister Lid	35 mins	2236	2247,2256	Pool,APC	Pool Area,Auxiliary Pool Crane
2247	4.1.2	Install TAD STC Lid	60 mins	2241	2260	APC,Pool	Auxiliary Pool Crane,Pool Area
2256	NOT in BFD	Prepare CHC	40 mins	2241	2260	CHC,Prep	Cask Handling Crane,Cask Prep Area
2260	4.1.3	Lift TAD STC to Staging Shelf	65 mins	2247,2256	2271	CHC,Pool	Cask Handling Crane,Pool Area
2271	4.1.4	Wash Cask Pool Handling Yoke Over Pool and Plane on Cask Pool Handling	15 mins	2260	2273	CHC,Pool	Cask Handling Crane,Pool Area
2273	4.1.5	Detach Pool Yoke Lift Adapter and Place onto Stand	40 mins	2271	2278	CHC,Pool	Cask Handling Crane,Pool Area
2278	4.1.6	Attach Cask Handling Yoke to Cask Handling Crane	25 mins	2273	2281	Pool,CHC	Pool Area,Cask Handling Crane
2281	4.1.7	Bolt TAD STC Lid with a minimum of Four Bolts	40 mins	2278	2285	Pool,SFTM	Pool Area,Spent Fuel Transfer Machine
2285	4.1.8	Lift TAD STC Out of Pool	35 mins	2281	2290	CHC,Pool	Cask Handling Crane,Pool Area
2290	4.1.9	Wash Lifting Yoke and Exterior of TAD STC Over Pool	30 mins	2285	2291	Pool,CHC	Pool Area,Cask Handling Crane
2291	4.1.10	Move TAD STC to TAD Closure Station	20 mins	2290	2296	CHC,TCS	Cask Handling Crane,TAD Closure Station



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Task | Milestone | Rolled Up Critical Task | Split | External Milestone
Critical Task | Summary | Rolled Up Milestone | External Tasks | External Milestone
Progress | Rolled Up Task | Rolled Up Progress | Project Summary | Deadline

Sheet 2

Figure A-2. Summary WHF Gantt Chart – Sheet 2

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ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
2296		Clean Up CHC	25 mins	2291	2300	Pool,CHC	Pool Area,Cask Handling Crane
2300	NOT in BFD	Install PPE and Temporary Shielding	90 mins	2296	2302	TCS,TCS JC	TAD Closure Station,TAD Closure Jib Crane
2302	4.1.11	Open TAD Stc Drain Port and Drain TAD STC Partially	34 mins	2300	2308	TCS	TAD Closure Station
2308	4.1.12	Remove TAD STC Lid Bolts	12 mins	2302	2311	TCS	TAD Closure Station
2310		TAD Welding (and Cold Vacuum Drying)	2266 mins				
2311	4.1.13	Remove TAD STC Lid and Place in Lid Rack	35 mins	2308	2318	TCS,TCS JC	TAD Closure Station,TAD Closure Jib Crane
2318	4.1.14	Install Cask Shield Ring	35 mins	2311	2325	TCS JC,TCS	TAD Closure Jib Crane,TAD Closure Station
2325	4.1.15	Drain TAD Partially	32 mins	2318	2329	TCS	TAD Closure Station
2329	4.1.16	Move TAD Canister Welding Machine to the TAD	15 mins	2325	2333	TCS JC,TCS,WS	TAD Closure Jib Crane,TAD Closure Station,TA
2333	4.1.17	Position the TAD Canister Welding Machine on the TAD Canister Lid	50 mins	2329	2338	TCS JC,TCS,WS,NDE	TAD Closure Jib Crane,TAD Closure Station,TA
2338	4.1.18	Weld TAD Inner Lid and Inspect Weld	440 mins	2333	2356	WS,TCS,TCS JC,NDE	TAD Canister Welding Machine,TAD Closure St
2356	4.1.19	Drain TAD Canister Fully	34 mins	2338	2362	TCS	TAD Closure Station
2362	4.1.20	Dry TAD Canister Interior, Helium Fill and Leak Test Weld	325 mins	2356	2387	TCS JC,WS	TAD Closure Jib Crane,TAD Canister Welding M
2387	4.1.21	Weld TAD Canister Drain Ports and Inspect Weld	200 mins	2362	2403	TCS,WS,NDE,TCS JC	TAD Closure Station,TAD Canister Welding Mac
2403	4.1.22	Remove TAD Canister Welding Machine from the TAD Canister	35 mins	2387	2410	TCS JC,TCS,WS	TAD Closure Jib Crane,TAD Closure Station,TA
2410	4.1.23	Place Outer Lid on Tad Canister	45 mins	2403	2417	TCS,TCS JC	TAD Closure Station,TAD Closure Jib Crane
2417	4.1.24	Move TAD Canister Welding Machine to the TAD Canister and Position	65 mins	2410	2426	TCS JC,WS,TCS	TAD Closure Jib Crane,TAD Canister Welding M
2426	4.1.25	Weld TAD Outer Lid and Inspect Weld	440 mins	2417	2444	WS,TCS,TCS JC,NDE	TAD Canister Welding Machine,TAD Closure St
2444	4.1.26	Remove TAD Canister Welding Machine from the TAD Canister	35 mins	2426	2451	TCS JC,WS,TCS	TAD Closure Jib Crane,TAD Canister Welding M
2451	4.1.27	Remove Cask Shield Ring	35 mins	2444	2458	WS,TCS JC	TAD Canister Welding Machine,TAD Closure Jit
2458	4.1.28	Install TAD STC Lid	40 mins	2451	2465	TCS,TCS JC	TAD Closure Station,TAD Closure Jib Crane
2465	4.1.29	Bolt TAD STC Lid (All Bolts Req'd to Exit Facility)	240 mins	2458	2467	TCS	TAD Closure Station
2467	4.1.30	Open TAD STC Drain Port	6 mins	2465	2470	TCS	TAD Closure Station
2470	4.1.31	Drain Annulus Between STC and TAD	38 mins	2467	2474	TCS	TAD Closure Station
2474	4.1.32	Dry Interior of TAD STC	110 mins	2470	2492	TCS,TCS JC,WS	TAD Closure Station,TAD Closure Jib Crane,TA
2492	Not in BFD	Close STC Drain Port	11 mins	2474		TCS	TAD Closure Station
2495	1.5	Receive Aging Overpack (AO = Aging Overpack)	394 mins	2235	2559		
2496	1.5.1	Move Site Transporter with Aging Overpack to Aging Overpack Access Plat	14 mins		2500	AOAP	Aging Overpack Access Platform
2500	1.5.2	Remove Aging Overpack Lid Bolts	96 mins	2496	2502	AOAP	Aging Overpack Access Platform
2502	1.5.3	Move Site Transporter with Aging Overpack into Loading Room	14 mins	2500			
2506	1.5.4	Move Cask Transfer Trolley into Preparation Station #1	20 mins		2510	PS1 JC,PS1,CTT	Preparation Station #1 Jib Crane[56%],Preparati
2510	1.5.5	Install Cask Pedestal in Cask Transfer Trolley	85 mins	2506	2529	CHC,CTT,EV	Cask Handling Crane,Canister Transfer Trolley,
2529	1.5.6	Move TAD STC to Cask Transfer Trolley	45 mins	2510	2535	CTT,PS1	Canister Transfer Trolley[50%],Preparation Stat
2535	1.5.7	Secure TAD STC to Cask Transfer Trolley	200 mins	2529	2552	CTT,PS1	Canister Transfer Trolley[51%],Preparation Stat
2552	1.5.8	Remove TAD STC Lid Bolts	12 mins	2535	2554		
2554	1.5.9	Move TAD STC into Cask Unloading Room	32 mins	2552		CTT	Canister Transfer Trolley
2559	5.1	Move TAD to AO	138 mins	2495	2597,2612		
2560	5.1.1	Remove AO Lid and Place in Laydown Area	30 mins		2567	CTM	Canister Transfer Machine
2567	5.1.2	Move Canister Transfer Machine to Cask Port Slide Gate	5 mins	2560	2568	CTM	Canister Transfer Machine
2568	5.1.3	Remove TAD STC Lid and Place in Laydown Area	30 mins	2567	2575	CTM	Canister Transfer Machine
2575	5.1.4	Open Canister Transfer Machine Slide Gate and Open Cask Port Slide Gate	2 mins	2568	2578	CTM	Canister Transfer Machine
2578	5.1.5	Lift TAD into Canister transfer Machine	25 mins	2575	2582	CTM	Canister Transfer Machine
2582	5.1.6	Close Canister Transfer Machine Slide Gate and Close Cask Port Slide Gate	2 mins	2578	2585	CTM	Canister Transfer Machine
2585	5.1.7	Move Canister Transfer Machine to Overpack Port	5 mins	2582	2587	CTM	Canister Transfer Machine
2587	5.1.8	Open Canister Transfer Machine Slide Gate and Open Overpack Port Slide (	2 mins	2585	2590	CTM	Canister Transfer Machine
2590	5.1.9	Lower TAD into Aging Overpack	35 mins	2587	2594	CTM	Canister Transfer Machine
2594	5.1.10	Close Canister Transfer Machine Slide gate and Close Overpack Port Slide (	2 mins	2590		CTM	Canister Transfer Machine
2597	1.6	Export TAD in Aging Overpack	299 mins	2559			
2598	1.6.1	Install Aging Overpack Lid	45 mins		2606	CTM	Canister Transfer Machine
2606	1.6.2	Move Site Transporter with Aging Overpack to Aging Overpack Access Plat	14 mins	2598	2610	AOAP	Aging Overpack Access Platform
2610	1.6.3	Bolt Aging Overpack lid	240 mins	2606		AOAP	Aging Overpack Access Platform
2612	1.7	Store Unloaded TAD STC	480 mins	2559			

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Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | External Milestone | External Milestone | Deadline

Sheet 3

Figure A-3. Summary WHF Gantt Chart – Sheet 3

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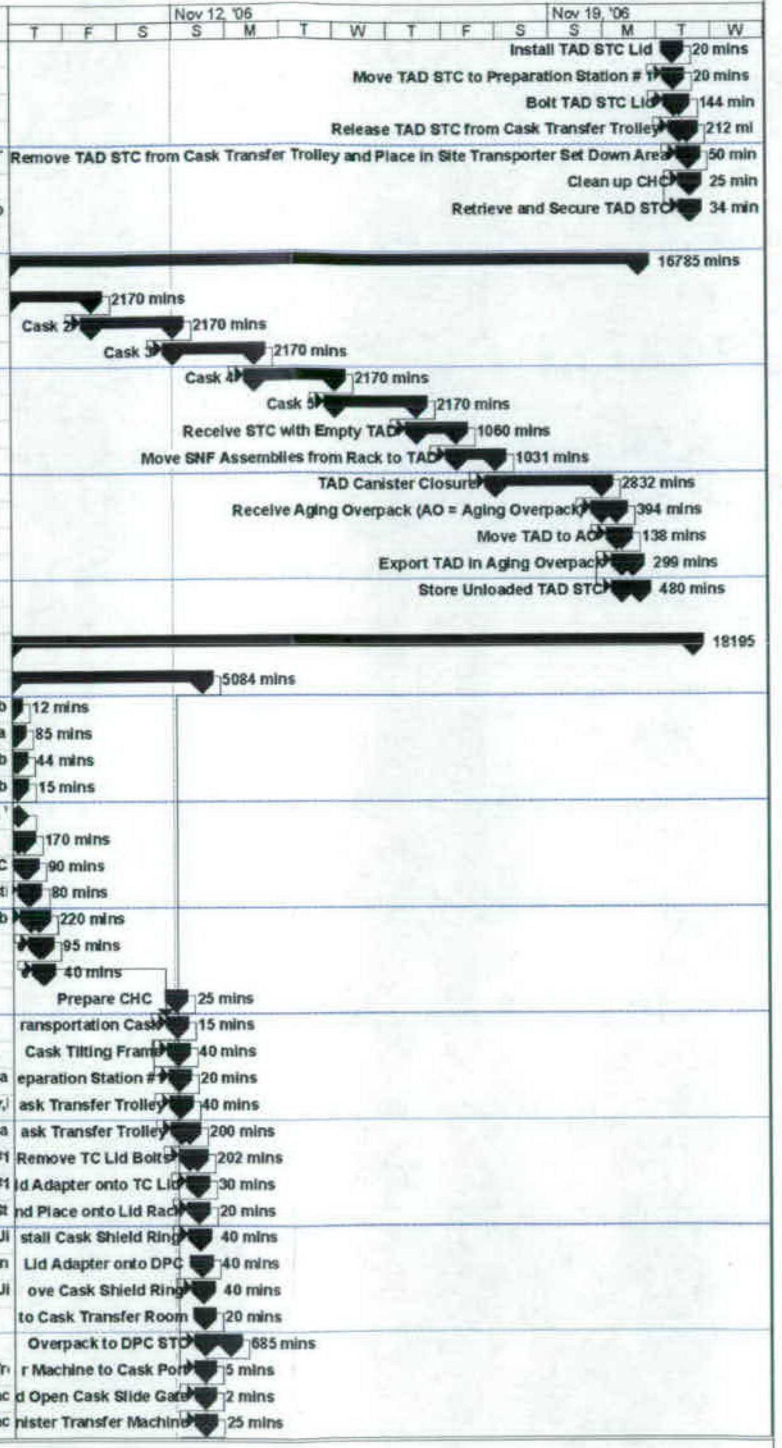
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
2613	1.7.1	Install TAD STC Lid	20 mins		2616	CHC,Prep	Cask Handling Crane,Cask Prep Area
2616	1.7.2	Move TAD STC to Preparation Station # 1	20 mins	2613	2620	CTT	Canister Transfer Trolley
2620	1.7.3	Bolt TAD STC Lid	144 mins	2616	2622		
2622	1.7.4	Release TAD STC from Cask Transfer Trolley	212 mins	2620	2642	CTT	Canister Transfer Trolley
2642	1.7.5	Remove TAD STC from Cask Transfer Trolley and Place in Site Transporter	50 mins	2622	2650,2654	CHC,Prep,CTT	Cask Handling Crane,Cask Prep Area,Canister '
2650	NOT in BFD	Clean up CHC	25 mins	2642		CHC,Prep	Cask Handling Crane,Cask Prep Area
2654	1.7.6	Retrieve and Secure TAD STC	34 mins	2642		EV	Transportation Cask Vestibule (Entrance Vestib
2668							
2669		**TC BWR TAD (in GA-9 Truck Cask)**	16785 mins				
2670		Cask 1	2170 mins		3015		
3015		Cask 2	2170 mins	2670	3360		
3360		Cask 3	2170 mins	3015	3705		
3705		Cask 4	2170 mins	3360	4050		
4050		Cask 5	2170 mins	3705	4395		
4395	1.3	Receive STC with Empty TAD	1060 mins	4050	4548		
4548	2.1	Move SNF Assemblies from Rack to TAD	1031 mins	4395	4558		
4558	4.1	TAD Canister Closure	2832 mins	4548	4818		
4818	1.5	Receive Aging Overpack (AO = Aging Overpack)	394 mins	4558	4882		
4882	5.1	Move TAD to AO	138 mins	4818	4920,4935		
4920	1.6	Export TAD in Aging Overpack	299 mins	4882			
4935	1.7	Store Unloaded TAD STC	480 mins	4882			
4991							
4992		**Hi-Star PWR DPC TAD**	18195 mins				
4993	1.1	Receive Transportation Cask with DPC	5084 mins		5233		
4994	Not in BFD	Receive Cask Pedestal	12 mins		5001	EV	Transportation Cask Vestibule (Entrance Vestib
5001	1.1.25	Install Cask Pedestal in Cask Transfer Trolley	85 mins	4994	5020	CHC,PS1,CTT	Cask Handling Crane,Preparation Station #1,Ca
5020	1.1.1	Park Tractor/Railcar with Transportation Cask in Receipt Area	44 mins	5001	5042	EV	Transportation Cask Vestibule (Entrance Vestib
5042	1.1.2	Move and Secure Platform into Position Around Tractor/Railcar	15 mins	5020	5045	EV,MAP	Transportation Cask Vestibule (Entrance Vestib
5045	Not in BFD	Remove and Store Personnel Barrier (if required)	0 mins	5042	5062	EVC,EV,MAP	Entrance Vestibule Crane,Transportation Cask '
5062	Not in BFD	Install Trunnions	170 mins	5045	5095	CHC,Prep	Cask Handling Crane,Cask Prep Area
5095	1.1.3	Remove Tie Downs	90 mins	5062	5105	CHC,MAP,Prep	Cask Handling Crane,Mobile Access Platform,C
5105	1.1.4	Move Transportation Cask with Impact Limiters to Cask Stand	80 mins	5095	5114	CHC,EV,Prep	Cask Handling Crane,Transportation Cask Vesti
5114	1.1.5	Remove and Store Impact Limiters	220 mins	5105	5138	EV,EVC,MAP	Transportation Cask Vestibule (Entrance Vestib
5138	1.1.6	Move Transportation Cask to Cask Tilting Frame	95 mins	5114	5149	CHC,Prep	Cask Handling Crane,Cask Prep Area
5149	1.1.7	Secure Transportation Cask to Cask Tilting Frame	40 mins	5138	5157	MAP	Mobile Access Platform
5153	Not in BFD	Prepare CHC	25 mins		5157	CHC	Cask Handling Crane
5157	1.1.8	Upend Frame with Transportation Cask	15 mins	5149,5153	5164,5160	CHC,Prep	Cask Handling Crane,Cask Prep Area
5160	1.1.9	Release Transportation Cask from Cask Tilting Frame	40 mins	5157	5164	CHC,MAP	Cask Handling Crane,Mobile Access Platform
5164	1.1.24	Move Cask Transfer Trolley to Preparation Station #1	20 mins	5157,5160	5168	CTT,Prep,PS1	Canister Transfer Trolley,Cask Prep Area,Prepa
5168	1.1.26	Move Transportation Cask to Cask Transfer Trolley	40 mins	5164	5173	CHC,CTT,PS1	Cask Handling Crane,Canister Transfer Trolley,I
5173	1.1.27	Secure Transportation Cask to Cask Transfer Trolley	200 mins	5168	5190	CTT,Prep,PS1 JC	Canister Transfer Trolley,Cask Prep Area,Prepa
5190	1.1.28	Remove TC Lid Bolts	202 mins	5173	5194	CTT,PS1	Canister Transfer Trolley,Preparation Station #1
5194	1.1.29	Attach TC Lid Adapter onto TC Lid	30 mins	5190	5200	CTT,PS1,PS1 JC	Canister Transfer Trolley,Preparation Station #1
5200	1.1.30	Remove Transportation Cask Lid and Place onto Lid Rack	20 mins	5194	5205	PS1 JC,PS1	Preparation Station #1 Jib Crane,Preparation St
5205	1.1.31	Install Cask Shield Ring	40 mins	5200		PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5213	1.1.32	Install DPC Lid Adapter onto DPC	40 mins	5212	5221	Prep,PS1 JC,CTT,PS1	Cask Prep Area,Preparation Station #1 Jib Cran
5221	1.1.33	Remove Cask Shield Ring	40 mins	5213		PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5229	1.1.34	Move Transportation Cask into Cask Transfer Room	20 mins	5228	5234	CTT	Canister Transfer Trolley
5233	5.2	Move DPC from TC/Aging Overpack to DPC STC	685 mins	4993	5291		
5234	5.2.11	Move Canister Transfer Machine to Cask Port	5 mins	5229	5236	CTM,CTT	Canister Transfer Machine,Canister Transfer Tr
5236	5.2.12	Open CTM Slide Gate and Open Cask Slide Gate	2 mins	5234	5239	CTT,CTM	Canister Transfer Trolley,Canister Transfer Mac
5239	5.2.13	Lift DPC into Canister Transfer Machine	25 mins	5236	5243	CTT,CTM	Canister Transfer Trolley,Canister Transfer Mac



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Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | External Milestone | External Milestone | Deadline

Sheet 4

Figure A-4. Summary WHF Gantt Chart – Sheet 4

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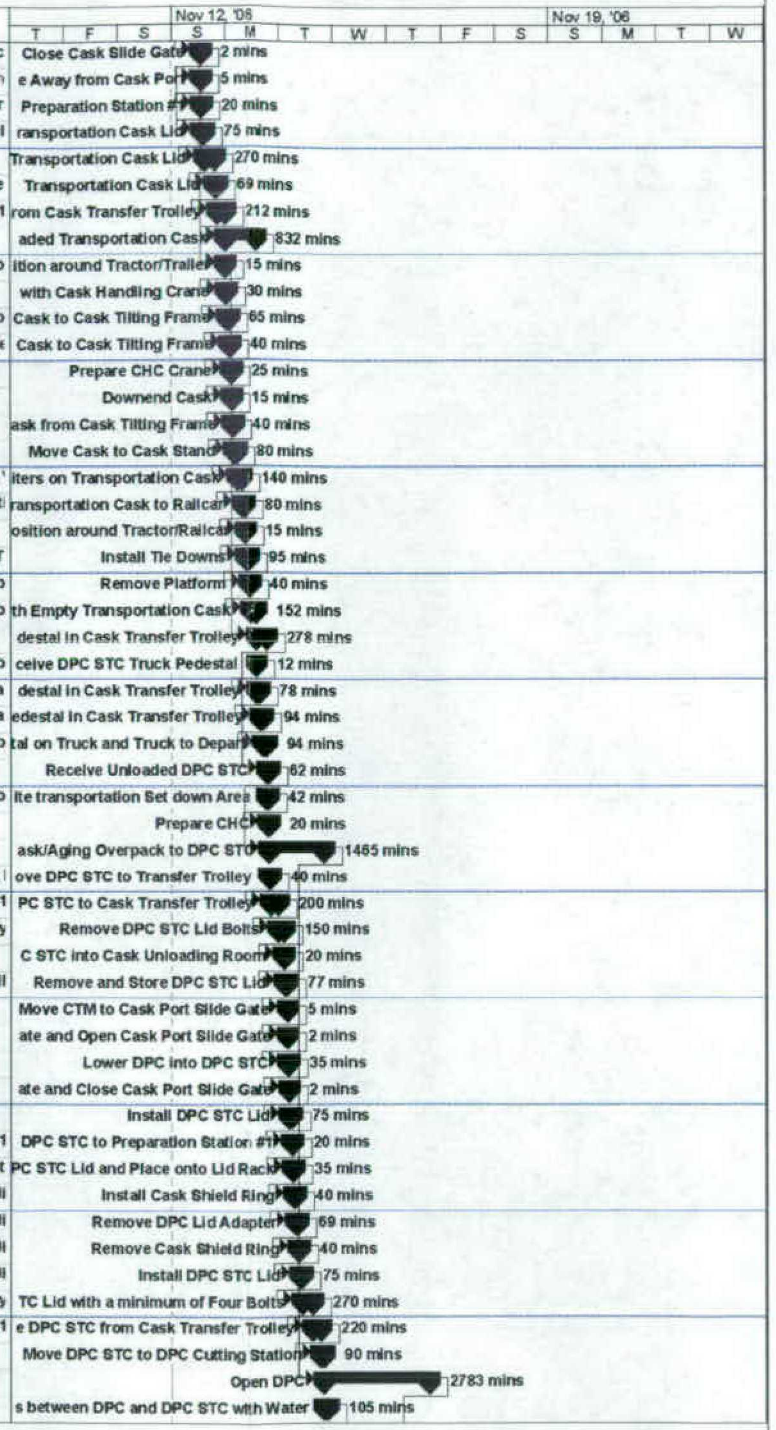
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
5243	5.2.14	Close CTM Slide Gate and Close Cask Slide Gate	2 mins	5239	5252,5246	CTT,CTM	Canister Transfer Trolley,Canister Transfer Mac
5246	5.2.15	Move Canister Transfer Machine Away from Cask Port	5 mins	5243	5248	CTM,CTT	Canister Transfer Machine,Canister Transfer Tr
5248	5.2.16	Move Transportation Cask to Preparation Station #1	20 mins	5246	5252	Prep,PS1,CTT	Cask Prep Area,Preparation Station #1,Canister
5252	5.2.17	Install Transportation Cask Lid	75 mins	5243,5248	5261	CTMMC,CTT	CTM Maintenance Crane,Canister Transfer Troll
5261	5.2.18	Bolt Transportation Cask Lid	270 mins	5252	5263	Prep,PS1	Cask Prep Area,Preparation Station #1
5263	5.2.19	Remove Transportation Cask Lid Adapter from Transportation Cask Lid	69 mins	5261	5271	PS1 JC,Prep	Preparation Station #1 Jib Crane,Cask Prep Are
5271	5.2.20	Release Transportation Cask from Cask Transfer Trolley	212 mins	5263	5292	CTT,PS1,PS1 JC	Canister Transfer Trolley,Preparation Station #1
5291	1.2	Export Unloaded Transportation Cask	832 mins	5233	5401		
5292	Not in BFD	Move and Secure Platforms into Position around Tractor/Trailer	15 mins	5271	5295	EV,MAP	Transportation Cask Vestibule (Entrance Vestib
5295	1.2.15	Engage Transportation Cask with Cask Handling Crane	30 mins	5292	5300		
5300	1.2.16	Move Transportation Cask to Cask Tilting Frame	65 mins	5295	5307	EV,CHC,MAP	Transportation Cask Vestibule (Entrance Vestib
5307	1.2.17	Secure Transportation Cask to Cask Tilting Frame	40 mins	5300	5311	MAP,EV	Mobile Access Platform,Transportation Cask Ve
5311	Not in BFD	Prepare CHC Crane	25 mins	5307	5315	CHC	Cask Handling Crane
5315	1.2.18	Downend Cask	15 mins	5311	5318	CHC	Cask Handling Crane
5318	1.2.19	Release Transportation Cask from Cask Tilting Frame	40 mins	5315	5322	MAP	Mobile Access Platform
5322	1.2.20	Move Cask to Cask Stand	80 mins	5318	5331	CHC	Cask Handling Crane
5331	1.2.21	Install Impact Limiters on Transportation Cask	140 mins	5322	5350	EVC,EV,MAP	Entrance Vestibule Crane,Transportation Cask '
5350	1.2.22	Move Transportation Cask to Railcar	80 mins	5331	5357	CHC,EV	Cask Handling Crane,Transportation Cask Vest
5357	1.2.23	Move and Secure Platform into Position around Tractor/Railcar	15 mins	5350	5360	MAP	Mobile Access Platform
5360	1.2.24	Install Tie Downs	95 mins	5357	5368	MAP,CHC,EV	Mobile Access Platform,Cask Handling Crane,T
5368	1.2.30	Remove Platform	40 mins	5360	5371	EV,MAP	Transportation Cask Vestibule (Entrance Vestib
5371	Not in BFD	Exit Tractor/Trailer with Empty Transportation Cask	152 mins	5368	5410	EV	Transportation Cask Vestibule (Entrance Vestib
5401	5.2.21	Switch Cask Pedestal in Cask Transfer Trolley	278 mins	5291	5455		
5402	Not in BFD	Receive DPC STC Truck Pedestal	12 mins		5409	EV	Transportation Cask Vestibule (Entrance Vestib
5409	Not in BFD	Uninstall Cask Pedestal in Cask Transfer Trolley	78 mins	5402	5422	CHC,PS1,CTT	Cask Handling Crane,Preparation Station #1,Ca
5422	Not in BFD	Install STC Pedestal in Cask Transfer Trolley	94 mins	5409	5436	CHC,PS1,CTT	Cask Handling Crane,Preparation Station #1,Ca
5436	NOT in BFD	Place Cask Pedestal on Truck and Truck to Depart	94 mins	5422		EV,CHC	Transportation Cask Vestibule (Entrance Vestib
5455	1.12	Receive Unloaded DPC STC	62 mins	5401	5467		
5456	1.12.1	Lay Down STC in Site transportation Set down Area	42 mins		5464	EV	Transportation Cask Vestibule (Entrance Vestib
5464	Not in BFD	Prepare CHC	20 mins	5456		CHC,Prep	Cask Handling Crane,Cask Prep Area
5467	5.2	Move DPC From Transportation Cask/Aging Overpack to DPC STC	1465 mins	5455	5608		
5468	5.2.22	Move DPC STC to Transfer Trolley	40 mins		5474	CTT,Prep,CHC,PS1	Canister Transfer Trolley,Cask Prep Area,Cask I
5474	5.2.23	Secure DPC STC to Cask Transfer Trolley	200 mins	5468	5491	CTT,PS1,PS1 JC	Canister Transfer Trolley,Preparation Station #1
5491	5.2.24	Remove DPC STC Lid Bolts	150 mins	5474	5493	PS1,CTT	Preparation Station #1,Canister Transfer Trolley
5493	5.2.25	Move DPC STC into Cask Unloading Room	20 mins	5491	5497	CTT	Canister Transfer Trolley
5497	5.2.26	Remove and Store DPC STC Lid	77 mins	5493	5508	CTMMC,CTT	CTM Maintenance Crane,Canister Transfer Troll
5508	5.2.27	Move CTM to Cask Port Slide Gate	5 mins	5497	5510	CTM	Canister Transfer Machine
5510	5.2.28	Open CTM Slide Gate and Open Cask Port Slide Gate	2 mins	5508	5513	CTM	Canister Transfer Machine
5513	5.2.29	Lower DPC into DPC STC	35 mins	5510	5517	CTM	Canister Transfer Machine
5517	5.2.30	Close CTM Slide Gate and Close Cask Port Slide Gate	2 mins	5513	5520	CTM	Canister Transfer Machine
5520	5.2.31	Install DPC STC Lid	75 mins	5517	5529	CTM	Canister Transfer Machine
5529	5.2.32	Move DPC STC to Preparation Station #1	20 mins	5520	5533	CTT,PS1	Canister Transfer Trolley,Preparation Station #1
5533	5.2.33	Remove DPC STC Lid and Place onto Lid Rack	35 mins	5529	5540	PS1 JC,PS1,CTT	Preparation Station #1 Jib Crane,Preparation St
5540	5.2.34	Install Cask Shield Ring	40 mins	5533	5548	PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5548	5.2.35	Remove DPC Lid Adapter	69 mins	5540	5556	PS1,PS1 JC,CTT	Preparation Station #1,Preparation Station #1 Ji
5556	5.2.36	Remove Cask Shield Ring	40 mins	5548	5564	PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5564	5.2.37	Install DPC STC Lid	75 mins	5556	5573	PS1,PS1 JC,CTT	Preparation Station #1,Preparation Station #1 Ji
5573	5.2.38	Bolt DPC STC Lid with a minimum of Four Bolts	270 mins	5564	5575	PS1,CTT	Preparation Station #1,Canister Transfer Trolley
5575	5.2.39	Release DPC STC from Cask Transfer Trolley	220 mins	5573	5595	CTT,PS1 JC,PS1	Canister Transfer Trolley,Preparation Station #1
5595	5.2.40	Move DPC STC to DPC Cutting Station	90 mins	5575		CHC,DPC-CM	Cask Handling Crane,DPC Cutting Machine
5608	3.1	Open DPC	2783 mins	5467	5840		
5609	3.1.1	Open DPC STC Fill/Vent Ports and Fill Annulus between DPC and DPC STC	105 mins		5630	DPC-C	DPC Cutting Station



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Legend: Task; Critical Task; Progress; Milestone; Summary; Rolled Up Task; Rolled Up Critical Task; Rolled Up Milestone; Rolled Up Progress; Split; External Tasks; Project Summary; External Milestone; External Milestone; Deadline

Sheet 5

Figure A-5. Summary WHF Gantt Chart – Sheet 5

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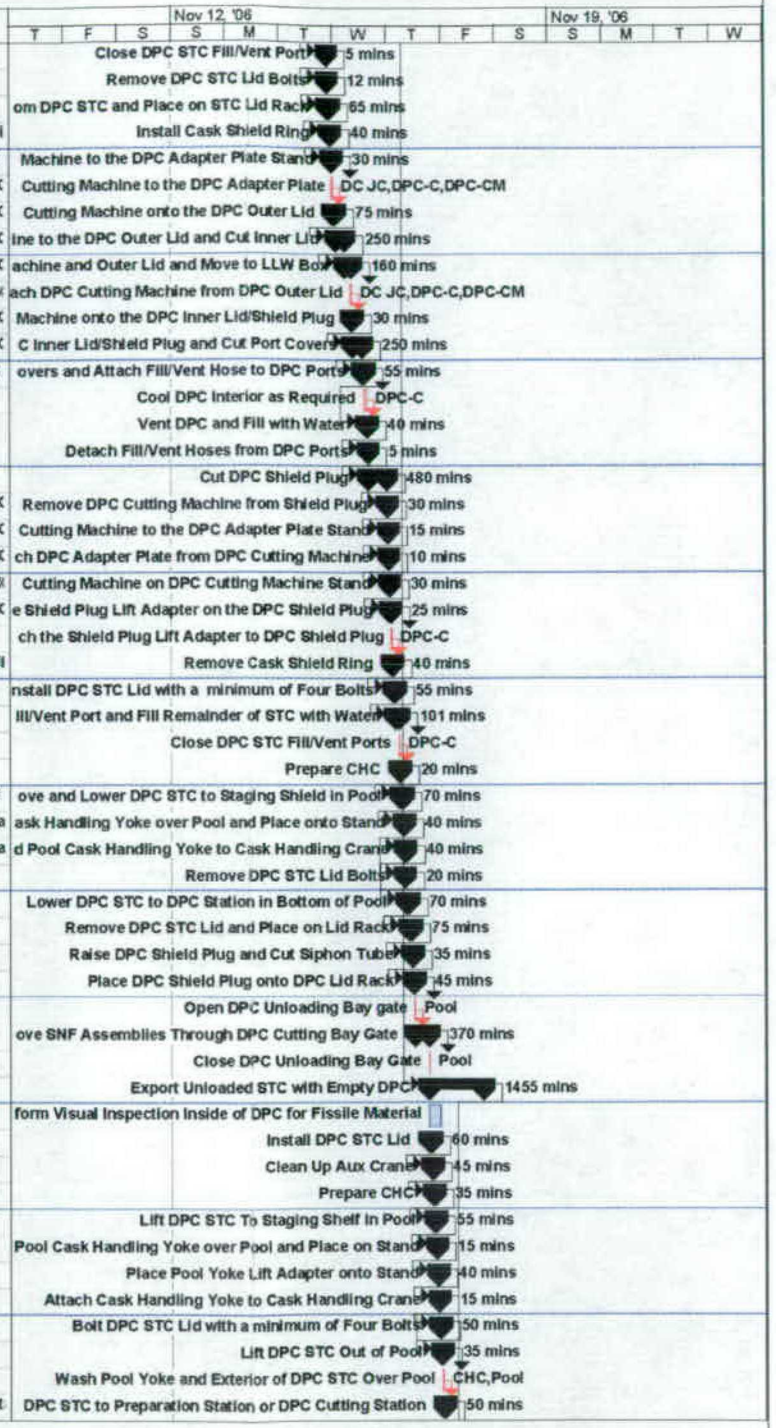
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
5630	3.1.2	Close DPC STC Fill/Vent Port	5 mins	5609	5632	DPC-C	DPC Cutting Station
5632	3.1.3	Remove DPC STC Lid Bolts	12 mins	5630	5634	DPC-C	DPC Cutting Station
5634	3.1.4	Remove Lid from DPC STC and Place on STC Lid Rack	65 mins	5632	5644	DPC-C,DC JC	DPC Cutting Station,DPC Cutting Jib Crane
5644	3.1.5	Install Cask Shield Ring	40 mins	5634	5652	PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5652	3.1.6	Move DPC Cutting Machine to the DPC Adapter Plate Stand	30 mins	5644	5657	DPC-C,DPC-CM,DC JC	DPC Cutting Station,DPC Cutting Machine,DPC
5657	3.1.7	Attach DPC Cutting Machine to the DPC Adapter Plate	10 mins	5652	5658	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5658	3.1.8	Position the DPC Cutting Machine onto the DPC Outer Lid	75 mins	5657	5662	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5662	3.1.9	Attach DPC Cutting Machine to the DPC Outer Lid and Cut Inner Lid	250 mins	5658	5666	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5666	3.1.10	Remove DPC Cutting Machine and Outer Lid and Move to LLW Box	160 mins	5662	5687	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5687	3.1.11	Detach DPC Cutting Machine from DPC Outer Lid	10 mins	5666	5688	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station[33%
5688	3.1.12	Position the DPC Cutting Machine onto the DPC Inner Lid/Shield Plug	30 mins	5687	5693	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5693	3.1.13	Attach DPC Cutting Machine to DPC Inner Lid/Shield Plug and Cut Port Cov	250 mins	5688	5697	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5697	3.1.14	Remove DPC Port Covers and Attach Fill/Vent Hose to DPC Ports	55 mins	5693	5705,5706	DPC-C,DPC-CM,DC JC	DPC Cutting Station,DPC Cutting Machine,DPC
5705	3.1.15	Cool DPC Interior as Required	60 mins	5697	5706	DPC-C	DPC Cutting Station
5706	3.1.16	Vent DPC and Fill with Water	40 mins	5697,5705	5712	DPC-C	DPC Cutting Station
5712	3.1.17	Detach Fill/Vent Hoses from DPC Ports	5 mins	5706	5715	DPC-C	DPC Cutting Station
5715	3.1.21	Cut DPC Shield Plug	480 mins	5712	5717	DPC-C,DPC-CM	DPC Cutting Station,DPC Cutting Machine
5717	3.1.22	Remove DPC Cutting Machine from Shield Plug	30 mins	5715	5721	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5721	3.1.23	Move DPC Cutting Machine to the DPC Adapter Plate Stand	15 mins	5717	5725	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5725	3.1.24	Detach DPC Adapter Plate from DPC Cutting Machine	10 mins	5721	5727	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5727	3.1.25	Park DPC Cutting Machine on DPC Cutting Machine Stand	30 mins	5725	5732	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station[67%
5732	3.1.26	Position the Shield Plug Lift Adapter on the DPC Shield Plug	25 mins	5727	5737	DC JC,DPC-C,DPC-CM	DPC Cutting Jib Crane,DPC Cutting Station,DP(
5737	3.1.27	Attach the Shield Plug Lift Adapter to DPC Shield Plug	15 mins	5732	5738	DPC-C	DPC Cutting Station
5738	3.1.28	Remove Cask Shield Ring	40 mins	5737	5746	PS1,PS1 JC	Preparation Station #1,Preparation Station #1 Ji
5746	3.1.29	Install DPC STC Lid with a minimum of Four Bolts	55 mins	5738	5750	DC JC,DPC-C	DPC Cutting Jib Crane,DPC Cutting Station
5750	3.1.30	Open DPC STC Fill/Vent Port and Fill Remainder of STC with Water	101 mins	5746	5771	DPC-C	DPC Cutting Station
5771	3.1.31	Close DPC STC Fill/Vent Ports	5 mins	5750	5772	DPC-C	DPC Cutting Station
5772	NOT In BFD	Prepare CHC	20 mins	5771	5775	CHC,Prep	Cask Handling Crane,Cask Prep Area
5775	3.1.32	Move and Lower DPC STC to Staging Shield in Pool	70 mins	5772	5783	CHC,DPC-C,Pool	Cask Handling Crane,DPC Cutting Station,Pool
5783	3.1.33	Wash Cask Handling Yoke over Pool and Place onto Stand	40 mins	5775	5788,5793	CHC,Prep,Pool	Cask Handling Crane,Cask Prep Area,Pool Area
5788	3.1.34	Attach Long Reach Adapter and Pool Cask Handling Yoke to Cask Handling	40 mins	5783	5795	CHC,Prep,Pool	Cask Handling Crane,Cask Prep Area,Pool Area
5793	3.1.35	Remove DPC STC Lid Bolts	20 mins	5783	5795		
5795	3.1.36	Lower DPC STC to DPC Station in Bottom of Pool	70 mins	5793,5788	5804	CHC,Pool	Cask Handling Crane,Pool Area
5804	3.1.37	Remove DPC STC Lid and Place on Lid Rack	75 mins	5795	5815	APC,Pool	Auxiliary Pool Crane,Pool Area
5815	3.1.38	Raise DPC Shield Plug and Cut Siphon Tube	35 mins	5804	5821	APC,Pool	Auxiliary Pool Crane,Pool Area
5821	3.1.39	Place DPC Shield Plug onto DPC Lid Rack	45 mins	5815	5830	APC,Pool	Auxiliary Pool Crane,Pool Area
5830	3.1.40	Open DPC Unloading Bay gate	5 mins	5821	5831	Pool	Pool Area
5831	3.1.41	Move SNF Assemblies Through DPC Cutting Bay Gate	370 mins	5830	5839	SFTM,Pool	Spent Fuel Transfer Machine,Pool Area
5839	3.1.42	Close DPC Unloading Bay Gate	5 mins	5831		Pool	Pool Area
5840	1.9	Export Unloaded STC with Empty DPC	1455 mins	5608	5965		
5841	Not in BFD	Perform Visual Inspection Inside of DPC for Fissile Material	320 mins				
5842	1.9.1	Install DPC STC Lid	60 mins		5850	APC,Pool	Auxiliary Pool Crane,Pool Area
5850	NOT In BFD	Clean Up Aux Crane	45 mins	5842	5856	APC	Auxiliary Pool Crane
5856	NOT In BFD	Prepare CHC	35 mins	5850	5860	CHC	Cask Handling Crane
5860	1.9.2	Lift DPC STC To Staging Shelf in Pool	55 mins	5856	5869	CHC,Pool	Cask Handling Crane,Pool Area
5869	1.9.3	Wash Pool Cask Handling Yoke over Pool and Place on Stand	15 mins	5860	5871	CHC,Pool	Cask Handling Crane,Pool Area
5871	1.9.4	Place Pool Yoke Lift Adapter onto Stand	40 mins	5869	5876	CHC,Prep	Cask Handling Crane,Cask Prep Area
5876	1.9.5	Attach Cask Handling Yoke to Cask Handling Crane	15 mins	5871	5884,5878	CHC,Prep	Cask Handling Crane,Cask Prep Area
5878	1.9.6	Bolt DPC STC Lid with a minimum of Four Bolts	50 mins	5876	5884	Pool,APC	Pool Area,Auxiliary Pool Crane
5884	1.9.7	Lift DPC STC Out of Pool	35 mins	5876,5878	5889	CHC,Pool	Cask Handling Crane,Pool Area
5889	1.9.8	Wash Pool Yoke and Exterior of DPC STC Over Pool	30 mins	5884	5890	CHC,Pool	Cask Handling Crane,Pool Area
5890	1.9.9	Move DPC STC to Preparation Station or DPC Cutting Station	50 mins	5889	5895	CHC,Pool,DPC-C	Cask Handling Crane,Pool Area,DPC Cutting St



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Task · Critical Task · Progress · Milestone · Summary · Rolled Up Task · Rolled Up Critical Task · Rolled Up Milestone · Rolled Up Progress · Split · External Tasks · Project Summary · External Milestone · External Milestone · Deadline

Sheet 6

Figure A-6. Summary WHF Gantt Chart – Sheet 6

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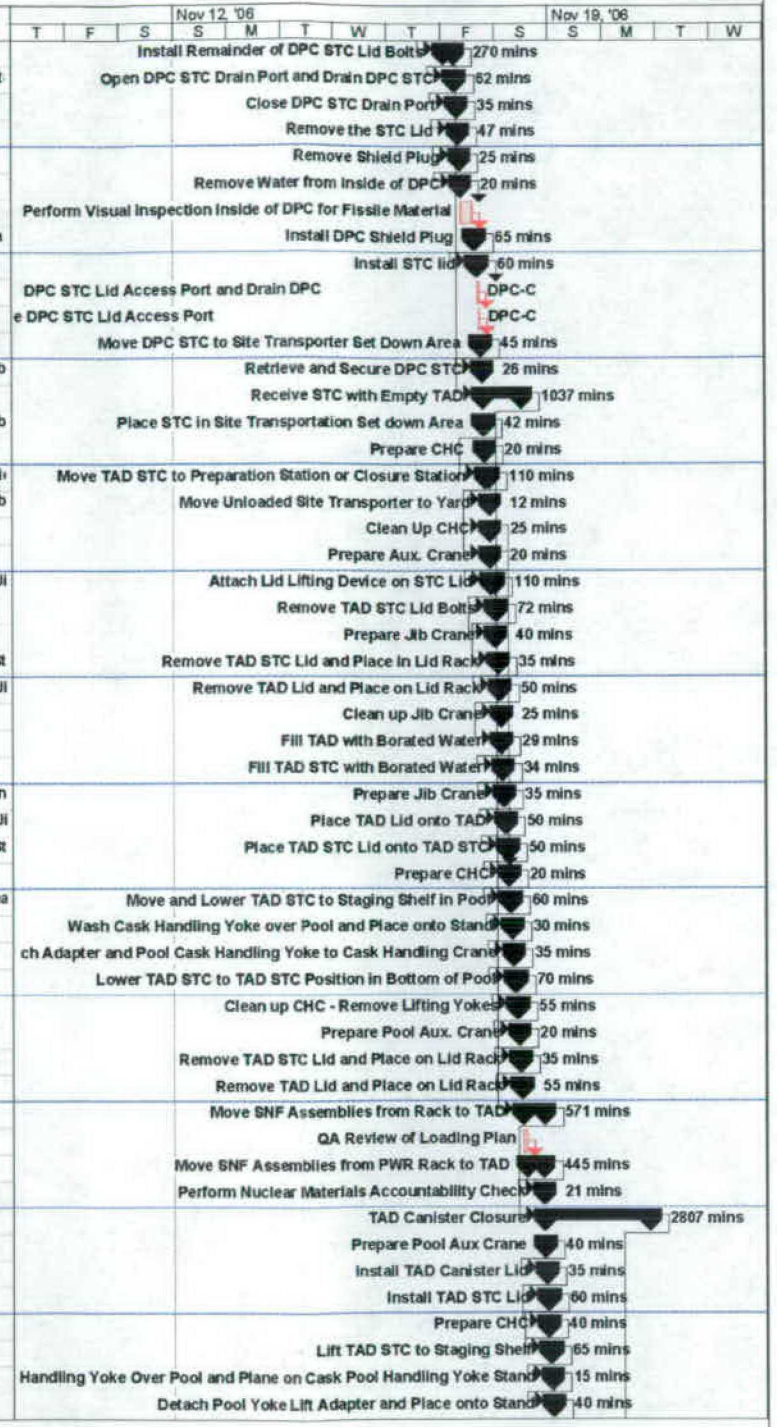
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
5895	1.9.10	Install Remainder of DPC STC Lid Bolts	270 mins	5890	5897		
5897	1.9.11	Open DPC STC Drain Port and Drain DPC STC	62 mins	5895	5903	Pool,CHC,DPC-C	Pool Area,Cask Handling Crane,DPC Cutting St
5903	1.9.12	Close DPC STC Drain Port	35 mins	5897,5902	5906	DPC-C	DPC Cutting Station
5906	Not in BFD	Remove the STC Lid	47 mins	5903	5914	APC	Auxiliary Pool Crane
5914	Not in BFD	Remove Shield Plug	25 mins	5906	5919		
5919	Not in BFD	Remove Water from Inside of DPC	20 mins	5914	5921		
5921	Not in BFD	Perform Visual Inspection Inside of DPC for Fissile Material	320 mins	5919	5922		
5922	Not in BFD	Install DPC Shield Plug	65 mins	5921	5933	APC,Prep,Pool	Auxiliary Pool Crane,Cask Prep Area,Pool Area
5933	Not in BFD	Install STC lid	60 mins	5922	5942	APC,Pool	Auxiliary Pool Crane,Pool Area
5942	1.9.13	Open DPC STC Lid Access Port and Drain DPC	45 mins	5933	5943	DPC-C	DPC Cutting Station
5943	1.9.14	Close DPC STC Lid Access Port	5 mins	5942	5944	DPC-C	DPC Cutting Station
5944	1.9.15	Move DPC STC to Site Transporter Set Down Area	45 mins	5943	5951	CHC,Prep	Cask Handling Crane,Cask Prep Area
5951	1.9.16	Retrieve and Secure DPC STC	26 mins	5944		EV	Transportation Cask Vestibule (Entrance Vestib
5965	1.3	Receive STC with Empty TAD	1037 mins	5840	6115		
5966	1.3.1	Place STC in Site Transportation Set down Area	42 mins		5977	EV	Transportation Cask Vestibule (Entrance Vestib
5974	Not in BFD	Prepare CHC	20 mins	5973	5977	Prep,CHC	Cask Prep Area,Cask Handling Crane
5977	1.3.2	Move TAD STC to Preparation Station or Closure Station	110 mins	5966,5974	5993,5986,5997	CHC,Prep,PS2	Cask Handling Crane,Cask Prep Area,Preparati
5986	NOT in BFD	Move Unloaded Site Transporter to Yard	12 mins	5977		EV	Transportation Cask Vestibule (Entrance Vestib
5993	NOT in BFD	Clean Up CHC	25 mins	5977	6062	CHC	Cask Handling Crane
5997	Not in BFD	Prepare Aux. Crane	20 mins	5977	6000	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
6000	NOT in BFD	Attach Lid Lifting Device on STC Lid	110 mins	5997	6008,6010	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
6008	1.3.3	Remove TAD STC Lid Bolts	72 mins	6000	6015	PS2	Preparation Station #2
6010		Prepare Jib Crane	40 mins	6000		PS2 JC	Preparation Station #2 Jib Crane
6015	1.3.4	Remove TAD STC Lid and Place in Lid Rack	35 mins	6008	6022	PS2 JC,PS2	Preparation Station #2 Jib Crane,Preparation St
6022	1.3.5	Remove TAD Lid and Place on Lid Rack	50 mins	6015	6034,6030	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
6030		Clean up Jib Crane	25 mins	6022		PS2 JC	Preparation Station #2 Jib Crane
6034	1.3.6	Fill TAD with Borated Water	29 mins	6022	6038	PS2	Preparation Station #2
6038	1.3.7	Fill TAD STC with Borated Water	34 mins	6034	6042	PS2	Preparation Station #2
6042		Prepare Jib Crane	35 mins	6038	6046	Prep,PS2 JC	Cask Prep Area,Preparation Station #2 Jib Cran
6046	1.3.8	Place TAD Lid onto TAD	50 mins	6042	6054	PS2,PS2 JC	Preparation Station #2,Preparation Station #2 Ji
6054	1.3.9	Place TAD STC Lid onto TAD STC	50 mins	6046	6062	PS2 JC,PS2	Preparation Station #2 Jib Crane,Preparation St
6062		Prepare CHC	20 mins	6054,5993	6065	CHC,Prep	Cask Handling Crane,Cask Prep Area
6065	1.3.10	Move and Lower TAD STC to Staging Shelf in Pool	60 mins	6062	6073	CHC,Prep,Pool,PS2	Cask Handling Crane,Cask Prep Area,Pool Area
6073	1.3.11	Wash Cask Handling Yoke over Pool and Place onto Stand	30 mins	6065	6077	CHC,Pool	Cask Handling Crane,Pool Area
6077	1.3.12	Attach Long Reach Adapter and Pool Cask Handling Yoke to Cask Handling	35 mins	6073	6081	CHC,Pool	Cask Handling Crane,Pool Area
6081	1.3.13	Lower TAD STC to TAD STC Position in Bottom of Pool	70 mins	6077	6090	CHC,Pool	Cask Handling Crane,Pool Area
6090	NOT in BFD	Clean up CHC - Remove Lifting Yokes	55 mins	6081	6096	CHC	Cask Handling Crane
6096	NOT in BFD	Prepare Pool Aux. Crane	20 mins	6090	6099	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
6099	1.3.14	Remove TAD STC Lid and Place on Lid Rack	35 mins	6096	6106	APC,Pool	Auxiliary Pool Crane,Pool Area
6106	1.3.15	Remove TAD Lid and Place on Lid Rack	55 mins	6099		APC,Pool	Auxiliary Pool Crane,Pool Area
6115	2.1	Move SNF Assemblies from Rack to TAD	571 mins	5965	6125		
6116	NOT IN BFD	QA Review of Loading Plan	105 mins		6117		
6117	2.1.1	Move SNF Assemblies from PWR Rack to TAD	445 mins	6116	6123	Pool,SFTM	Pool Area,Spent Fuel Transfer Machine
6123	NOT IN BFD	Perform Nuclear Materials Accountability Check	21 mins	6117			
6125	4.1	TAD Canister Closure	2807 mins	6115	6385		
6126	NOT IN BFD	Prepare Pool Aux Crane	40 mins		6131	APC,Prep	Auxiliary Pool Crane,Cask Prep Area
6131	4.1.1	Install TAD Canister Lid	35 mins	6126	6137,6146	Pool,APC	Pool Area,Auxiliary Pool Crane
6137	4.1.2	Install TAD STC Lid	60 mins	6131	6150	APC,Pool	Auxiliary Pool Crane,Pool Area
6146	NOT In BFD	Prepare CHC	40 mins	6131	6150	CHC,Prep	Cask Handling Crane,Cask Prep Area
6150	4.1.3	Lift TAD STC to Staging Shelf	65 mins	6137,6146	6161	CHC,Pool	Cask Handling Crane,Pool Area
6161	4.1.4	Wash Cask Pool Handling Yoke Over Pool and Plane on Cask Pool Handlin	15 mins	6150	6163	CHC,Pool	Cask Handling Crane,Pool Area
6163	4.1.5	Detach Pool Yoke Lift Adapter and Place onto Stand	40 mins	6161	6168	CHC,Pool	Cask Handling Crane,Pool Area



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Task, Critical Task, Progress, Milestone, Summary, Rolled Up Task, Rolled Up Critical Task, Rolled Up Milestone, Rolled Up Progress, Split, External Tasks, Project Summary, External Milestone, External Milestone, Deadline

Sheet 7

Figure A-7. Summary WHF Gantt Chart – Sheet 7

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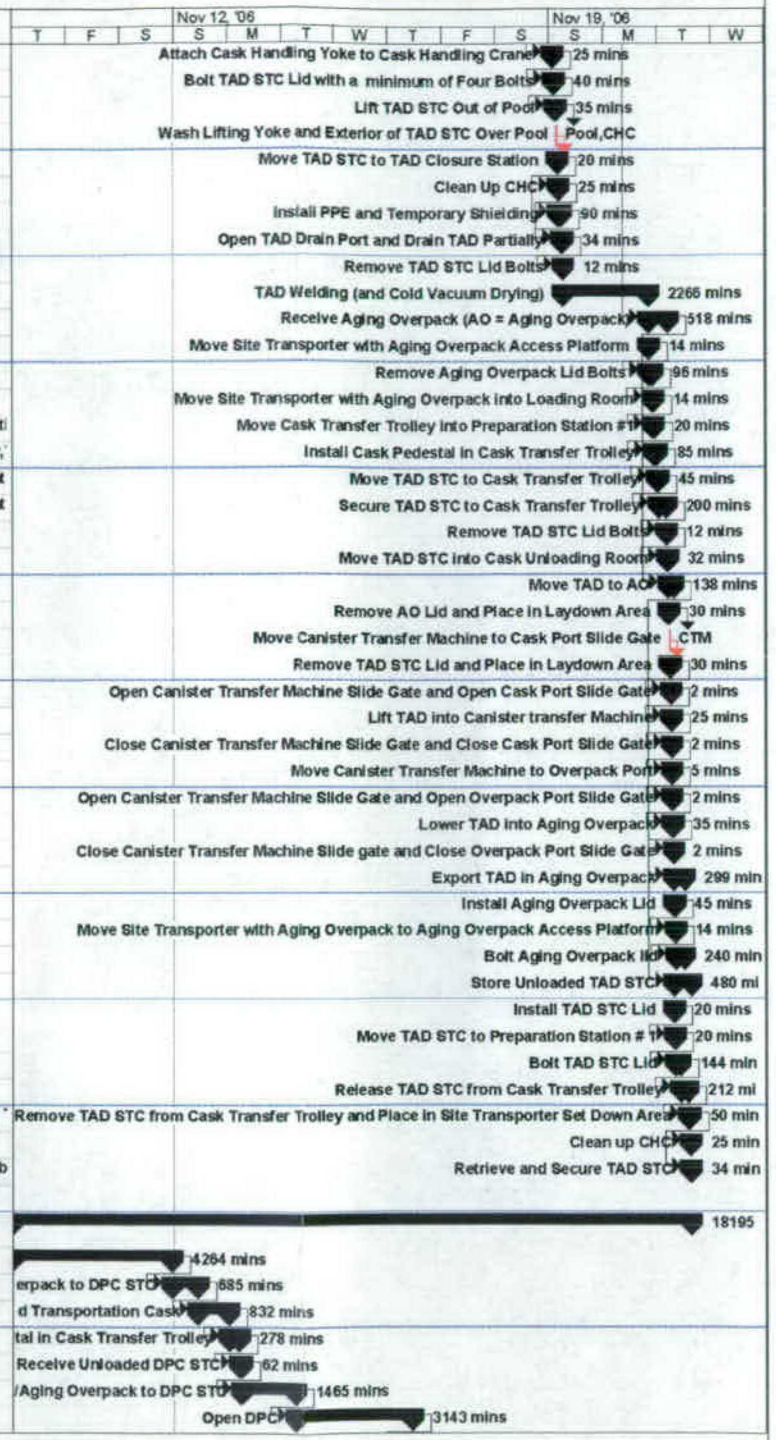
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
6168	4.1.6	Attach Cask Handling Yoke to Cask Handling Crane	25 mins	6163	6171	Pool,CHC	Pool Area,Cask Handling Crane
6171	4.1.7	Bolt TAD STC Lid with a minimum of Four Bolts	40 mins	6168	6175	Pool,SFTM	Pool Area,Spent Fuel Transfer Machine
6175	4.1.8	Lift TAD STC Out of Pool	35 mins	6171	6180	CHC,Pool	Cask Handling Crane,Pool Area
6180	4.1.9	Wash Lifting Yoke and Exterior of TAD STC Over Pool	30 mins	6175	6181	Pool,CHC	Pool Area,Cask Handling Crane
6181	4.1.10	Move TAD STC to TAD Closure Station	20 mins	6180	6186,6190	CHC,TCS	Cask Handling Crane,TAD Closure Station
6186	Not in BFD	Clean Up CHC	25 mins	6181	6192	Pool,CHC	Pool Area,Cask Handling Crane
6190	NOT in BFD	Install PPE and Temporary Shielding	90 mins	6181	6192	TCS,TCS JC	TAD Closure Station,TAD Closure Jib Crane
6192	4.1.11	Open TAD Drain Port and Drain TAD Partially	34 mins	6186,6190	6198	TCS	TAD Closure Station
6198	4.1.12	Remove TAD STC Lid Bolts	12 mins	6192	6201	TCS	TAD Closure Station
6200		TAD Welding (and Cold Vacuum Drying)	2266 mins				
6385	1.5	Receive Aging Overpack (AO = Aging Overpack)	518 mins	6125	6449		
6386	1.5.1	Move Site Transporter with Aging Overpack Access Platform	14 mins		6390	AOAP	Aging Overpack Access Platform
6390	1.5.2	Remove Aging Overpack Lid Bolts	96 mins	6386	6392	AOAP	Aging Overpack Access Platform
6392	1.5.3	Move Site Transporter with Aging Overpack into Loading Room	14 mins	6390	6396		
6396	1.5.4	Move Cask Transfer Trolley into Preparation Station #1	20 mins	6392	6400	PS1 JC,PS1,CTT	Preparation Station #1 Jib Crane[56%],Preparat
6400	1.5.5	Install Cask Pedestal in Cask Transfer Trolley	85 mins	6396	6419	CHC,CTT,EV	Cask Handling Crane,Canister Transfer Trolley,
6419	1.5.6	Move TAD STC to Cask Transfer Trolley	45 mins	6400	6425	CTT,PS1	Canister Transfer Trolley[50%],Preparation Stat
6425	1.5.7	Secure TAD STC to Cask Transfer Trolley	200 mins	6419	6442	CTT,PS1	Canister Transfer Trolley[51%],Preparation Stat
6442	1.5.8	Remove TAD STC Lid Bolts	12 mins	6425	6444		
6444	1.5.9	Move TAD STC into Cask Unloading Room	32 mins	6442		CTT	Canister Transfer Trolley
6449	5.1	Move TAD to AO	138 mins	6385	6487,6502		
6450	5.1.1	Remove AO Lid and Place in Laydown Area	30 mins		6457	CTM	Canister Transfer Machine
6457	5.1.2	Move Canister Transfer Machine to Cask Port Slide Gate	5 mins	6450	6458	CTM	Canister Transfer Machine
6458	5.1.3	Remove TAD STC Lid and Place in Laydown Area	30 mins	6457	6465	CTM	Canister Transfer Machine
6465	5.1.4	Open Canister Transfer Machine Slide Gate and Open Cask Port Slide Gate	2 mins	6458	6468	CTM	Canister Transfer Machine
6468	5.1.5	Lift TAD into Canister transfer Machine	25 mins	6465	6472	CTM	Canister Transfer Machine
6472	5.1.6	Close Canister Transfer Machine Slide Gate and Close Cask Port Slide Gate	2 mins	6468	6475	CTM	Canister Transfer Machine
6475	5.1.7	Move Canister Transfer Machine to Overpack Port	5 mins	6472	6477	CTM	Canister Transfer Machine
6477	5.1.8	Open Canister Transfer Machine Slide Gate and Open Overpack Port Slide (	2 mins	6475	6480	CTM	Canister Transfer Machine
6480	5.1.9	Lower TAD into Aging Overpack	35 mins	6477	6484	CTM	Canister Transfer Machine
6484	5.1.10	Close Canister Transfer Machine Slide gate and Close Overpack Port Slide (	2 mins	6480		CTM	Canister Transfer Machine
6487	1.6	Export TAD in Aging Overpack	299 mins	6449			
6488	1.6.1	Install Aging Overpack Lid	45 mins		6496	CTM	Canister Transfer Machine
6496	1.6.2	Move Site Transporter with Aging Overpack to Aging Overpack Access Plat	14 mins	6488	6500	AOAP	Aging Overpack Access Platform
6500	1.6.3	Bolt Aging Overpack lid	240 mins	6496		AOAP	Aging Overpack Access Platform
6502	1.7	Store Unloaded TAD STC	480 mins	6449			
6503	1.7.1	Install TAD STC Lid	20 mins		6506	CHC,Prep	Cask Handling Crane,Cask Prep Area
6506	1.7.2	Move TAD STC to Preparation Station # 1	20 mins	6503	6510	CTT	Canister Transfer Trolley
6510	1.7.3	Bolt TAD STC Lid	144 mins	6506	6512		
6512	1.7.4	Release TAD STC from Cask Transfer Trolley	212 mins	6510	6532	CTT	Canister Transfer Trolley
6532	1.7.5	Remove TAD STC from Cask Transfer Trolley and Place in Site Transporter	50 mins	6512	6540,6544	CHC,Prep,CTT	Cask Handling Crane,Cask Prep Area,Canister
6540	NOT in BFD	Clean up CHC	25 mins	6532		CHC,Prep	Cask Handling Crane,Cask Prep Area
6544	1.7.6	Retrieve and Secure TAD STC	34 mins	6532		EV	Transportation Cask Vestibule (Entrance Vestib
6558							
6559		Hi-Star BWR DPC TAD	18195 mins				
6560	1.1	Receive Transportation Cask with DPC	4264 mins		6800		
6800	5.2	Move DPC from TC/Aging Overpack to DPC STC	685 mins	6560	6858		
6858	1.2	Export Unloaded Transportation Cask	832 mins	6800	6968		
6968	5.2.21	Switch Cask Pedestal in Cask Transfer Trolley	278 mins	6858	7022		
7022	1.12	Receive Unloaded DPC STC	62 mins	6968	7034		
7034	5.2	Move DPC From Transportation Cask/Aging Overpack to DPC STC	1465 mins	7022	7175		
7175	3.1	Open DPC	3143 mins	7034	7407		



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Legend: Task; Critical Task; Progress; Milestone; Summary; Rolled Up Task; Rolled Up Critical Task; Rolled Up Milestone; Rolled Up Progress; Split; External Tasks; Project Summary; External Milestone; External Milestone; Deadline

Sheet 8

Figure A-8. Summary WHF Gantt Chart – Sheet 8

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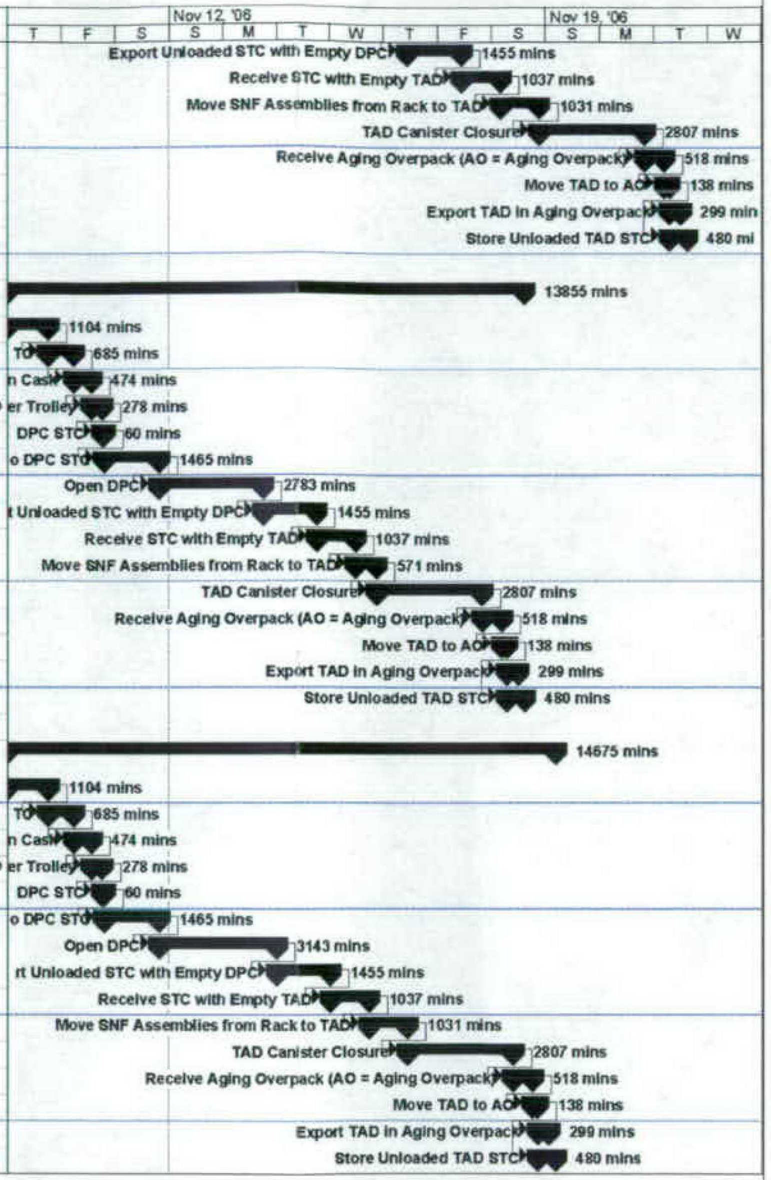
ID	BFD ID	Task Name	Duration	P	S	R.I.	Resource Names
7407	1.9	Export Unloaded STC with Empty DPC	1455 mins	7175	7532		
7532	1.3	Receive STC with Empty TAD	1037 mins	7407	7682		
7682	2.1	Move SNF Assemblies from Rack to TAD	1031 mins	7532	7692		
7692	4.1	TAD Canister Closure	2807 mins	7682	7952		
7952	1.5	Receive Aging Overpack (AO = Aging Overpack)	518 mins	7692	8016		
8016	5.1	Move TAD to AO	138 mins	7952	8054,8069		
8054	1.6	Export TAD in Aging Overpack	299 mins	8016			
8069	1.7	Store Unloaded TAD STC	480 mins	8016			
8125							
8126		**PWR DPC (in Rail Cask)**	13855 mins				
8127	1.1	Receive Transportation Cask with DPC	1104 mins		8280		
8280	5.2	Move DPC from TC/Aging Overpack to DPC STC	685 mins	8127	8338		
8338	1.2	Export Unloaded Transportation Cask	474 mins	8280	8411		
8411	5.2.21	Switch Cask Pedestal in Cask Transfer Trolley	278 mins	8338	8465	EV,CHC,PS1,CTT	Transportation Cask Vestibule (Entrance Vestib
8465	1.12	Receive Unloaded DPC STC	60 mins	8411	8477		
8477	5.2	Move DPC From Transportation Cask/Aging Overpack to DPC STC	1465 mins	8465	8618		
8618	3.1	Open DPC	2783 mins	8477	8851		
8851	1.9	Export Unloaded STC with Empty DPC	1455 mins	8618	8976		
8976	1.3	Receive STC with Empty TAD	1037 mins	8851	9126		
9126	2.1	Move SNF Assemblies from Rack to TAD	571 mins	8976	9136		
9136	4.1	TAD Canister Closure	2807 mins	9126	9396		
9396	1.5	Receive Aging Overpack (AO = Aging Overpack)	518 mins	9136	9460		
9460	5.1	Move TAD to AO	138 mins	9396	9498,9513		
9498	1.6	Export TAD in Aging Overpack	299 mins	9460			
9513	1.7	Store Unloaded TAD STC	480 mins	9460			
9569							
9570		**BWR DPC (in Rail Cask)**	14675 mins				
9571	1.1	Receive Transportation Cask with DPC	1104 mins		9724		
9724	5.2	Move DPC from TC/Aging Overpack to DPC STC	685 mins	9571	9782		
9782	1.2	Export Unloaded Transportation Cask	474 mins	9724	9855		
9855	5.2.21	Switch Cask Pedestal in Cask Transfer Trolley	278 mins	9782	9909	EV,CHC,PS1,CTT	Transportation Cask Vestibule (Entrance Vestib
9909	1.12	Receive Unloaded DPC STC	60 mins	9855	9921		
9921	5.2	Move DPC From Transportation Cask/Aging Overpack to DPC STC	1465 mins	9909	10062		
10062	3.1	Open DPC	3143 mins	9921	10295		
10295	1.9	Export Unloaded STC with Empty DPC	1455 mins	10062	10420		
10420	1.3	Receive STC with Empty TAD	1037 mins	10295	10570		
10570	2.1	Move SNF Assemblies from Rack to TAD	1031 mins	10420	10580		
10580	4.1	TAD Canister Closure	2807 mins	10570	10840		
10840	1.5	Receive Aging Overpack (AO = Aging Overpack)	518 mins	10580	10904		
10904	5.1	Move TAD to AO	138 mins	10840	10942,10957		
10942	1.6	Export TAD in Aging Overpack	299 mins	10904			
10957	1.7	Store Unloaded TAD STC	480 mins	10904			



Project: Wet Handling Facility (WHF) P
Date: Wed 10/31/07

Task · Critical Task · Progress · Milestone · Summary · Rolled Up Task · Rolled Up Critical Task · Rolled Up Milestone · Rolled Up Progress · Split · External Tasks · Project Summary · External Milestone · External Milestone · Deadline

Sheet 9

Figure A-9. Summary WHF Gantt Chart – Sheet 9

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APPENDIX B -

HOLTEC INTERNATIONAL EMAIL

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HOLTEC
INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

SENT VIA E-MAIL ONLY

March 15, 2007

Bechtel SAIC Company, LLC
1180 N. Town Center Drive
Las Vegas, NV 89144

Attention: Mr. Scott Estey scott_estey@ymp.gov
Phone: 702-821-7484

Reference: Yucca Mountain Project
Design, Fabricate, and Furnish Helium Dehydrator for
Transport, Aging, and Disposal Canister (TAD) Drying and Inerting System
RFI No. ENG-07-013

Subject: Responses to Questions Posed During March 15, 2007 Telephone Call
With John Griffiths

Dear Mr. Estey:

Holtec is pleased to once again assist you with the above referenced project.

Below are our responses to the questions posed during your telephone conversation today with John Griffiths, of Holtec.

Question 1: Is an air cooled condensing module viable in an indoor application?

Holtec Response to Question 1: The air-cooled condensing module is the standard FHD design supplied to Holtec's nuclear clients. The heat rejected by the condensing module (180,000 to 200,000 BTU/hr) needs to be evaluated against the plant HVAC system to ensure that the system is not overloaded.

Question 2: What are the typical drying times seen for FHD?

Holtec Response to Question 2: Typical drying times are from 16 to 38 hours per canister, depending on the heat load of the canister and the operational practices of the site. TAD drying is expected to be of similar duration with high heat load canisters and well insulated canisters requiring a shorter duration drying time.

HOLTEC INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

Mr. Scott Estey
Bechtel SAIC Company, LLC
March 15, 2007
Page 2 of 2

Question 3: How much water is typically removed in FHD drying?

Holtec Response to Question 3: Typical water recovered in drying Holtec systems is about 10 gallons. The bulk of the liquid water is removed during a carefully controlled canister blow-down process.

Again, Holtec looks forward to working with Bechtel throughout the review process and to having the opportunity to bid on this project when the RFP is released.

Sincerely,

Kay Becnel
Marketing Specialist

CC: Mr. A. Narayanan (Vijay) (Bechtel)
Mr. John Griffiths (Holtec)
Ms. Joy Russell (Holtec)

Document ID: 5633ab

ATTACHMENT I-
SIMCAD™ MODEL, GANTT CHARTS, RESULT FILES, AND FLOWCHARTS

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I.1 Listing of Electronic Files Contained on Compact Disk

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Directory of \Attachment I

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10/30/2007  04:13 PM    <DIR>          ..
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10/25/2007  05:47 PM           105,984 Case_4_output.xls
10/25/2007  05:57 PM           107,520 Case_5_output.xls
10/25/2007  05:36 PM           109,056 Case_3_output.xls
10/25/2007  06:16 PM           109,568 Case_7_output.xls
10/25/2007  06:36 PM           114,176 Case_9_output.xls
10/25/2007  06:06 PM           114,688 Case_6_output.xls
10/25/2007  06:26 PM           119,296 Case_8_output.xls
10/25/2007  04:31 PM           124,928 Case_2_(Peak)_output.xls
10/25/2007  06:47 PM           152,576 Case_10_output.xls
10/25/2007  06:59 PM           187,904 Case_11_output.xls
10/25/2007  07:12 PM           195,072 Case_12_output.xls
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09/13/2007  04:24 PM           123,197 050mh0h00000211.pdf
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                                       102407_15h_05m_FINAL.mpp
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02/26/2007  04:10 PM        29,298,176 Waste Stream Evaluation.xls
10/29/2007  09:24 AM            29,184 Summary Output.xls

              34 File(s)    195,971,611 bytes
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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SPECIAL INSTRUCTION SHEET

1. QA: N/A

This is a placeholder page for records that cannot be scanned.

2. Record Date 10/31/07	3. Accession Number Attn. to ENG.20071102.0019
4. Author Name(s) Monroe-Rammsy, J	5. Authorization Organization Engineering-Special Projects-Systems Engineering

6. Title/Description
put ⓜ1165137
Preliminary Wet Handling Facility Through Study

7. Document Number(s) 050-30R-MGR0-00300-000	8. Version Designator 003
9. Document Type Media	10. Medium 2 CD's

11. Access Control Code
N/A

12. Traceability Designator
050-30R-MGR0-00300-000-003

13. Comments
CD's 1 Original & 1 Copy

Validation of complete file transferred. All files copied. Software used: Excel

THIS IS AN ELECTRONIC
ATTACHMENT

14. RPC Electronic Media Verification

XREF MOL.20071107.0100

NOV 07 2007 Tchurch /BSC-BS

MD5 Validation

I.1 Listing of Electronic Files Contained on Compact Disk

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Directory of \Attachment I

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10/30/2007  04:13 PM    <DIR>          ..
10/25/2007  12:21 PM        19,202,560 WHF-rev02-102507-STCin-12h00m.SIM
10/25/2007  05:24 PM           102,912 Case_1_(Avg)_output.xls
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10/25/2007  06:59 PM           187,904 Case_11_output.xls
10/25/2007  07:12 PM           195,072 Case_12_output.xls
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02/26/2007  04:10 PM        29,298,176 Waste Stream Evaluation.xls
10/29/2007  09:24 AM            29,184 Summary Output.xls

              34 File(s)    195,971,611 bytes
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