Total System Model Version 6.0 Preprocessor Work Order Algorithm Validation Report

Prepared for:
U.S. Department of Energy
Office of Civilian Radioactive Waste Management
1000 Independence Avenue, SW
Washington, D.C. 20585

Prepared by:
Bechtel SAIC Company, LLC
1180 Town Center Drive
Las Vegas, Nevada 89144

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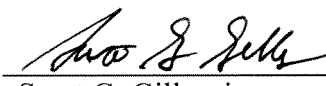
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Prepared by: _Andrew Al Blake_   10/29/2007
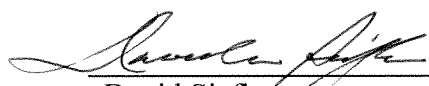
                                Andrew Al Blake   Date

Checked by: 10/31/2007

                                Stephen L. Turner   Date

Reviewed by: 11/02/2007

                                Scott G. Gillespie   Date

Approved By: 11/05/07

                                David Siefken   Date
                                Manager, Waste Management
                                Integration

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CHANGE HISTORY

Revision No.	Date	Description
0	10/2007	Original issue, for use with TSM Version 6, SimCAD™ 7.1 Build 1235

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CONTENTS

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FIGURES

TABLES

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ACRONYMS AND ABBREVIATIONS

BSC   Bechtel SAIC Company, LLC

CRD   CRWMS Requirements Document
CRWMS   Civilian Radioactive Waste Management System
CSNF   Commercial Spent Nuclear Fuel

DOE   U.S. Department of Energy
DPC   Dual-Purpose Canister
DOE SNF   U.S. Department of Energy Spent Nuclear Fuel

EM   U.S. DOE Office of Environmental Management

GROA   Geologic Repository Operations Area

IS   Initial State

S   Shipping Threshold
SY   Shipping threshold/year variations in WO algorithm
SNF   Spent Nuclear Fuel (implies both CSNF and DSNF)

TAD   Transportation, Aging, and Disposal
TSM   Total System Model
TSMCC   Total System Model Control Center
TSMPP   Total System Model Preprocessor

UM   User Manual

VB   Visual Basic
VCG   Valley Curve Generator

WO   Work Orders

Y   Years

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1. OBJECTIVE AND BACKGROUND

The purpose of this validation is to compare TSM simulation results using the manually calculated work orders (WO) for the transportation cask fleet to simulation results using an automated WO algorithm developed to estimate the cask fleet.

This validation report supports the issuance of Version 6.0 of the Total System Model (TSM, BSC 2007a) that is described in the TSM User Manual (UM), see Reference BSC 2007b, and the TSM Preprocessor (TSMPP) UM (BSC 2007c). The validation of changes to the automated WO algorithm for TSM Version 6.0 are included in Appendix A. The WO algorithm documented in the main body of this report was validated for TSM Version 5.0 (BSC 2007d). However, the information has been retained for completeness in the TSM Version 6.0 validation.

This report assumes the reader has detailed, working knowledge of the TSM functions and the Civilian Radioactive Waste Management System (CRWMS) operations.

Work Orders and cask fleet decisions are covered in Section 4.1.2 of the TSM UM (BSC 2007a).

This validation was performed in accordance with AP-ENG-006, *Total System Model (TSM) - Changes to Configuration Items and Base Case.*

The TSM has been designed to run many different possible waste generation scenarios in support of the Civilian Radioactive Waste Management System (CRWMS). In part, these scenarios are setup using an initial state file that is created by the TSMPP. Given user criteria and known/anticipated waste inventories, the TSMPP will generate a waste shipment schedule in an Excel format. This is the Initial State (IS) file of all of the cask loads to be shipped that drives the TSM simulation.

In the past, the quantity and timing of the purchase of the transportation casks to form the cask fleet was performed manually. The WO software algorithm was developed to provide an automated alternative to the manual process. This is the validation report that evaluates the automated Work Orders algorithm with its comparison to prior manual calculations.

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2. VALIDATION

The basic method is to compare the cask fleets that are generated by both methods and to compare Valley Curves of identical simulations using the two cask fleets. The Valley Curves are the accepted method to evaluate shipping logistics. Note that the shipments in the comparison simulations are identical; only the cask fleet changes. Validation was performed for a typical bare case and a Transport, Aging, and Disposal (TAD) canister case.

A software tool (called ISMorph) was developed in Visual Basic 6 to take an existing IS file as input, then output a "morphed" IS file attaching WO line items for the transportation casks as a function of anticipated cask load shipments.

The WO algorithm was designed to match as close as practical the manual method of generating work orders. ISMorph is the code that is implemented within TSMPP except that ISMorph uses an IS file as the input for the cask load information; TSMPP generates the cask load information. It is extracted to make the testing and validation easy. The validation includes checking that the ISMorph results for the cask fleet match the results from WO algorithm integrated into the TSMPP.

In general, based on the manual practices developed over many years, the number of shipping casks required for a year can be related to the anticipated number of shipments using Table 1.

Table 1.   Cask Fleet Requirements

Shipping Threshold per year	Number of Casks needed
1 – 15	3
16-30	6
31-45	9
46-60	12
61-89	15
90-120	21
>120	24

When one of the above shipping thresholds is exceeded in a particular year, the WO algorithm will then ask if the increased level of shipping will be sustained for some period of time beyond that year. In short – "is the cask purchase worth it?".

In the manual process of establishing work orders for the various transportation casks, a pivot table was performed in Excel on the subject IS file and the relative demand for casks was evaluated on a yearly basis for casks based upon the scheduled of spent nuclear fuel (SNF) cask loads. This method allows the user to "look forward" and see the shipping quantities over the life of the cask and make common sense decisions on the cask needed. For example, the user can distinguish if a cask is purchased to satisfy a shipping demand spike, or to satisfy a persistent demand over the course of time.

The automated method needed a way to calculate this "user intuitive" common sense. As such, a function was created (called "IsCaskPurchaseWorthIt()") that tries to level away shipping demand spikes.

The WO algorithm develops a yearly demand for each transportation cask to be purchased based on the shipments in the IS file generated by the TSMPP. When the demand exceeds a threshold (as identified in Table 1 above), then control is passed to the "IsCaskPurchasWorthIt()" algorithm. This algorithm attempts to smooth demand spikes via two parameters:

   S -   Ship Goal. A percentage from the previous to the proposed next threshold.
   Y -   % Years remaining that will be at or above the ship goal.

Using Table 1 as an example, if a case S5Y7 (the number of casks indicated is 50% [S5] toward the next threshold and 70% [Y7] years remaining are above the ship goal) is discussed with a transportation cask demand for a specific year of 32 shipments, the program will authorize a purchase (to a total cask fleet of 9 units) if 70% of the remaining years of the cask life in the model meet and/or exceed a shipping goal of at least 50% of the way between 31 and 45 shipments per year. Otherwise, the 32 shipments in that year is considered a demand spike and the cask purchase is not worth it.

The shipping thresholds were established based on many simulations and were considered fairly well established. However, the parameters shipping goal (S), and percent of years remaining at goal (Y) were less well founded so validation focused on sensitivity testing of cask fleet and simulation results by varying these parameters. This exercise also supported the final values for S and Y used in the TSMPP 6.0.7 which is part of Version 5.0 of the TSM.

In summary, the "IsCaskPurchaseWorthIt()" function establishes a future shipping goal, then asks what percentage of the remaining years will be at or above the shipping goal. As it turns out, the rather simple algorithm of shipment thresholds and the "IsCaskPurchaseWorthIt()" check are adequate to estimate a workable cask fleet.

2.1   METHOD

To test the WO algorithm and the sensitivity of the S and Y factors, a TSM model run matrix was set up using cases from the so-called "Phase 1 TAD Study" (BSC 2005): a typical TAD canister case, 25B1, and a typical bare case, OBU. "Base case" runs for this validation were run with the manually generated work orders used in the Phase 1 TAD Study. The manually generated work orders are in the IS files in the base case run files that are electronic attachments to this report. (Note that the cases from the Phase 1 TAD Study evaluated herein use the same scenario input parameters as the TAD study but are not the same simulation since Phase 1 TAD Study scenarios were run with TSM Version 3.0J or (earlier) and this validation is with TSM Version 3.0L2a. Therefore the Valley Curves and other results in this validation will not match those reported in the Phase 1 TAD Study.)

Several cases were set up using the ISMorph program to generate the IS files for Case 25B1, varying the S parameter from 0.5 to 0.7 and varying the Y parameter from 0.5 to 0.7 in the function IsCaskPurchaseWorthIt() that is shown in Figure 1.

For the S factor, the impacted line of code was (see Figure 1):
    iShipGoal = Int(Round(0.5 * (iCurShips + iFutureShips), 0))

For the Y factor, the impacted line of code was:
    If iYearsAtGoal / iRemainYears >= 0.7 Then

Figure 1.   IsCaskPurchaseWorthIt() Function

```
Function  IsCaskPurchaseWorthIt(vCaskId  As  String,  iCurShips  As  Long,
iFutureShips As Long, iCurYear As Long, iMaxYear As Long) As Boolean

' Initializations
  Dim iShipGoal As Long, iYearsAtGoal As Long, iRemainYears As Long

' Calculate the vector strength of shipments between this and the next break
point
  iShipGoal = Int(Round(0.5 * (iCurShips + iFutureShips), 0))

' How many of the remaining years achieve the shipping goal?
  vSQL = "SELECT Sum(1) As YearsAtGoal FROM zwoShipmentsByYear WHERE CaskId =
'" & vCaskId & "' AND Total > " & iShipGoal & " AND Year > " & iCurYear
  Set rs = MyDB.OpenRecordset(vSQL)
  If Not rs.EOF Then
      If IsNull(rs("YearsAtGoal")) = True Then
         iYearsAtGoal = 0
      Else
         iYearsAtGoal = rs("YearsAtGoal")
      End If
  Else
      iYearsAtGoal = 0
  End If
  Set rs = Nothing

' Do more than Y percent of years exceed the shipping goal?
  IsCaskPurchaseWorthIt = False
  iRemainYears = iMaxYear - iCurYear
  If iRemainYears > 0 Then
      If iYearsAtGoal / iRemainYears >= 0.5 Then
         IsCaskPurchaseWorthIt = True
      End If
  End If
```

After the detailed sensitivity runs of Case 25B1 were made, the extremes (S5Y5 – which will purchase the most casks, and S7Y7 – which will purchase the least casks) were tested using Case 0BU from the Phase 1 TAD Study. This was done to determine if the WO algorithms would perform relatively consistently and satisfactorily against both TAD canister and bare SNF cask TSM model scenarios.

The algorithm includes a constraint for the maximum number of any particular cask and as the validation proceeded the maximum was modified from 24 to 33 units to improve the fidelity of the manual and WO algorithm methods.

Finally, a test was performed to ensure that the WO algorithm would perform consistently between the TSMPP and ISMorph software.

2.2   VALIDATION RESULTS

Testing showed that the WO algorithm is a reasonable way to establish a first guess for transportation cask purchases for an IS file. Overall simulation results were not appreciably impacted no mater what combination of S and Y factors were used. This is because the capacity of the Geologic Repository Operations Area (GROA) is the driver for Valley Curves behavior as long is the cask fleet is adequate. Also, the number of cask in the fleet was not very sensitive to variations of S and Y.

2.2.1   Results For Case 25B1

Nine variants of Case 25B1 were run to test the sensitivity of S and Y parameters. All variants performed relatively consistently with the manual case; however, all appeared to be a bit more liberal with cask purchasing over the manual case, causing smaller waste acceptance delays to the GROA.

Figure 2.   Valley Curves for Case 25B1

Base Case is shown in back at the bottom (years 6 through 17), then merges with the rest of the cases. The case S7Y7, the most restrictive of the variants tested, appears to be the best average to the manual case over the life of the case.
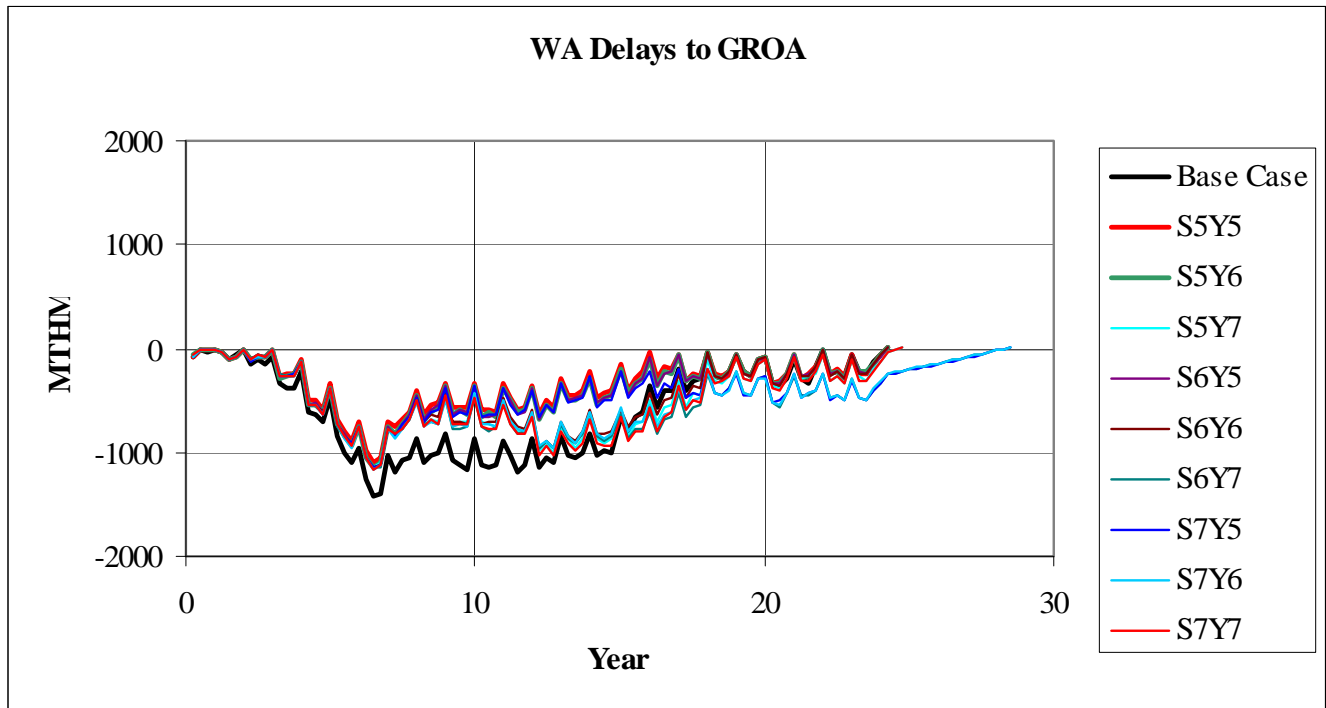
The SY variants produced differences in the quantity of cask purchases in the respective IS files. These differences are shown in Table 2. It should be noted that there are a number of casks in the base case where the purchase quantity is shown as 0. This is because these casks are actually on "open buy" (unrestricted purchase) in the TSM model. In these cases, the WO from the algorithm does not set the number of casks in the simulation for these casks, the "open buy" does. This applies to the TAD overpacks (Casks 208 and 253).

Table 2. Cask Purchases, Base Case and Case 25B1 SY Variants

	Base	S5Y5	S5Y5/33Max	S5Y6	S5Y7	S6Y5	S6Y6	S6Y7	S7Y5	S7Y6	S7Y7
CASK1	10	9	9	6	6	6	6	6	6	6	6
CASK102	3	3	3	3	3	3	3	3	3	3	3
CASK106	0	3	3	3	3	3	3	3	3	3	3
CASK109	0	1	1	1	1	1	1	1	1	1	1
CASK202	3	6	6	6	6	6	6	5	6	5	5
CASK208	0	15	15	15	15	12	12	12	12	12	9
CASK214	3	3	3	3	3	3	3	3	3	3	3
CASK217	3	3	3	3	3	3	3	3	3	3	3
CASK226	6	6	6	6	3	6	3	3	6	3	3
CASK232	0	3	3	3	3	3	3	3	3	3	3
CASK235	0	3	3	3	3	3	3	3	3	3	3
CASK238	3	3	3	3	3	3	3	3	3	3	3
CASK244	1	3	3	3	3	3	3	3	3	3	3
CASK247	3	3	3	3	3	3	3	3	3	3	3
CASK253	0	24	33	24	24	24	24	24	24	24	24
CASK290	0	3	3	3	3	3	3	3	3	3	3
CASK298	0	2	2	2	2	2	2	2	2	2	2
CASK44	15	15	15	15	15	15	15	15	15	15	15
CASK50	5	5	5	5	5	5	5	5	5	5	5
CASK51	5	5	5	5	5	5	5	5	5	5	5
CASK52	5	5	5	5	5	5	5	5	5	5	5
CASK6	15	21	21	15	15	15	15	15	15	12	12
Grand Total	80	144	153	135	132	132	129	128	132	125	122

It should also be noted that for Table 2, an IS file was prepared (but not run with TSM) to show what the cask purchasing difference would be with the WO algorithm altered to allow a maximum of 33 units per cask type to be purchased (S5Y/533Max). The motivation for this algorithm change is discussed in Section 2.2.3. The IS file prepared was "IS_Scn25B1_104LE_DOE_WO_8-23R1_ISMorph_s5Y5_33Max.xls". The only difference shown is for "CASK253", that are set to "open buy" in scenario 25B1. As such, there is no appreciable impact on model performance. So, this case was not run as part of the validation. TSM V5.0 also sets Cask 208 and 253 to "open buy".
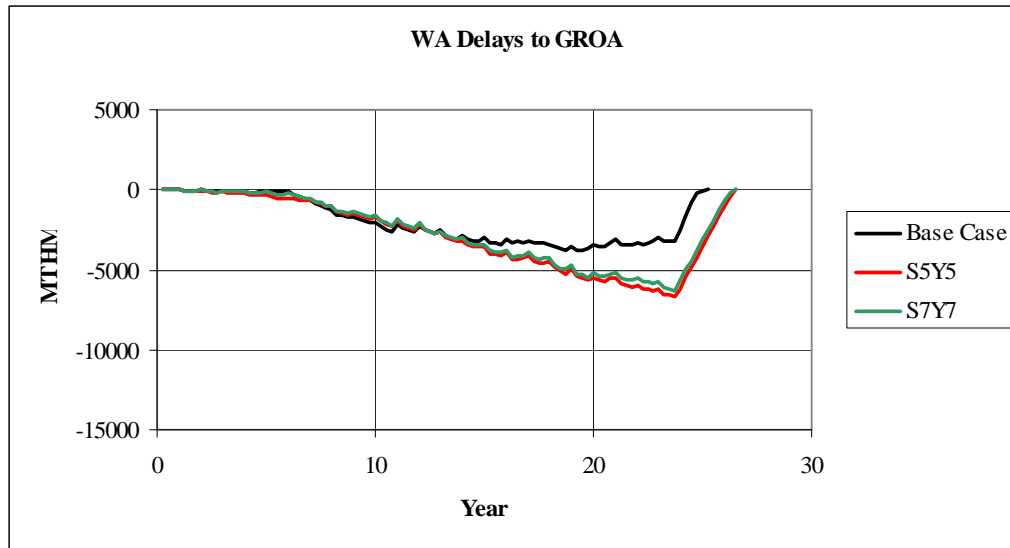
2.2.2 Results For Case 0BU, 24 Max

The test cases in 25B1 demonstrates that intermediate variations of the S and Y parameters do not have a significant impact. As such, only the extreme cases of S5Y5 (the least restrictive purchase parameters) and S7Y7 (the most restrictive purchase parameters) were tested for the 0BU scenario. These results are shown in Figure 3.

Analysis of the deeper valley curves for the WO algorithm cases demonstrate that the WO algorithm does allocate enough casks if the number of cask loads per year exceed 120 units/per year. Case OBU had years with Cask 26 loads up to about 270 per year.

Figure 3.   Valley Curves, Case 0BU – Maximum Cask Purchase of 24 Units
Base Case is shown in black at the top (years 13 through 25). The other two cases lag the base case due to the under-purchase of Cask 26. For variants S5Y5 and S7Y7, a maximum of 24 casks could be purchased for any one type of cask.

2.2.3 Results for Case 0BU, Variant S5Y5, Max 33

The results identified in Section 2.2.2 above demonstrate the need for a revision of the purchase algorithm to accommodate higher cask per year shipments. The algorithm was revised to allow a maximum purchase of 33 units per cask type as in Table 3.

As a result of these changes, Figure 4 shows that the performance of the WO algorithm has very good fidelity with the manual method.

Table 3.   Revised Cask Fleet Requirements

Shipping Threshold per year	Number of Casks needed
1 – 15	3
16-30	6
31-45	9
46-60	12
61-89	15
90-120	21
121-150	24
151-180	27
181-210	30
>210	33

Figure 4.   Valley Curves, Case 0BU – Maximum Cask Purchase of 33 Units
Base Case is shown in back at the top (years 5 through 7), but otherwise nearly indistinguishable from the S5Y5 variant where a maximum of 33 casks could be purchased for any one type of cask
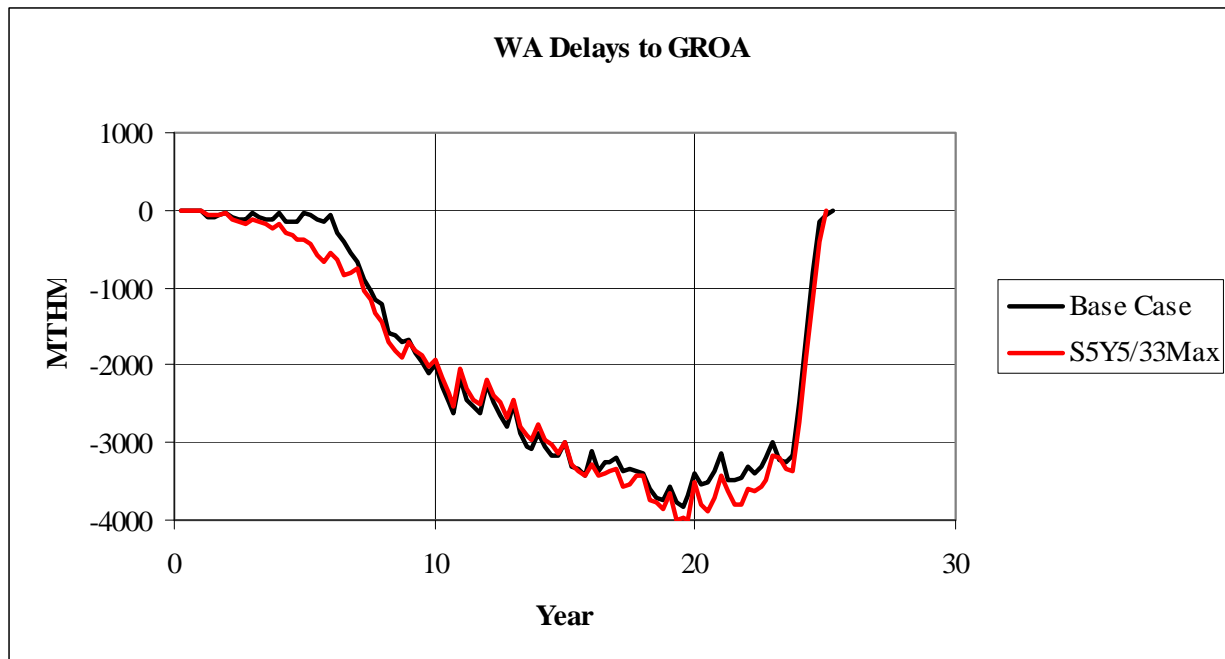

Table 4 shows the number of casks for the 0BU cases. Notice the S5Y5/33Max overestimates the overall fleet but provides the best simulation fidelity for bare cases. It is preferable to over-estimate the cask fleet to ensure waste acceptance is met.

Table 4. Cask Purchase Base Case and Case 0BU SY Variants

	Base	S5Y5	S7Y7	S5Y5/33Max
CASK1	14	9	6	9
CASK202	31	24	24	33
CASK214	3	3	3	3
CASK217	1	3	3	3
CASK226	6	6	6	6
CASK229	2	3	3	3
CASK232	6	3	3	3
CASK238	6	6	6	6
CASK244	1	3	3	3
CASK247	3	3	3	3
CASK26	29	24	24	33
CASK29	3	6	6	6
CASK44	15	15	15	15
CASK50	5	5	5	5
CASK51	5	5	5	5
CASK52	5	5	5	5
CASK6	15	21	15	21
CASK60	3	3	3	3
CASK62	2	3	2	3
CASK63	2	2	2	2
CASK65	3	6	6	6
CASK66	3	3	3	3
Grand Total	**163**	**161**	**151**	**179**

2.2.4   Comparison Between TSMPP And ISMorph Performance

The Work Order algorithm was carefully coded as a module to ensure that it is properly isolated from other TSMPP code and will have no impacts on the TSMPP other than to create a working cask fleet. This module was then incorporated into ISMorph to allow a capacity to modify existing IS files without the need to rerun the TSMPP.

A test was performed to ensure that the TSMPP and ISMorph software tools would produce the same WO records. The test procedure was:
1) Create an IS file using the TSMPP (which automatically includes WO)
2) Run the IS file output in Step 1 as input to ISMorph to generate the WO.
3) Compare the WO's between Steps 1 and 2.

The test was successful as there were no differences found between the work orders generated in Step 1, versus the work orders generated in Step 2.

2.3 OBSERVATIONS

The WO algorithm provides an initial estimate for a working cask fleet in a given TSM model scenario. The results of the WO algorithm provide simulation results similar to the previously used manual method of WO estimates for bare and TAD canister cases.

Based on the results of this validation the WO algorithm is set in the TSMPP for Version 5.0 of the TSM with S and Y factors at S5Y5 and a maximum of 33 casks of any one type. The algorithm is also set to provide no casks for the Cask 208 and 253 overpacks since these casks are set with "open buys" in TSM Version 5.0.

It is anticipated that WO may be developed manually in the future for some special cases or to optimize the cask fleet. The WO algorithm provides a good starting point for this process. Users may manually adjust the suggested cask fleet to minimize or optimize the fleet based on iterative simulations. The results from the WO algorithm are not an optimized or minimized fleet- the results provide a suitable fleet to ensure the simulation successfully runs with a minimum impact on waste acceptance.

Notice the WO provides a fleet for commercial CSNF and for DOE wastes.

The validation in this report can actually use any working TSM version as long as the TSM used is consistent for all the runs since all the results are made by relative comparisons. Version 3.0L2a was used because it was available when the test runs were initiated and used the TSM Control Center (TSMCC).

In support of TSM Model Version 6 (BSC 2007a), the WO algorithms were expanded to include work orders for trucks and work orders for baskets and shells for DOE waste streams. As shown in Appendix A, these new algorithms performed as designed.

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3. USE OF COMPUTER SOFTWARE AND MODELS

The following computer software and models are used in this calculation:

- TSM Interim Version 3.0L2a (included in run files attached to this report)
- SimCADPro™ 7.1
- MS EXCEL 2003
- MS Access 2003
- Valley Curve Generator dated 2-28-2007 (included in results to this report)
- ISMorph (included in attachments to this report)

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4. REFERENCES

4.1 DOCUMENTS CITED

BSC 2005. *TSM System Study: Impact of a Canister-Based System on the CRWMS*. MIS-CRW-SE-000003 REV 00, Bechtel SAIC Company, LLC, Washington, D.C. ACC: DOC.20051213.0001.

BSC 2007a. *Total System Model Version 6.0*. Washington DC: BSC. Software ID: 50040.

BSC 2007b. *User Manual for the Total System Model Version 6.0*, 50040-UM-01-6.0-00, Bechtel SAIC Company, LLC, Washington, D.C. ACC: Submit to RPC..

BSC 2007c. *User Manual for the Total System Model Version 6.0 Preprocessor*, 50040-UM-02-6.0-00, Bechtel SAIC Company, LLC, Washington, D.C. ACC: Submit to RPC.

BSC 2007d. *Total System Model Version 5.0 Preprocessor Work Order Algorithm Validation Report.* 50040-VAL-04-5.0-00. Bechtel SAIC Company, LLC, Washington, D.C. ACC: DOC.20070427.0008

BSC-2007e. *Engineering Study: Total System Model Analysis for Repository Postclosure Thermal Envelope Study, Phase 1*. 000-00R-G000-00600-000-001. Washington, DC: BSC. ACC: ENG.20070905.0023.

BSC 2007f. *User Manual for the Total System Model Version 6.0 Preprocessor*, 50040-UM-02-6.0-00, Bechtel SAIC Company, LLC, Washington, D.C. ACC: Submit to RPC.

BSC 2007g. *Total System Model Version 6.0 Validation Report*, 50040-VAL-01-6.0-0, Bechtel SAIC Company, LLC, Washington, D.C. ACC: Submit to RPC.

4.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

AP-ENG-006 REV 1 ICN 0, *Total System Model(TSM) – Changes to Configuration Items and Base Case.* Washington, DC: BSC. ACC: Submit to RPC.

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5. ATTACHMENTS

The files in Table 5 are included electronically.

Table 5.   Electronic Attachments

File Names	Description	Size (kB)	Date
VCG_Scn_25B1_TestVariants_2-28.xls	Valley Curve Generator Version for 25B test cases	2,932	3/21/07
WOPurchases_25B1.xls	Compilation of the number of WO purchases from each of the 25B IS files.	17	3/22/07
IS_Scn25B1_104LE_DOE_WO_8-23R1_ISMorph_S5Y5_33Max.xls	IS file demonstrating changes of the WO algorithm with the maximum purchasing is set to 33 units/cask for case variant S5Y5.	8,774	3/22/07
VCG_Scn_OBU_TestVariants_2-28.xls	Valley Curve Generator Version for OBU test cases	2,892	3/22/07
WOPurchases_OBU.xls	Compilation of the number of WO purchases from each of the 0BU IS files.	16	3/22/07
TSM_V3.0J2_Scn25B1_02_23_07_base_lmh.zip	25B1 base case run files	42,768	3/20/07
TSM_V3.0J2_Scn25B1_02_21_07__S5Y5_lmh.zip	25B1 S5Y5 case variant run files	33,975	3/20/07
TSM_V3.0J2_Scn25B1_02_26_07_S5Y6_lmh.zip	25B1 S5Y6 case variant run files	42,413	3/20/07
TSM_V3.0J2_Scn25B1_2_27_07_S5Y7_lmh.zip	25B1 S5Y7 case variant run files	42,526	3/20/07
TSM_V3.0J2_Scn25B1_2_28_07_S6Y5_lmh.zip	25B1 S6Y5 case variant run files	42,609	3/20/07
TSM_V3.0J2_Scn25B1_3_2_07_S6Y6_lmh.zip	25B1 S6Y6 case variant run files	42,365	3/20/07
TSM_V3.0J2_Scn25B1_3_5_07_S6Y7_lmh.zip	25B1 S6Y7 case variant run files	42,373	3/20/07
TSM_V3.0J2_Scn25B1_3_6_07_S7Y5_lmh.zip	25B1 S7Y5 case variant run files	42,520	3/20/07
TSM_V3.0J2_Scn25B1_3_7_07_S7Y6_lmh.zip	25B1 S7Y6 case variant run files	42,471	3/20/07
TSM_V3.0J2_Scn25B1_3_8_07_S7Y7_lmh.zip	25B1 S7Y7 case variant run files	42,538	3/20/07
TSM_V3.0L2_J2_to_L5-0BU_lisa_031407.zip	OBU base case run files	45,064	3/12007
TSM_V3.0L2_S5Y5_lisa_031607.zip	0BU S5Y5 case variant run files	57,496	3/20/07
TSM_V3.0L2_S7Y7_lisa_031907.zip	0BU S7Y7 case variant run files	53,804	3/20/07

File Names	Description	Size (kB)	Date
TSM_V3.0L2_S5Y5_33Max_lisa_032207.zip	0BU S5Y5 at 33 Max case variant run files	53,160	3/22/07
ISMorph.zip	ISMorph Visual Basic software tool	30	3/21/07
TSMPPvsISMorphCompare.xls	Compilation of the number of WO purchases from an IS produced the TSMPP versus the IS file as modified by ISMorph	14	3/22/07
TSMPPWOTest.xls	IS file produced by the TSMPP	8,440	3/22/07
TSMPPWOTest_ISMorph.xls	IS file produced by the TSMPP, then run through ISMorph for WO calculations.	8,440	3/22/07
TSMPP 6.0.7_with_MDB.zip	TSMPP source code and database files	4,839	3/22/07

Table 6.   Electronic Attachments for Appendix A

File Names	Description	Size (kB)	Date
IS_CD-1_70K_nocrit_2011TADs_YFF5_22kW_R1a_ISMorph_WO.xls	IS file with WO generation. (Ref. Appendix A1)	8,404	7/23/07
IS_CD-1_70K_nocrit_2011TADs_YFF5_22kW_R1a_ISMorph_DOEBasketAndShell.xls	An IS file with the basket and shell WO algorithm (Appendix A.3).	8,421	7/23/07
TSM_V3.0L5_THERMAL-70K_russ_011907.zip	Base case run files containing the IS file used for this validation.	24,809	6/22/07
ISMorph.zip	Visual Basic 6 program files for ISMprop	37	7/23/07

APPENDIX A

WO ENHANCEMENTS FOR TSM VERSION 6.0

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APPENDIX A
WO ENHANCEMENTS FOR TSM VERSION 6.0

The successful implementation of the cask Work Orders (WO) in TSM Version 5.0 lead to a decision to include two enhancements for Version 6.0. The WO enhancements are: 1) work orders for the trucks associated with their respective casks and 2) work orders for DOE waste streams when the cask basket and shell approach implemented in TSM Version 6.0 is used for their transport. As previously, the goal of the WO algorithms is to provide the user with a working fleet of equipment while providing insights into the timing, costs, and logistical bottleneck issues associated with GROA operations. As will be shown in sections A1 and A2 below, the new WO algorithms performed as anticipated.

The WO validation in this appendix was performed with TSM Version 5.0, modified to include the additional WO algorithms. These changes have also been made in the TSMPP Version 6.0. The validation for the implementation in TSMPP Version 6.0 is done as part of the overall TSMPP Version 6.0 validation performed and documented separately (BSC 2007f). The validation for implementation of the Basket and Shell approach for DOE waste streams is a part of the overall validation TSM Model Version 6 (BSC 2007a) and documented separately (BSC 2007g).

A.1 Work Orders for Trucks

There are five cask types that are transported by truck: Casks 1, 6, 11, 12, and 18. As a truck can only transport one of these casks at a time, the buy algorithm for trucks is the same as for these casks types. In other words, trucks are ordered one-for-one with these casks and at the same timing.

Testing of this WO algorithm has demonstrated that work orders for trucks are generated at the same timing and quantity as the total of all truck casks. An EXCEL workbook file showing the side by side comparison is listed in Table 6 (see IS_CD-1_70K_nocrit_2011TADs_YFF5_22kW_R1a_ISMorph_DOEBasketAndShell.xls).

A.2 Work Orders for DOE Baskets and Shells

TSM Version 6.0 has been upgraded to allow the user to select the Basket and Shell approach for the DOE high-level radioactive waste (HLW), multi-canister overpack (MCO), and U.S. Department of Energy spent nuclear fuel (DOE SNF) waste streams. Note that naval SNF casks are not included. If the Basket and Shell approach is not used, the casks purchases for these streams are hard coded as shown in Table A-1.

Table A-1. Hard Coded Work Order Quantities for DOE Casks

Waste Type	Cask	Quantity
HLW	Cask44	15
MCO	Cask50	5
DSNF18[1]	Cask51	5
DSNF24[1]	Cask56	5

Note 1 – DNSF18 = DOE SNF 18 inches in diameter; DSNF24 = DOE SNF 24 inches in diameter

TSM Version 6.0 allows the user to use the Basket and Shell approach in transporting the DOE waste streams. This means that each of the waste streams will have its own basket to pack the waste material; however, all share a common shell or over pack, defined in the model as "CASK2XX". The commercial cask purchasing algorithm (discussed in detail in Section 2 of the main text) is used for the DOE waste streams. The algorithm parameters for the HLW, MCO and DOE SNF waste streams are shown in Table A-2.

Table A-2 Cask Fleet Requirements for HLW, MCO and DOE SNF

Shipping Threshold per year	Casks required for HLW, MCO and DOE SNF waste streams
1 – 30	5
31-60	10
61-90	15
91-120	20
121-150	25
151-180	30
>180	35

Testing of the Basket and Shell WO algorithm produced baskets in the same quantity as the hard coded cask quantities, though at a different timing. A total of 20 shells were purchased reflecting the cumulative shipping demand of the various waste types. Two EXCEL workbook files showing the DOE cask results with and without the Basket and Shell algorithm activated are listed in Table 6 (files IS_CD-1_70K_nocrit_2011TADs_YFF5_22kW_R1a_ISMorph_ DOEBasketAndShell.xls and IS_CD-1_70K_nocrit_2011TADs_YFF5_22kW_R1a_ISMorph_ WO.xls respectively).