BSC

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Complete only applicable items.

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2006 Projection of Future Spent Nuclear Fuel Discharges

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00A	Initial Issue	15	7	Amir S. Mobasheran 8/31/06	Barrie McLeod 8/31/06	David Siefken 9/25/06

DISCLAIMER

The calculations contained in this document were developed by Bechtel SAIC Company, LLC (BSC) and are intended solely for the use of BSC in its work for the Yucca Mountain Project.

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TABLES

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ACRONYMS

BSC	Bechtel SAIC Company, LLC
BWR	boiling water reactor
CRWMS	Civilian Radioactive Waste Management System
DOE	U.S. Department of Energy
EIA	Energy Information Administration
LE	life extension
MOX	mixed oxide
NRC	U.S. Nuclear Regulatory Commission
PWR	pressurized water reactor
SNF	spent nuclear fuel

ABBREVIATIONS

GWd/MTU	gigawatt days per metric ton of uranium
MTU	metric ton of uranium

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1. INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

The purpose of this calculation is to project future utility spent nuclear fuel (SNF) discharges regarding their timing, quantity, burnup, and initial enrichment. The 2006 projected discharges complement the 2002 utility-supplied historic discharges and their accompanying first-five-discharge projections, as they are long-term projections that complete the total life cycle of discharges for each of the current U.S. nuclear power reactors. The first-five-discharge projections are the primary input to the projection process. The 2002 data are provided via the revised final version of the Energy Information Administration (EIA) 2002 RW-859 utility survey, as documented in *Report on the Final 2002 RW-859 Data Set* (BSC 2005a).

The objectives of this calculation are to provide summaries of historical and projected SNF discharges and prepare the projected life cycle SNF discharge quantities and characteristics in the format required by the Total System Model Preprocessor (BSC 2006a). The preprocessor prepares input data for the Total System Model (BSC 2006b), used for performing system logistics analysis and Total System Life Cycle Cost Analysis to support the design of the Civilian Radioactive Waste Management System (CRWMS).

This calculation was performed in accordance with AP-ENG-005, Total System Model (TSM) – Usage.

1.2 SCOPE

The scope of this calculation is limited to the projection of commercial spent nuclear fuel discharges, beginning with the year 2003, for 104 operating reactors. Two cases are considered in this calculation: a 44-life extension (LE) case and a 104-LE case.

The 44-LE case updates the previous (2005b) 32-LE case. This includes additional future reactor power uprates that the U.S. Nuclear Regulatory Commission (NRC) has approved or is reviewing and 20-year operating license extensions (LEs) for 12 nuclear reactors that have received LEs from the NRC, since the 32-LE projection, as of June 30, 2006 (for a total of 44 reactors).

The 104-LE case includes the same power uprates as the ones for the 44-LE case, but assumes that, as a bounding case, all operating reactors receive a 20-year LE from the NRC.

This calculation adopted the method and updated the Microsoft Excel workbooks described in *Calculation Method for the Projection of Future Spent Nuclear Fuel Discharges* (BSC 2005b). The modifications (updating) of input data concerning future power uprates, additional NRC approval of LEs, and Energy Information Administration's (EIA) projected total nuclear-electric generation (as of June 30, 2006) were the main steps involved in conducting the new calculations.

2. ASSUMPTIONS AND REQUIREMENTS

This calculation uses the same assumptions and requirements that are provided in Section 3 of BSC 2005b.

3. METHODOLOGY

The 2006 projection of future SNF discharges was conducted by following the method developed and documented in *Calculation Method for the Projection of Future Spent Nuclear Fuel Discharges* (BSC 2005b).

3.1 COMPUTER SOFTWARE

This calculation uses Microsoft Excel (Excel) 2003 to perform, with updated data, the series of calculations that originally were implemented in three Excel 97 workbooks as attachments to BSC 2005b. The three (old) workbooks are as follows

1. RW85902_UtilProjdDischgs.xls
   This workbook provides all calculations of future SNF discharge projections with the results of the 2002 RW-859 utility first-five-discharge projections, as to assemblies, metric tons of initial uranium (MTU), enrichment, and discharge dates. This workbook is included in the electronic attachment to this calculation (see Section 6). The following workbooks have generally been designated as "Projection Workbooks" in BSC 2005b.

2. R02LE32_CP00_BE_R10_TSLCC05R1.XLS
   This Projection Workbook, which had projected the SNF discharges based on 32 NRC-approved reactor LEs, was modified to incorporate new information/data.

3. R02LE104_CP00_BE_R13_DB_R2.XLS.
   This Projection Workbook had projected the SNF discharges based on the assumption that all 104 reactors had received life extensions. While incorporating new information/data in this workbook, it was noticed that some corrections should have been done to the burnup values of the four reactors (Catawba 1, Catawba 2, McGuire 1, and McGuire 2) which had accommodated some mixed oxide (MOX) fuel assemblies. The necessary corrections to the BURNUP worksheet were made (in red), and the revised workbook was saved as R02LE104_CP00_BE_R13_DB_R3.XLS. This file is included in the electronic attachment to this calculation (see Section 6).

Each Projection Workbook includes one macro that calculates the burnup distributions and performs data sorting and required data formatting. This provides the projection data in an output format consistent with the input requirements for performing the SNF delivery, selection, container loading, and logistics analyses used by the Total System Model (BSC 2006b) to support design of the CRWMS.

The Projection Workbooks for this calculation, named R02LE44_CP00_BE_R10_TSLCC06.xls and R02LE104_CP00_BE_R13_DB_2006.xls, for the 44-LE case and the 104-LE case, respectively, are included in the electronic attachments to this calculation (see Section 6).

3.2 UPDATING OF INPUT DATA

The input data for the 2006 projection were prepared by updating (as of June 30, 2006) the 2005 input data used for the 32-LE case and the104-LE case (BSC 2005b). It should be noted that, for the 104-LE case, the updating was done to the corrected version of the 2005 file, as explained in the previous section. The projection used the 2002 RW-859 data on historic and utility-projected next 5 discharges for each reactor (BSC 2005a) with 44 LEs and 104 LEs, conformed to the annual totals of nuclear-electric generation in the June 2006 EIA Fee Revenue Projection (Sitzer 2006). The revision of data on licensed maximum reactor power, power uprates, and reactor life extensions was based on the NRC's 2005-2006 Edition of Information Digest (NRC 2005) and the NRC's information available at its website (www.nrc.gov/reactors/operating/licensing/power-uprates/approved-applications.html for power uprates and www.nrc.gov/reactors/operating/licensing/renewal/applications.html for license renewal).

The changes made to the 2005 32-LE case and the corrected 2005 104-LE case have been reflected in blue in the updated Excel worksheets of their corresponding Excel workbooks. The Excel files for the 2006 projections are included in the electronic attachment to this calculation (see Section 6).

Table 1, below, identifies the 32 reactors that had been granted NRC LEs at the time of the 32-LE projection, and the additional 12 reactors that have subsequently received NRC-approved LEs for the total of 44 LEs, as of June 30, 2006.

Table 1. Reactors That Have Received 20-Year Operating License Extensions as of June 30, 2006

Reactors with LEs for the 2005 32-LE Case	Additional Reactors with LEs for the 2006 44-LE Case
Arkansas Nuclear One 1	Arkansas Nuclear One 2
Calvert Cliffs 1, 2	Browns Ferry 1
Catawba 1, 2	Browns Ferry 2
Dresden 2, 3	Browns Ferry 3
Farley 1, 2	Brunswick 1
Fort Calhoun	Brunswick 2
Ginna	Cook 1
Hatch 1, 2	Cook 2
McGuire 1, 2	Millstone 2
North Anna 1, 2	Millstone 3
Oconee 1, 2, 3	Point Beach 1
Peach Bottom 2, 3	Point Beach 2
Quad Cities 1, 2	
Robinson 2	
Saint Lucie 1, 2	
Summer	
Surry 1, 2	
Turkey Point 3, 4	

4. RESULTS

Short summaries of the results for the 2006 44-LE and 104-LE cases are provided in Tables 2 and 3, respectively.

Table 2. Summary of Results for the Case with 44 Reactor License Extensions

Characteristic		Historical 1968 - 2002	Projected After 12/2002	Total
MTU[1]	BWR	16,708	21,115	37,823
	PWR	30,292	40,337	70,629
	Total	47,000	61,452	108452
Assemblies				
	BWR	93,354	120,258	213,612
	PWR	70,292	92,021	162,313
	Total	163,646	212,279	375,925
Average Burnup (GWd/MTU)[2]				
	BWR	28.476	44.196	37.252
	PWR	36.252	49.163	43.626
	Overall	33.487	47.456	41.402

[1] Metric ton of uranium
[2] Gigawatt days per metric ton of uranium

Table 3. Summary of Results for the Case with 104 Reactor License Extensions

Characteristic		Historical 1968 - 2002	Projected After 12/2002	Total
MTU[1]	BWR	16,708	28,603	45,311
	PWR	30,292	54,820	85,112
	Total	47,000	83,423	130,423
Assemblies				
	BWR	93,354	162,739	256,093
	PWR	70,292	124,873	195,165
	Total	163,646	287,612	451,258
Average Burnup (GWd/MTU)[2]				
	BWR	28.476	47.513	40.493
	PWR	36.252	51.717	46.213
	Overall	33.487	50.275	44.225

[1] Metric ton of uranium
[2] Gigawatt days per metric ton of uranium

Table 4, below, provides a summary-level comparison between the current (2006) 104-LE and the previous (corrected 2005) 104-LE projections.

Table 4. Comparison of 2006 and 2005 104-LE Cases

Case	Assemblies	MTU[1]
2006 104-LE	287,612	83,423
2005 104-LE	288,109	83,555
Difference ('06 – '05)	-497	-132

[1]Metric ton of uranium

The above differences are within about 0.16 % of each other, and are not considered to be significant. The total two EIA nuclear-electric generation projections, to which the above are normalized, are substantially identical.

Table 5, below, provides a summary-level comparison between the current (2006) 44-LE and the previous (2005) 32-LE projections.

Table 5. Comparison of 2006 44-LE and 2005 32-LE Cases

Case	Assemblies	MTU[1]
2006 44-LE	212,279	61,452
2005 32-LE	193,187	56,892
Difference ('06 – '05)	19,092	4,560

[1]Metric ton of uranium

The primary differences between the above two projections are due to an additional 20 years of operation at each of 12 reactors, a total of 240 reactor operating years. The average (annual) discharge is 4,560 MTU/240 operating years, which equals 19.0 MTU/operating year, which is consistent with the typical rule-of-thumb of 20 MTU/year for the average reactor.

5. REFERENCES

5.1 DOCUMENTS CITED

Bechtel SAIC Company, LLC (BSC) 2005a. *Report on the Final 2002 RW-859 Data Set.* TDR-WAT-NU-000004 REV 00. Washington, D.C.: BSC. ACC: DOC.20051024.0003.

BSC 2005b. *Calculation Method for the Projection of Future Spent Nuclear Fuel Discharges.* TDR-WAT-NU-000002 REV 02. Washington, D.C.: BSC. ACC: DOC.20051024.0002.

BSC 2006a. *User Manual for the Total System Model Preprocessor.* MIS-CRW-MD-000004 Rev. 01. Washington, D.C.:BSC. ACC: DOC.20060622.0006.

BSC 2006b. *User Manual for the Total System Model.* MIS-CRW-MD-000003 Rev. 01. Washington, D.C.:BSC. ACC: DOC.20060719.0003.

Sitzer, S.B. 2006. "Nuclear Waste Fund Revenue Projections." Memorandum from S.B. Sitzer (EIA) to C.A. Kouts (OCRWM), June 2006. ACC: TBD.

5.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

AP-ENG-005 Revision 0 ICN 0, Total System Model (TSM) – Usage. Washington, D.C.: U.S. Department of Energy Office of Civilian Radioactive Waste Management. ACC: DOC.20050131.0002.

U.S. Nuclear Regulatory Commission (NRC) 2005. Information Digest, 2005 – 2006 Edition. NUREG-1350, Volume 17. Washington, D.C.: NRC. ACC: Readily Available.

6. ATTACHMENTS

The following table lists the Microsoft Excel files contained on the compact disk that is part of the records package for this calculation.

Table 6. Description of Electronic Files

File Name	File Description	File Size (kilo byte)	File Creation Date
R02LE104_CP00_BE_R13_DB_R3.XLS[1]	Corrected 2005 104-LE case	19,886	8/30/2006
RW85902_UtilProjdDischgs.xls[2]	Utility-projected five discharges	5,002	7/1/2005
R02LE44_CP00_BE_R10_TSLCC06.XLS	2006 44-LE case	19,493	8/30/2006
R02LE104_CP00_BE_R13_DB_2006.XLS	2006 104-LE case	19,897	8/30/2006

[1] Corrected version of R02LE104_CP00_BE_R13_DB_R2.XLS
[2] It provided utility projections used in the 2005 Projection Workbooks (BSC 2005b).

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	3. Accession Number
08/31/06	ATT: TO: ENG.20061003.0001
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AMIR S. MOBASHERAN	BSC/WASTE MANAGEMENT INTEGRATION

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DATA	2 CD'S

11. Access Control Code Public

12. Traceability Designator
000-00C-CRWW-00100-000-00A

13. Comments
1 ORIGINAL
1 COPY

VALIDATION OF COMPLETE FILE TRANSFER. ALL FILES COPIED. SOFTWARE USED IS MS EXCEL.

THIS IS AN ELECTRONIC ATTACHMENT

XREF MOL.20061006.0008

OCT 06 2006 T Church

MD5 Validation

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 Volume in drive D is 060908_1737
 Volume Serial Number is 7E67-5149

 Directory of D:\

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08/30/2006  06:00p          20,374,528 R02LE104_CP00_BE_R13_DB_2006.xls
07/01/2005  02:09p           5,122,048 RW85902_UtilProjdDischgs.xls

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08/30/2006  06:00p          20,374,528 R02LE104_CP00_BE_R13_DB_2006.xls
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08/30/2006  06:00p          20,374,528 R02LE104_CP00_BE_R13_DB_2006.xls
07/01/2005  02:09p           5,122,048 RW85902_UtilProjdDischgs.xls
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