OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
CALCULATION COVER SHEET

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2. Calculation Title

Stainless Steel in Waste Packages for TSPA-SR

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1. Remarks

Revision History

10. Revision No.	11.Description of Revision
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1. PURPOSE

The objective of the calculation is to determine how commercial spent nuclear fuel (CSNF) stainless-steel clad assemblies are distributed over the CSNF waste packages (WPs) in the Yucca Mountain repository. The calculation defines the number of CSNF WPs that will contain stainless-steel clad assemblies, and the stainless steel content, on average, in those WPs for the Total System Performance Assessment in Support of Site Recommendation (TSPA-SR). Cladding models for TSPA-SR for stainless-steel clad assemblies differ from the models used for zirconium-clad assemblies. The information derived in this calculation helps to determine how the cladding models are applied to WPs in TSPA-SR. The calculation addresses the WP configurations for CSNF defined in an interoffice correspondence from E.P. Stroupe to D.R. Wilkins (Stroupe 2000) and shown in Table 1.

The calculation was prepared using the development plan, *Cladding Degradation - Abstraction and Summary Analysis Results for Input to TSPA Analysis* (CRWMS M&O 1999). It supports Task 7. The calculation was developed using AP 3.12Q, Rev. 0, ICN 1.

2. METHOD

Microsoft Excel 97 was used to sum the number of WPs containing stainless-steel clad assemblies and calculate the stainless steel content on average in those WPs.

With regard to development of this calculation, the control of electronic management of data was evaluated in accordance with YAP-SV.1Q, *Control of the Electronic Management of Data.* The evaluation (CRWMS M&O 2000b) determined that current work processes and procedures are adequate for the control of electronic management of data for this activity.

3. ASSUMPTIONS

This calculation assumes that assemblies arriving together in a shipment are loaded together in the appropriate WP. For example, a shipment of 26 pressurized water reactor (PWR) assemblies destined for packaging according to Configuration 1 in Table 1 would be divided into two WPs, one with 21 assemblies from the shipment, and another with 5 assemblies from this shipment and 16 assemblies from another shipment. This assumption is used in Section 5.

The rationale for this assumption is that it is logically reasonable. There is no basis that stainless-steel clad assemblies will be isolated from the other assemblies and packaged by themselves, and no basis that the stainless-steel clad assemblies will be distributed evenly among the other assemblies. Consequently, it is reasonable to conclude that assemblies will be packaged into WPs as they arrive, and no further confirmation is required.

All other bases for this calculation have been documented in referenced sources, and no additional assumptions were required to derive the results.

4. USE OF COMPUTER SOFTWARE AND MODELS

4.1 SOFTWARE

None used.

4.2 SOFTWARE ROUTINES

This calculation was performed using Microsoft Excel 97, a commercially available software. Excel is an appropriate application because the calculation required only simple mathematical expressions and operations that are standard in Excel to derive the final results. No software routines or macros were developed in Excel. All manipulations are discussed in sufficient detail in Section 5 to allow independent repetition of the calculation.

4.3 MODELS

None used.

5. CALCULATION

5.1 INPUTS

The calculation has two sources of input:

- "Approach to Implementing the Site Recommendation Design Baseline" (Stroupe 2000)
- *Waste Packages and Source Terms for the Commercial 1999 Design Basis Waste Streams* (CRWMS M&O 2000a)

The interoffice correspondence from E.P. Stroupe to D.R. Wilkins (Stroupe 2000) directs that the attachment included with the correspondence be considered "management edict" as defined in AP-3.15Q, *Managing Technical Product Inputs*. Therefore, the material can be used without an attached to be verified (TBV). The correspondence specifies the loading configurations and number of CSNF WPs, which are summarized in Table 1.

Table 1. Design Basis WP Configurations for Site Recommendation

Configuration Number	Type of Fuel	Description
1	CSNF	WP with absorber plates for criticality control that will hold a capacity of 21 pressurized water reactor (PWR) assemblies.
2	CSNF	WPs with control rods for criticality control that will hold a capacity of 21 PWR assemblies.
3	CSNF	WP with absorber plates for criticality control that will hold a capacity of 12 PWR assemblies.
4	CSNF	WP with absorber plates for criticality control that will hold a capacity of 44 boiling water reactor (BWR) assemblies.
5	CSNF	WP with thick absorber plates for criticality control that will hold a capacity of 24 BWR assemblies.

The calculation *Waste Packages and Source Terms for the Commercial 1999 Design Basis Waste Streams* (CRWMS M&O 2000a) gives information about proposed shipments of CSNF to the Yucca Mountain repository. Attachment III of CRWMS M&O (2000a) (the "bin.dat" output file) includes the arrival year for each batch, the number of assemblies in each batch, the type of fuel in each batch (PWR versus BWR), the proposed WP configuration for each batch, and the batches that contain stainless-steel clad assemblies (CRWMS M&O 2000a). "Bin.dat" contains over 26,000 records and is accessible via a CD included with the calculation, *Waste Packages and Source Terms for the Commercial 1999 Design Basis Waste Streams* (CRWMS M&O 2000a).

5.2 PROCEDURE

The calculation uses the information from the sources listed above to determine the number of WPs that will contain stainless-steel clad assemblies, and the stainless steel content, on average, in those WPs.

There are 291,703 assemblies that will arrive at the repository in 26,183 batches prior to closure of the repository (CRWMS M&O 2000a). The batches contain the assembly totals that are shown in Table 2. The number of packages required in each case are also shown in Table 2.

Table 2. Number of Assemblies and Number of Packages Associated with Each Configuration

Configuration Number	Number of Assemblies	Number of Packages Required
1	119,480	5,690
2	2,207	105
3	3,513	293
4	164,165	3,731
5	2,338	97
Total	291,703	9,916
Total with Stainless Steel Cladding		346

320 of the 26,183 batches contain stainless-steel clad assemblies and 346 out of the 9,916 WPs will contain stainless-steel clad assemblies. The result is that (346x100)/9916 or 3.49% of the WPs will contain some number of stainless-steel clad assemblies.

Table 3. Division of Stainless-steel Clad Assemblies Among WPs

	Column A Number of WPs	Column B Fraction of assemblies in that WP that are stainless-steel clad assemblies	Column A x Column B
	77	0.05	3.85
	42	0.10	4.20
	27	0.14	3.78
	71	0.19	13.49
	16	0.24	3.84
	7	0.29	2.03
	11	0.33	3.63
	11	0.38	4.18
	6	0.43	2.58
	7	0.48	3.36
	3	0.52	1.56
	8	0.57	4.56
	6	0.62	3.72
	5	0.67	3.35
	1	0.71	0.71
	6	0.76	4.56
	4	0.81	3.24
	2	0.86	1.72
	2	0.90	1.80
	6	0.95	5.70
	28	1.00	28.00
Total	346		103.86

In the 346 packages that contain stainless-steel clad assemblies, how many of the assemblies are stainless-steel clad assemblies on average? Table 3 derived from CRWMS M&O (2000a) shows the distribution of stainless-steel clad assemblies among the 346 WPs. For example, the first row in Table 3 indicates that in 77 of the 346 WPs, stainless-steel clad assemblies constitute 5% of the assemblies in the WP. Likewise, in 42 of the 346 WPs in CRWMS M&O (2000a), stainless-steel clad assemblies constitute 10% of the assemblies in the WP. Therefore, for an average package (among the 346 WPs), stainless-steel clad assemblies constitute x percent of the assemblies in the WP where x is calculated as (Equation 1):

$$x = \frac{\sum (\text{Column A x Column B})}{\sum (\text{Column A})} \times 100 = (103.86 \times 100)/346 = 30.02\% \qquad \text{Eq (1)}$$

6. RESULTS

A total of 3.49% of the CSNF WPs contain stainless-steel clad assemblies. The average fraction of assemblies in these packages that are stainless-steel clad assemblies is 29.93%.

Aside from the impact of TBV inputs, the results of this calculation do not need to be confirmed prior to their use in subsequent analyses. This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

7. REFERENCES

AP-3.12Q, Rev 0, ICN 1. *Calculations.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL. 20000512.0065.

AP-3.15Q, Rev 1, ICN 1. *Managing Technical Product Inputs.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000218.0069.

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CRWMS M&O 2000a. *Waste Packages and Source Terms for the Commercial 1999 Design Basis Waste Stream.* CAL-MGR-MD-000001 REV 00. Las Vegas, Nevada. CRWMS M&O. ACC: MOL20000214.0479.

CRWMS M&O 2000b. Process Control Evaluation For Supplement V: "Performance Assessment Operations. (Reference QAP-2-0 Activity Evaluation Form. Conduct Of Performance Assessment, November 9, 1999)." Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000128.0236.

Stroupe, E.P. 2000. "Approach to Implementing the Site Recommendation Design Baseline." Interoffice Correspondence from E.P. Stroupe (CRWMS M&O) to D.R. Wilkins, January 26, 2000, LV.RSO.EPS.1/00-004, with attachment. ACC: MOL.20000214.0480.

YAP-SV.1Q Rev. 0 ICN 1. *Control Of The Electronic Management Of Data.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991008.0209.

8. ATTACHMENTS

None