QA: L

MOL.19981124.0287

Office of Civilian Radioactive Waste Management

PROCEDURE

DOCUMENT REVIEW

QAP 6.2

Revision 3, ICN 2

Effective Date: 08/20/98

Approval(s): Cathleen Hampton 8/4/98
R.W. Clark
Acting Director, Office of Quality Assurance
Date

Concurrence(s): N/A
Date

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WM-11 PDR

102.2

CHANGE HISTORY

Revision Number	Interim Change No.	Effective Date	Description of Change
0	-	05/18/92	Initial Issue
1	-	07/26/93	Revised to incorporate new requirements of OCRWM Quality Assurance Requirements and Description, DOE/RW-0333P, Revision 0. Incorporates standard review criteria for procurement documents previously identified in QAAP 7.1. Incorporates new QAP 5.1 format. Incorporates 1992 QAMA recommendation 10C to review documents for conflicts with other documents for conflicts with other documents. Refer to DAR 009.
2	-	06/20/94	Revised to reflect Yucca Mountain Site Characterization Office reorganization, update definitions, incorporate editorial enhancements, and incorporate exhibits as attachments.
2	1	03/06/95	ICN to make completed Comment Sheet(s) QA records (DAR 1223), and minor editorial changes. Page affected is page 8.
3		03/01/96	Complete revision in accordance with DAR 1648. Revised for consistency with QAP 5.1, *Quality Assurance Program Procedures*, Revision 7: Section 5.0 and 6.0 combined; updated requirements for designation of required review organization/ disciplines; revised Document Review Record and Comment Sheet and deleted Change Control Board process which is addressed by YAP-3.5Q, *Change Control Process*.
3	1	04/01/96	ICN to correct Exhibit QAP-6.2.2. Pages affected are 12 and 13 of 18.
3	2	08/20/98	ICN to reflect verification and acceptance of the RTN Matrix in Section 5.3.2. Page affected is 6.

1.0 PURPOSE

This procedure provides a process for the review of documents and resolution of review comments. This procedure represents the minimum process required and may be supplemented by Local Procedures (LPs).

2.0 APPLICABILITY

This procedure applies to individuals who participate in the review of documents for the Office of Civilian Radioactive Waste Management (OCRWM). This procedure is implemented when other procedures invoke its use. This procedure is also used to review deliverables submitted to the OCRWM by Affected Organizations for acceptance, if the review is not specifically governed by another procedure.

3.0 DEFINITIONS

Terms in this procedure are used as defined in the *Quality Assurance and Requirements Description* (QARD), DOE/RW-0333P, Glossary. The following definitions are specific to this procedure.

3.1 ***Responsible Individual*** - The OCRWM Office or Division Director; Manager or Assistant Manager responsible for an organization or discipline that is identified as a reviewing organization or discipline.

3.2 ***Governing Document*** - The OCRWM document invoking implementation of this procedure.

3.3 ***Mandatory Comment*** - A comment requiring resolution that identifies a problem such as a conflict with existing OCRWM requirements, failure to meet stated review criteria, or an inadequacy or error that could adversely impact the suitability of the document for its intended purpose.

3.4 ***Quality Assurance (QA) Program Procedure*** - Procedures for activities subject to the QARD, including Quality Assurance Procedures (QAPs) and Q-designated LPs and Administrative Procedures (APs).

3.5 ***Review Coordinator*** - The OCRWM Office or Division Director; Manager or Assistant Manager assigned the responsibility for developing a specific document or the individual designated to accept, for OCRWM, a document submitted by another Affected Organization.

4.0 RESPONSIBILITIES

4.1 The Director, Office of Quality Assurance (OQA) is responsible for the preparation, change, and approval of this procedure.

4.2 The following positions are responsible for activities identified in Section 5.0 of this procedure:

a) Review Coordinator

b) Responsible Individual

c) Document Reviewer

5.0 PROCESS

A brief overview of this process is depicted in the flowchart shown in Attachment 1, QAP 6.2, Flowchart. Acronyms and abbreviations used in this procedure are defined in Attachment 2, Acronyms and Abbreviations, and/or in the flowchart legend.

PROCESS OUTLINE

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5.2 DOCUMENT REVIEW 4
5.3 COMMENT RESOLUTION 5

5.1 INITIATING DOCUMENT REVIEW

5.1.1 Review Coordinator:

a) Initiate the Document Review Record (DRR), Attachment 3, and Comment Sheet, Attachment 4, including:

1) Identification of applicable review criteria specific to the document being reviewed using:

- Standard Document Review Criteria, Attachment 5, for QA implementing documents and other documents that specify technical or quality requirements.
- specific review criteria required by the governing document.
- any additional review criteria determined to be appropriate by OCRWM management.

2) Identification of the Responsible Individual and organization or discipline required to review the document including:

- each organization or discipline affected by the initial issue or revision of a document.
- each organization or discipline affected by a change to a document.
- each organization or discipline required by the governing document.
- any organization or discipline determined to be necessary, as identified by the Review Coordinator.
- the OQA for the initial issue, revision, or change to a QA Program Procedure or a QA Program Procedure that is being re-classified from quality-related to nonquality-related (Q to non-Q).
- for a new or revised LP or an Interim Change Notice (ICN) to an LP that supplements a QAP, the Responsible Individual for the QAP.

b) Forward to each Responsible Individual identified on the DRR, a copy of the Review Package which includes:

1) DRR

2) Comment Sheet

3) Document to be reviewed including any referenced exhibits

4) Any documents required by the governing document

5) Any necessary background information pertinent to the document to be reviewed, but not readily accessible to the Document Reviewers, as determined by the Review Coordinator.

5.1.2 Responsible Individual:

Designate a Document Reviewer technically competent in the subject area being reviewed, who is not the author or preparer of the document, or who did not directly participate in the preparation of the document or portion of the document to be reviewed.

5.2 DOCUMENT REVIEW

Document Reviewer:

a) Perform the document review using the assigned review criteria to determine the acceptability of the document.

b) If the document review cannot be completed by the due date, obtain an extension from the Review Coordinator.

c) Record comments or indicate that there are no comments on the Comment Sheet.

d) Identify mandatory comments with an asterisk (*) and nonmandatory comments with a code letter (N) on the Comment Sheet.

- Minor or editorial comments such as typographical errors, grammar, or titles for which no response is required may be marked on the document being reviewed instead of the Comment Sheet.

e) Sign and date the REVIEW COMPLETED BY block on the DRR indicating that the review criteria have been read, understood, and used in completing the document review.

f) Return the DRR, Comment Sheet(s), and any marked-up pages of the document, to the Review Coordinator by the due date.

5.3 COMMENT RESOLUTION

5.3.1 Review Coordinator:

a) Review comments for possible incorporation into the document.

b) Document responses on the Comment Sheets.

1) A response shall be required for each mandatory comment.

2) A response to nonmandatory comments may be provided at the Review Coordinator's discretion.

3) Comments provided by reviewers other than the designated reviewers shall be considered non-mandatory and do not require response.

4) Comments returned after the due date are not required to be considered; however, if not considered, the Review Coordinator shall confirm the adequacy of the review is not impacted due to unreviewed area(s) of expertise. Any comments not considered shall be returned to the reviewer who may elect to request further changes in accordance with the governing document or other appropriate means.

c) Incorporate necessary changes into the document.

d) Forward a comment resolution package consisting of the modified document, any documents required by the governing document, and copies of the DRRs and Comment Sheets to the Document Reviewers for acceptance of the comment resolutions and concurrence with the modified document.

5.3.2 Document Reviewer:

a) Review the updated document and comment responses.

b) Indicate agreement with the responses to his/her own mandatory comments by initialing and dating the ACCEPT block on the Comment Sheet adjacent to the appropriate response.

c) If a response to a mandatory comment is not acceptable:

1) Attempt to resolve the issue with the Review Coordinator.

2) If the issue cannot be resolved, leave the accept column blank adjacent to the unacceptable response.

d) If additional comments are required as a result of changes made to address comment resolution, document them on a Comment Sheet.

e) If all comments have been acceptably resolved and the modified document is acceptable, complete the CONCURRENCE block of the DRR.

NOTE: OQA concurrence shall indicate verification and acceptance of requirements matrix.

f) Return the DRR and Comment Sheets to the Review Coordinator.

5.3.3 Review Coordinator:

a) Review the returned DRRs and Comment Sheets to ensure that all responses to mandatory comments have been accepted and all concurrence signatures obtained.

b) If any comment is unresolved, attempt to negotiate an acceptable response with the Document Reviewer.

c) If a comment cannot be resolved with the Document Reviewer, elevate the dispute to progressively higher levels of management within the reviewing organization until resolution is obtained and documented on the Comment Sheet and concurrence with the document is obtained and documented on the DRR.

- The Director, OCRWM shall be the final resolution authority for OCRWM issues.

d) Incorporate any additional changes into the document as a result of the comment resolution process.

e) If changes, other than editorial corrections, are made to the document during the comment resolution process, obtain reconcurrence from the reviewing organization(s) affected by the change.

f) Complete the processing of the document in accordance with the governing document, following resolution of all mandatory comments and receipt of all concurrence signatures.

- During subsequent processing, if changes other than editorial corrections are made to the document, initiate a re-review of the changes by any discipline or organization affected by the changes in accordance with Subsection 5.1

g) Process records in accordance with Section 6.0 of this procedure.

6.0 QA RECORDS

The documents listed in Subsection 6.1 and 6.2 shall be collected and maintained as QA records in the QA records package generated in accordance with the governing document and in accordance with HLP-17.1Q, *QA Records Management*, or YAP-17.1Q, *Records Management Requirements and Responsibilities*. The documents listed in Subsection 6.1 and 6.2 that are generated for the review of non-OCRWM generated documents shall be collected and maintained in accordance with HLP-17.1Q or YAP-17.1Q.

Records generated by this procedure for non "Q" designated documents should be retained in records packages as identified above and in accordance with applicable records management program requirements.

6.1 LIFETIME QA RECORDS

"Q" designated Document Review Record

6.2 NONPERMANENT QA RECORDS

"Q" designated Comment Sheets
Copies of non-OCRWM generated documents (reviewed drafts or approved documents)

7.0 REFERENCES

7.1 DEVELOPMENTAL REFERENCES

a) *Quality Assurance Requirements and Description*, DOE/RW-0333P

b) QAP 5.1, *Quality Assurance Program Procedures*

7.2 IMPLEMENTATION REFERENCES

a) HLP-17.1Q, *QA Records Management*

b) YAP-17.1Q, *Records Management Requirements and Responsibilities*

8.0 ATTACHMENTS

Exhibits attached to this procedure are controlled and distributed as full-size exhibits separate from this procedure; these exhibits may be copied for use when implementing this procedure.

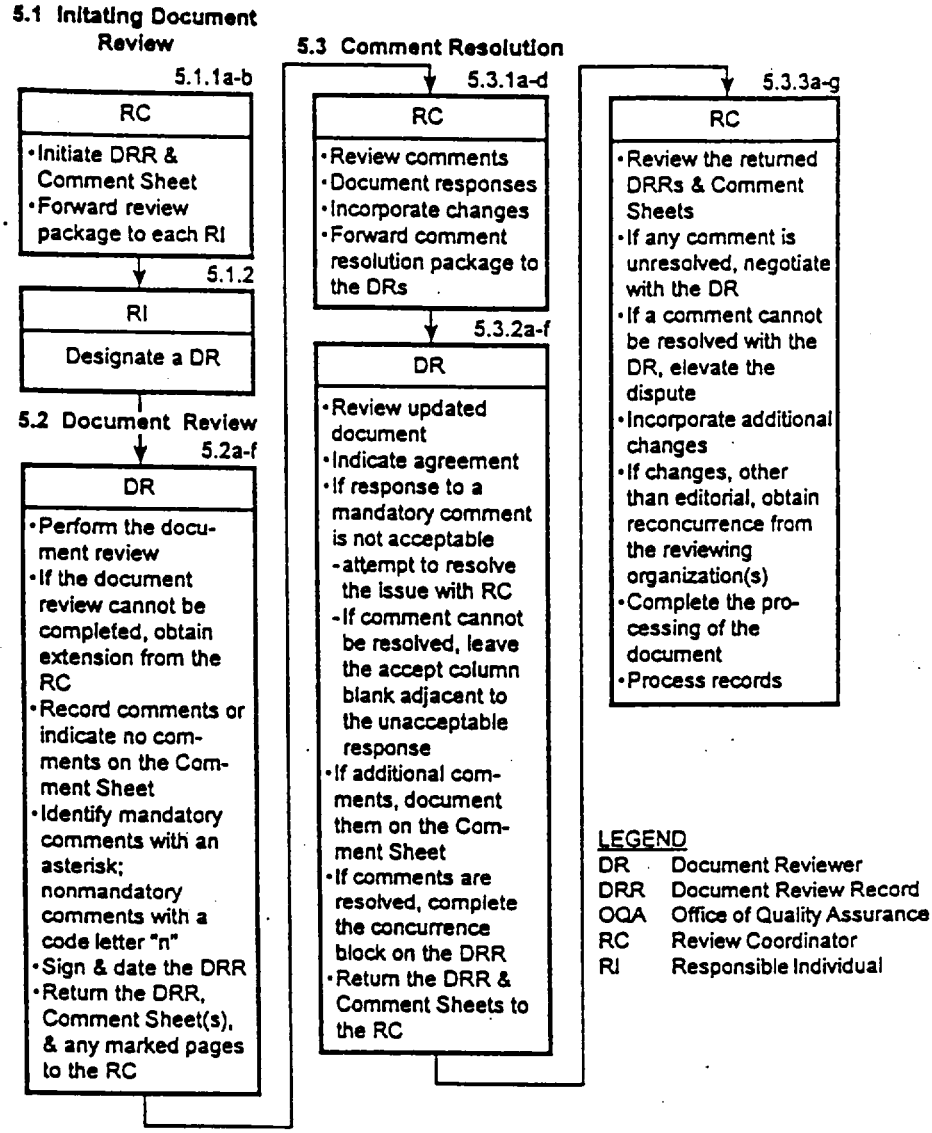
Attachment 1 - QAP 6.2 Flowchart

Attachment 2 - Acronyms and Abbreviations

Attachment 3 - Document Review Record (Exhibit QAP-6.2.1)

Attachment 4 - Comment Sheet (Exhibit QAP-6.2.2)

Attachment 5 - Standard Document Review Criteria



Attachment 1 - QAP 6.2 Flowchart

AP	Administrative Procedure
DRR	Document Review Record
ICN	Interim Change Notice
LP	Local Procedure
OCRWM	Office of Civilian Radioactive Waste Management
OQA	Office of Quality Assurance
QA	Quality Assurance
QAP	Quality Assurance Procedure
QARD	Quality Assurance Requirements and Description
RTN	Requirement Traceability Network

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT REVIEW RECORD

12. Page 1 of ____
1. DAR No.: _____

2. Document Title: _____
3. Document Number: _____ 4. Revision/Change: _____ 5. Date: _____ 6. ☐ Q ☐ Non-Q
7. Governing Document Number: _____ 8. Revision/Change: _____

REVIEW CRITERIA

9. ☐ Standard: _____ (Source)

10. ☐ Specific:
- ☐ Source: _____
- ☐ Attached: _____
- ☐ Listed Below:

EXAMPLE

11. REVIEWERS Responsible Individual	Org./Discipline	Review Criteria	Responsible Individual	Org./Discipline	Review Criteria

DRR AND COMMENT SHEET(S)

13. Due Date: _____
14. Review Coordinator:
_____ Print Name
_____ Signature/Date

REVIEW COMPLETED BY:

15. _____ Print Name
16. _____ Org./Discipline _____ Phone
17. _____ Signature _____ Date

COMMENT RESPONSES BY:

18. _____ Signature _____ Date

CONCURRENCE

19. Document Revision/Change: _____ Date: _____
20. Reviewer: _____ Signature _____ Date

DISPUTE RESOLUTION: (Complete only if appliable)

21. _____ Management Authority Concurrence _____ Date
22. _____ Title

Rev. 03/01/96

Exhibit QAP-6.2.1

INSTRUCTIONS FOR COMPLETING THE DOCUMENT REVIEW RECORD

DOCUMENT COORDINATOR

1. Identify the total number of pages for the DRR (e.g., if 1 page of specific review criteria is attached, mark page 1 of 2).
2. Record the DAR number or "N/A" if DAR is not applicable.
3. Record title of document to be reviewed.
4. Record number of document to be reviewed. Mark "N/A" if no number is assigned.
5. Record proposed revision/change and indicator, as applicable. Mark "N/A" if there is no revision/change indicator.
6. Record date of document to be reviewed. Mark "N/A" is no date is assigned.
7. Identify if QARD applies to document.
8. Identify the document invoking the review. Mark "N/A" if not applicable.
9. Identify the revision/change indicator or date, as applicable, of the governing document.
10. If standard review criteria from an implementing document apply, mark appropriate box and identify the source (e.g., QAP 6.2, Rev. 3)
11. If specific review criteria apply, mark appropriate box. Identify where the review criteria can be located (e.g., contract number and section or on an attached page).
12. Identify the responsible individual, organization or discipline, and the specific review criteria assigned.
13. Assign a due date for the completion of the review.
14. Print and sign name. Record date.

DOCUMENT REVIEWER

15. Print name.
16. Identify organization or discipline represented. Record phone number.
17. Sign and date.

COMMENT RESPONDER

18. Sign and date.

DOCUMENT REVIEWER If comment(s) are accepted:

19. Record revision/change/date, as applicable, of document being accepted.
20. Sign and date. (If comment(s) are not accepted, leave blocks 19 and 20 blank)
21. Mark N/A if Reviewer concurs with the document.

MANAGEMENT AUTHORITY ACCEPTING DOCUMENT (complete if Document Reviewer does not concur with the document)
Upon resolution of disputed issue:

19. Record revision/change/date, as applicable, of document being accepted.

20 Mark N/A.

21. Sign and date.
22. Record title of Management Authority.

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
COMMENT SHEET

12. Page ____ ____
1. DAR No.: _____

2. Document Title: _____

3. Document Number: _____ 4. Revision/Change: _____ 5. Date: _____ 6. ☐Q ☐Non-Q

7. Governing Document Number: _____ 8. Revision/Change: _____

9 NO. CODE	10 SECT./ PARA.	11 COMMENT	14 RESPONSE	15 ACCEPT

EXAMPLE

13. Reviewer: _____ Date: _____
Signature

Exhibit QAP-6.2.2

Rev. 04/01/96

INSTRUCTIONS FOR COMPLETING THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT COMMENT SHEET

REVIEW COORDINATOR

1. Record DAR number or "N/A" if DAR is not applicable.
2. Record title of reviewed document.
3. Record number of reviewed document. Mark "N/A" if there is no revision/change indicator.
4. Record proposed revision/change indicator, as applicable. Mark "N/A" if there is no revision/change indicator.
5. Record date of document to be reviewed. Mark "N/A" if no date is assigned.
6. Identify if QARD applies to document.
7. Identify the document invoking the review. Mark "N/A" if not applicable.
8. Identify the revision/change indicator or date, as applicable, of the governing document.

DOCUMENT REVIEWER

9. Number comments sequentially. Mark mandatory comments with an asterisk (*) and non-mandatory comments with a code letter (N).
10. Identify the section or paragraph to which comment applies.
11. Record comment. Include explanation of the basis for comment if necessary and suggested change when possible.
12. Identify the total number of pages for the comment sheet(s).
13. Sign and date.

REVIEW COORDINATOR

14. Document response adjacent to each comment.

DOCUMENT REVIEWER

15. Initial and date adjacent to each comment when the response is accepted. Leave blank if not accepted. Acceptance of responses to non-mandatory comments is not required.

MANAGEMENT AUTHORITY ACCEPTING DISPUTED ISSUE (complete if Document Reviewer does not accept comment resolution)

15. Initial and date adjacent to comment after resolution of disputed issue and documentation of final response by Review Coordinator.

STANDARD DOCUMENT REVIEW CRITERIA

These standard review criteria are used as applicable to determine the acceptability of the document reviewed:

1.0 MANAGEMENT REVIEW CRITERIA

1.1 Does any change to existing policy expressed in the document represent a deliberate and appropriate decision?

1.2 When the document affects the reviewing organization, are management and administrative impacts acceptable?

1.3 Are processes as straight forward and simple as feasible?

1.4 Is the document user friendly, or could it be simplified or reorganized into a more consistent, logical order?

1.5 Does the document avoid elevating administrative convenience to a requirement level?

1.6 If the document addresses a management approach or methodology, is the reviewing organization satisfied that the approach is as simple and effective as any readily available alternative?

1.7 Are the purpose and scope of work clearly specified?

1.8 Are the activities, documents, materials, or data, and the individuals or organizations to which the document applies adequately described?

1.9 Are all individuals or organizations responsible for implementing the document delineated?

1.10 Are the responsibilities clearly delineated and in accordance with established organizational division of responsibility or as established in approved procurement documents?

1.11 Are the requirements delineated in the document implementable?

1.12 Are terms defined adequately to ensure consistent interpretation of the document?

1.13 Are all the supporting details necessary and sufficient?

1.14 Are the content, format, and style of the document consistent with applicable requirements?

1.15 Do the exhibits specify the minimum information required?

1.16 Are all the exhibits and attachments consistent with the document being reviewed?

1.17 Are all actions requested in approved Document Action Requests incorporated appropriately?

1.18 Does the document change history and referenced Document Action Request relating to the proposed change, conflict with a previously implemented requirement?

1.19 If the document is scheduled for cancellation, will the cancellation adversely impact any ongoing or planned work?

1.20 Have the correct organizations or disciplines been assigned to review the document? Are the review criteria adequate and correct?

1.21 Does the document conflict with other documents?

1.22 Is the document legible?

2.0 TECHNICAL REVIEW CRITERIA

2.1 Is the document prepared in accordance with QAP 3.5, *Technical Document Preparation*?

2.2 Are document input sources, appropriate, current, correct, and useable? Do the inputs meet applicable requirements for qualified data?

2.3 Are any assumptions used in the development of the technical document stated explicitly? Are they reasonable?

2.4 Is document content consistent with established OCRWM objectives?

2.5 In the case of a design document, is the design approach compatible with OCRWM objectives and constraints and with prescribed systems engineering requirements?

2.6 Are calculations sufficiently detailed such that a technically qualified person can understand the analysis?

2.7 Have the computer programs required by the technical document been verified?

2.8 When applicable, are potential interactions with other technical work addressed adequately?

2.9 Are analytical and design approaches and results reasonable and appropriate?

2.10 Does the final document correctly incorporate technical input? Is there adequate, complete, accurate and traceable flow of requirements from source documents to the final document?

2.11 If referenced standards contain conflicting requirements, is the requirement that governs designated?

2.12 If the technical document is for design purposes, are the following requirements evident: basic functions of items, performance, regulatory, technical, security, and safety?

2.13 Are applicable interfaces identified and documented such as for work performed in sequence or for product received from another Affected Organization?

2.14 Are the responsibilities for interface requirements delineated?

2.15 If there are any constraints on required interfaces, are they described adequately?

2.16 Are any unverified portions of design documents clearly identified as such?

2.17 Are units of measure consistent, compatible, and appropriate?

2.18 Does the document contain qualitative and quantitative data, and if so, are any necessary tolerances and parameters provided for this data?

3.0 QA REVIEW CRITERIA

3.1 Are specified responsibilities and authority consistent with OCRWM policy or other applicable requirements?

3.2 When applicable, does the document provide for involvement of the QA organization?

3.3 Are terms that are defined in the QARD used in a context consistent with QARD definitions?

3.4 Are all QA records to be generated during the implementation of the document identified and correctly classified? Is the procedure for handling those QA records identified? Is the responsibility for submitting records to the records management system clearly delineated?

3.5 Do the defined process and controls adequately, completely, accurately, and correctly address the applicable QA requirements?

3.6 Is the item or activity to which the document applies clearly identified?

3.7 Is there adequate traceability of information used as input to the document?

3.8 Are methods for qualifying any unqualified input specified, as necessary? If qualification is to be tracked, has the input been appropriately identified?

3.9 Are the applicable requirements of the source documents incorporated into the document? For an LP that supplements a QAP, does the LP correctly and completely incorporate the content of the QAP that it supplements?

3.10 Does the document include or reference appropriate quantitative and qualitative acceptance criteria for determining that prescribed processes have been satisfactorily accomplished?

3.11 Are adequate, complete, and correct technical requirements identified, including drawings and specifications; codes, standards, and regulations; acceptance criteria; and traceability requirements, where appropriate?

3.12 Are the technical and QA program deliverables, including QA records, required to be generated and submitted completely and clearly specified?

4.0 PROCUREMENT DOCUMENT REVIEW CRITERIA

4.1 Is the scope of work clearly specified?

4.2 Are adequate, complete, and correct technical requirements identified, including drawings and specifications; codes, standards and regulations; acceptance criteria; and traceability requirements, where appropriate? If applicable, are revision levels or change status of these documents identified?

4.3 Are adequate, complete, and correct QA requirements appropriate to the scope of work identified as outlined in applicable procurement procedures?

4.4 Do procurement documents require the supplier to submit an implementing document on organization and a matrix indicating where applicable QARD requirements are addressed, or a documented QA program implementing the appropriate or specified portions of the QARD for OCRWM acceptance prior to the start of work? If the supplier is not required to submit either of the above, does the procurement document require that the supplier work to the specific sections and implementing procedures of the OCRWM QA program?

4.5 Do the procurement documents require the supplier to incorporate the appropriate QA program requirements in subtier procurements?

4.6 Do the procurement documents contain provisions for access by OCRWM (or designee authorized by OCRWM) to supplier's facility and records for audit and surveillance to verify compliance with applicable requirements?

4.7 Do the procurement documents contain provisions for establishing hold points (such as provisions for performance of readiness reviews, when applicable) beyond which work may not be initiated or continued without purchaser authorization?

4.8 Have the items or services required to be provided by the supplier been completely and clearly specified?

4.9 Has adequate acceptance criteria for each item or service been identified?

4.10 Do the procurement documents specify the records to be developed by the supplier and submitted to OCRWM for information or review and acceptance? Are record storage requirements, retention times, and turnover or disposition requirements and schedules identified?

4.11 Have methods for the disposition of items or services that do not meet procurement document requirements been established between OCRWM and the supplier?

4.12 For procurement of items, have any necessary spare or replacement parts or assemblies been identified? If spare parts or assemblies are identified, has the technical and QA information required for ordering been included?

4.13 Are the procurement documents composed in an appropriate form such that they are contractually and legally binding on both parties?

5.0 EXTERNAL COMMITMENT REVIEW CRITERIA

5.1 Is the document content consistent with applicable regulatory requirements?

5.2 Does the document content affect existing regulatory or other external commitments and is it consistent with such commitments?

5.3 If the document makes any commitment or addresses a topic of regulatory interest, is it consistent with OCRWM policy?

5.4 If the document will meet a formal submittal requirement, does format and organization of material comply with submittal requirements?

5.5 Are there any contradictions between the document, U.S. Department of Energy orders, regulatory requirements or commitments?

6.0 QARD REQUIREMENTS MATRIX CRITERIA

6.1 Does the RTN Matrix identify the correct title of each implementing document(s) currently linked to specific applicable QARD requirements?

6.2 Does the RTN Matrix identify the correct version (e.g., revision/modification/change level, interim change level, and/or date, etc.) of each of the implementing documents?

6.3 Do the implementation requirements listed on the RTN Matrix completely implement the identified QARD requirements?

6.4 Do the implementing documents identified on the RTN Matrix provide an adequate and viable method for clearly, completely, and correctly satisfying the associated QARD requirement?

6.5 Are all requirements marked "N/A" correct for the Affected Organization's scope of work?

6.6 When a QARD requirement, or part thereof, is considered not applicable to the scope of work for the Affected Organization, is it indicated "N/A" on the RTN Matrix?

6.7 Does each implementation marked "Exception" on the RTN Matrix have satisfactory justification approved by OQA?

CRWMS/M&O	QA Classification 1 **Important to Radiological Safety**	QA: L

Classification Checklists for Storage Page 1 of 4

Name and Item Identifier: _____

Yes	No	
		1.1 Is the item required:
☐	☐	a. To maintain temperature, humidity, and inert atmosphere of the storage mode?
☐	☐	b. To maintain integrity of the fuel assembly/high level waste form?
☐	☐	c. To mitigate the effects of an accident as defined by methods described in the supporting analysis that could directly or indirectly result in a release of radioactive materials that would result in a dose on or beyond the nearest controlled area boundary of $\geq$ 5 rem whole body or any organ?
☐	☐	d. To monitor and/or control QA Classification 1 sections of SSCs important to radiological safety?
☐	☐	e. For the functioning of any equipment required to mitigate the effects of an accident as defined by methods described in the supporting analysis?
		1.2 Can failure of the item:
☐	☐	a. Initiate an accident that would result in damage to a fuel assembly?
☐	☐	b. Directly cause a release of radioactive materials that would result in a dose at or beyond the nearest controlled area boundary of $\geq$ 5 rem whole body or any organ?
☐	☐	c. Increase the probability or consequences of an accident or failure of items important to radiological safety in a facility with which the storage facility shares services?
☐	☐	d. Result in significant loss of SNF cooling capability?
		1.3 Is the item:
☐	☐	a. A consumable/expendable item that is part of, or contained within, and directly affects the safety function of any component identified in Section 1.1 or 1.2 above?
☐	☐	b. A part of a system for monitoring the performance of the SNF?

If the answer to any question in 1.1, 1.2, or 1.3 is Yes, then the item is QA Classification 1.

Civilian Radioactive Waste Management System
Management and Operating Contractor

Principal Isotope Selection Report

Document Identifier No.: B00000000-01717-5705-00104 REV 00

August 28, 1998

Prepared by: _____ **Date:** 8/28/98
K. D. Wright, Preparer
Neutronics Methodology

Reviewed by: _____ **Date:** 8/28/98
J. M. Scaglione, Checker
Neutronics Methodology

Approved by: _____ **Date:** 08/28/98
D. A. Thomas, Supervisor
Neutronics Methodology

Approved by: _____ **Date:** 8-28-98
T. W. Doering, Department Manager
Waste Package Design

102.2

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1. Introduction

Utilizing nuclear fuel to produce power in commercial reactors results in the production of hundreds of fission product and trans-uranic isotopes in the spent nuclear fuel (SNF). When the SNF is disposed of in a repository, the criticality analyses could consider all of the isotopes, some principal isotopes affecting criticality, or none of the isotopes, other than the initial loading. The selected set of principal isotopes will be the ones used in criticality analyses of the SNF to evaluate the reactivity of the fuel/waste package composition and configuration. This technical document discusses the process used to select the principal isotopes and the possible affect that these isotopes could have on criticality in the SNF.

1.1. Background

SNF contains hundreds of fission products and trans-uranic actinides. An important design objective for the repository is to ensure that the SNF meets guidelines to maintain a sufficient subcritical margin. Since the economics of commercial reactor operation require the nuclear fuel to be highly burned, it is apparent that the SNF will be highly subcritical. Simulations of critical conditions to evaluate the potential for nuclear criticality could be based on the isotopic concentrations being representative of fresh fuel. While this assumption simplifies nuclear criticality evaluations, it could result in significant economic penalties. Therefore, criticality analyses of SNF, that will be deposited in a repository, will include the effects of burnup on the isotopic concentrations of the fuel.

1.2. Objective

The objective of this technical document is to discuss the process used to select the principal isotopes for disposal criticality evaluations with commercial SNF. The principal isotopes will be used as supporting information in the *Disposal Criticality Analysis Methodology Topical Report* which will be presented to the United States Nuclear Regulatory Commission (NRC) when approved by the United States Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM).

1.3. Scope

This technical document discusses the process for selecting the principal isotopes and the selected principal isotopes to be used in the disposal criticality methodology for SNF. The principal isotopes will be used in supporting documents and as supporting information in the *Disposal Criticality Analysis Methodology Topical Report*.

1.4. Quality Assurance (QA)

The QA program applies to the development of this technical document. The information provided in the technical document is to be indirectly used in the evaluation of the Monitored Geologic Repository waste package and engineered barrier segment. The waste package and engineered barrier segment have been identified as items important to safety, waste isolation, and physical protection of materials in the QAP-2-3 evaluation entitled "Classification of the

Preliminary MGDS Repository Design" (Ref. 6.1, TBV-228). The Waste Package Design Department (WPDD) responsible manager has evaluated the technical document development activity in accordance with QAP-2-0, "Conduct of Activities." The QAP-2-0 activity evaluation, "Develop Technical Documents" (Ref. 6.2), has determined that the preparation and review of this technical document is subject to "Quality Assurance Requirements and Description" (Ref. 6.3) requirements. As specified in NLP-3-18, "Documentation of QA Controls on Drawings, Specifications, Design Analyses, and Technical Documents," this activity is subject to QA controls.

1.5. Use of Computer Software

There was no computer software used in the development of this technical document.

2. Description of the Principal Isotope Set Selection Process

The hundreds of fission products and trans-uranic actinides in the SNF significantly reduce the reactivity of the fuel. The repository will be a permanent installation that will contain the fuel material for thousands of years. Since degradation in any hypothetical environment over a period of tens of thousands of years is possible, this degradation must be considered for criticality evaluations. The simulation of hypothetical degradation of the waste package structure and the contained fuel for criticality analyses introduces two of the most important considerations for the selection of a set of principal isotopes to represent the SNF:

1. The simulation of the composition and configuration of the fuel and waste package must include the hypothetical degradation into the most reactive conditions.

2. The selection of the principal isotopes must include consideration of the physical-chemistry properties of the SNF that are consistent with the hypothetical degradation, in addition to the neutronic properties.

Experience with reactor fuel designs and previous preliminary sensitivity evaluations have shown that degraded fuel, within degraded waste packages, can be made to be very reactive. The degraded fuel reactivity can be increased towards a maximum value by increasing the ratio of water moderating material relative to the SNF material.

2.1 Simulation of Hypothetically Degraded SNF

There are two important neutronic characteristics of the reactor fuel that influence the selection process for the principal isotopes affecting repository criticality evaluations. The first is the production of isotopes during reactor operation that results in highly reactive SNF when it is discharged. The second is the potential for a highly reactive fuel configuration due to a hypothetically degraded repository/waste package configuration. The first characteristic is discussed in Section 2.3. This section discusses the simulation of the fuel configuration that has been modified to achieve a maximum reactivity in a hypothetically degraded condition.

With the repository being a permanent installation for the SNF, there are several states of hypothetical degradation. The use of the principal isotopes in criticality evaluations is limited by a degraded state. This limiting degraded state is defined by the cladding material being intact but having some holes that would allow water to be outside of the pellet material, between the pellet and cladding. This limiting degraded state does not consider the pellet material to be mixed with or in solution with the water. Further description of the degraded SNF configuration is provided in Section 3.

Reference 6.4 includes discussions of the neutronic evaluations of the degraded fuel. An important consideration made in the evaluations was that the selection process will be based on the neutronic characteristics of a highly thermalized system. The water moderation is a dominating effect that reduces the importance of fast fissions, increases the resonance escape probability, reduces the neutron leakage and the importance of the water reflection, and enhances the overall effects of thermal reactions on the system's reactivity.

2.2 Physical and Chemical Properties

The hypothetical degradation of the fuel and waste package considered in the principal isotope selection evaluation results in holes in the waste package and holes in the fuel cladding. The holes provide the means of allowing water to permeate the SNF environment. The holes also provide the means of allowing the fission products and trans-uranic actinides, that are associated with the pellet-clad gap region, to be displaced.

The displacement of any isotope due to the physical-chemical properties of the respective elements would be extremely difficult to treat in the criticality evaluations. Consequently, the selection process for the principal isotopes is limited by the physical-chemical properties of the elements.

Mendeleev's periodic table of the elements (pp. 16, 17, Ref. 6.5) indicates which elements have similar chemical properties and would be unaffected by the fuel degradation, and which elements should not be considered in principal isotope selection. Those elements that would be most affected by the degradation are the inert gases, the halogens, and the alkali metals. These elements were dropped from the principal isotope selection process. Those elements that would be unaffected are the ones with the same principal oxidation state as the actinides. This includes the Lanthanides and the other elements in groups IB through VIIB and VIII.

The isotopes selected as the principal ones are noted in Section 4. These isotopes include 15 fission products and 14 actinides. The selected actinides are stable with respect to their physical-chemical properties in the degraded SNF environment. Of the 15 fission products, 10 are in the group of Lanthanides. This group includes 2 isotopes of Neodynium, 5 of Samarium, 2 of Europium and 1 of Gadolinium. Another 4 of the fission product isotopes, Molybdenum, Technetium, Ruthenium and Rhodium are associated with the stable metals Chromium, Manganese, Iron and Cobalt, respectively. The last of the 15 fission product isotopes is contained in the noble metal group of elements (Silver). The groups of elements representing the fission products are stable with respect to their physical-chemical properties in the degraded SNF environment.

2.3 Neutronic Variables

The hundreds of fission product and trans-uranic isotopes that are in the SNF from commercial power reactors significantly decrease the reactivity of the fuel in comparison to the initial fresh fuel loadings. The criticality evaluations of the repository will insure that there is an appropriate margin of subcriticality for the SNF. Insuring an appropriate subcritical margin for the SNF and including the reactivity uncertainties associated with the hundreds of fission product and trans-uranic isotopes introduces too much uncertainty into the criticality evaluations. To reduce the uncertainty, such that a subcritical margin can be evaluated with a sufficiently high degree of confidence, requires that the hundreds of fission product and trans-uranic isotopes be reduced to a set of principal isotopes. Criticality evaluations with the principal isotopes must be based on a high degree of confidence that the predicted concentrations are well known, with a defined uncertainty. In addition, the neutronic properties of the isotopes should include the majority of the neutron productions and absorptions that are associated with the hundreds of fission products and actinides.

The selection process for the principal isotopes was based on identifying the nuclear properties necessary for the isotopes to adequately represent the SNF. Since the isotopes in the SNF are radioactive, they are continually changing with time. Therefore, the time-dependent behavior of the neutron production and absorption must be evaluated. Reference 6.4 contains calculations of the degraded SNF decaying from a period of 5 years through 250,000 years. The results of the calculations indicated that the decay initially causes the reactivity of the SNF to decrease (p. 9, Ref. 6.4). However, after a period of 150 years, the decay caused the SNF reactivity to increase (p. 9, Ref. 6.4). The reactivity peaked at a period of 14,000 years for the most reactive SNF (p. 10, Ref. 6.4).

For other SNF, that is highly reactive, but with lower enrichments than the most reactive fuel, the peak occurred before 14,000 years (p. 10, Ref. 6.4). Following the peak in reactivity, the continuing decay of the SNF resulted in a continuing decrease in reactivity (p. 10, Ref. 6.4). Therefore, the selection process for the principal isotopes was focused on the reactivity of the SNF as a function of time. During the periods of high reactivity at 5 years and 14,000 years (or before) the principal isotopes must have a relatively constant effect on reactivity. Reviewing the selected set of isotopes in Section 4 indicates that these isotopes are generally either stable with no decay or decay with a half-life on the order of several hundred thousand years. Those isotopes that decay in shorter periods have a complementary long half-life isotope that provides a near constant reactivity effect (e.g., the stable isotope Eu-151 is complementary to the short-lived isotope Sm-151).

The selection process included a verification that the principal isotopes held a nearly constant reactivity by maintaining a nearly constant absorption fraction, relative to the SNF, with all fission products and actinides included. As discussed in Reference 6.4, the verification included comparisons to different fuel types as well as different operating conditions. Independent of the neutronic variables associated with the fuel types and operating conditions, the selected set of principal isotopes was shown to have at least 96 percent of the absorption as compared to all of the fission products and actinides for the more reactive degraded SNF during the period between the initial decay at 5 years and the peak reactivity around 14,000 years (p. 52, Ref. 6.4).

Following the peak reactivity period, the less reactive degraded SNF that was highly burned and decayed was shown to have at least 92 percent of the absorption compared to all of the fission products and actinides (p. 52, Ref. 6.4).

3. Description of Calculations Performed to Support the Selection of Principal Isotopes

The discussion presented in this section is a summary of the calculations documented in Reference 6.4. The methods used in the calculations to support the selection of the principal isotopes were those of nuclear physics for critical systems, and systems with time dependent isotopics. These methods included neutron transport theory and the theory of nuclear reactions and disintegrations. Neutron transport theory was represented by the time-independent transport equation with a critical eigenvalue representing an asymptotic time period and a buckling eigenvalue representing spatial leakage. The nuclear reactions and disintegrations were represented by a set of coupled differential equations. The solution of the differential equations produced a set of coupled exponential equations (the Bateman equations). These exponential equations represented the time-dependent changes in the isotopics with each product isotope dependent on its own reactions and disintegrations, and on the reactions and disintegrations of the parent and daughter isotopes.

The methods of determining solutions for the isotopic reactions and reactivity effects of the isotopes in the transport equation were based on the XSDRNPM-S computer code module of the SAS2H sequence in the SCALE 4.3 computer software package (p. 6, Ref. 6.4). The XSDRNPM-S results were utilized by the ORIGEN-S computer code (p. 6, Ref. 6.4). The ORIGEN-S module of the SAS2H sequence in the SCALE 4.3 software package used the (Bateman) set of coupled exponential equations to determine the time dependent isotopics within the SNF. The ORIGEN-S results included the reaction rate density along with the isotopic concentration density. The reaction rates were primarily determined in XSDRNPM-S, and collapsed through the COUPLE code module of the SAS2H sequence. The ORIGEN-S edit provided a relative ranking of the isotopic absorption reaction rate density. This ranking provided the means of identifying the principal fission product isotopes affecting critical conditions. This ranking also provided the means of identifying the principal trans-uranic and actinide isotopes affecting critical conditions. The importance of the trans-uranic and actinide isotopes was evaluated using both the relative ranking of the absorption rate and the product of the relative absorption rate and the isotopic k_∞. The isotopic k_∞ was calculated using the following expression:

$$k_\infty = \left(\frac{\Sigma_{f_i} \nu_i}{\Sigma_{a_i}}\right) = \left(\frac{N_i \sigma_{f_i} \nu_i}{N_i \sigma_{a_i}}\right) = \left(\frac{\sigma_{f_i} \nu_i}{\sigma_{a_i}}\right)$$

where the values of σ_{f_i}, ν_i, and σ_{a_i} represented the microscopic fission cross section of isotope i, the average number of neutrons resulting from thermal neutron induced fission of isotope i, and the microscopic absorption cross section of isotope i, respectively (p. 4, Ref. 6.4). The isotopic k_∞ was determined with 2200 meter per second σ_{f_i}, ν_i, and σ_{a_i} values (p. 4, Ref. 6.4).

The calculations were performed to provide results that would assist in selecting the principal isotopes which have the largest influence on the SNF reactivity. Therefore, the calculations were performed on a highly reactive degraded SNF configuration. The degraded fuel configuration represented a geometrical arrangement of fuel and moderator which enhanced neutron moderation and thermal neutron interaction within the fuel. Hence, the thermal neutron induced fission rate in the SNF was enhanced resulting in a highly reactive SNF configuration. The degraded fuel configuration was represented as having no grid or other structural material within the assembly lattice, and no material outside the assembly lattice other than a neighboring assembly or a moderator reflector of water. In the degraded configuration, the fuel clad was the only structure and the cladding was degraded to the extent that water was between the pellet and clad. Also in the degraded configuration, the fuel rods and assemblies were further represented as having bowed to the maximum extent within the area of two assembly pitch gap widths. Additionally, the degraded fuel configuration had the following characteristics: (a) no poisons or other elements in the water, (b) water and all material temperatures were decreased to 20 °C, and (c) the water density was maximized at 1.0 gram per cubic centimeter. The lack of soluble poisons, the lack of moderator exclusion, the low temperature conditions, and the maximum hydrogen density all served to maximize the neutron thermalization, thus increasing the thermal neutron population available to induce fission in the SNF.

Since the degraded fuel configuration included degradation of the fuel rod cladding such that water had penetrated the cladding and filled the gap between the fuel pellet and clad, the following two neutron spectrum effects were generated:

1. The material between fuel pellets in the radial plane was greater than before, thereby making each pellet more isolated. The additional material reduced the Dancoff factor.

2. The additional water contributed to a more thermalized neutron spectrum.

Concerning the Dancoff factor, the relative decrease in resonance absorption did not affect the relative absorption rates of the various isotopes with the exceptions of Uranium-238 and Plutonium-239. This was due to the fact that the resonance absorption in the various isotopes other than Uranium-238 and Plutonium-239 was not significant with respect to relative thermal neutron absorption in a configuration characterized by a highly thermalized neutron spectrum.

The calculations used to support the principal isotopes selection process included (a) 18 SAS2H depletion cases (each containing a final depletion pass which represented the SNF at the end of its reactor life in a degraded fuel configuration) and (b) 18 ORIGEN-S decay cases (one case immediately following each of the 18 SAS2H cases to calculate the decay of the SNF to a number of time periods). Table 3-1 lists the parameters that characterized each of the 18 different SAS2H fuel assembly depletion calculations. The infinite neutron multiplication factor (k_{inf}) and relative isotopic absorption rate results, obtained from SAS2H/ORIGEN-S for each of the degraded SNF configurations at 31 different decay times, were used to rank the isotopes according to their effect on SNF reactivity to support selection of the principal isotope set.

The B&W 15 by 15 fuel assembly specifications corresponded to the Fuel Batch 3 specifications from the Crystal River Unit 3 reactor (p. 7, Ref. 6.4). The Westinghouse 17 by 17 OFA specifications correspond to the Fuel Batch 6B specifications from the McGuire Unit 1 reactor (p. 7, Ref. 6.4). The Westinghouse 17 by 17 standard lattice fuel assembly specifications corresponded to the Fuel Batch 2 specifications from the McGuire Unit 1 reactor (p. 7, Ref. 6.4).

Table 3-1. Calculational Parameters (pp. 7, 8, Ref. 6.4)

SAS2H/ ORIGEN-S Case Number	Fuel Type	Enrichment (wt% U-235 in U of UO_2)[3]	Burnup (MWd/MTU)[1]	Assembly Power	Control Rods
1	B&W 15 by 15	2.5	18,000	100% 14.5085 MW[2]	None
2	B&W 15 by 15	2.5	30,000	100% 14.5085 MW	None
3	B&W 15 by 15	5.0	30,000	50% 7.2542 MW	None
4	B&W 15 by 15	5.0	30,000	100% 14.5085 MW	None
5	B&W 15 by 15	5.0	30,000	100% 14.5085 MW	Inserted
6	B&W 15 by 15	5.0	63,000	100% 14.5085 MW	None
7	Westinghouse OFA 17 by 17	2.5	18,000	100% 17.6736 MW	None
8	Westinghouse OFA 17 by 17	2.5	30,000	100% 17.6736 MW	None
9	Westinghouse OFA 17 by 17	5.0	30,000	50% 8.8368 MW	None
10	Westinghouse OFA 17 by 17	5.0	30,000	100% 17.6736 MW	None
11	Westinghouse OFA 17 by 17	5.0	30,000	100% 17.6736 MW	Inserted
12	Westinghouse OFA 17 by 17	5.0	63,000	100% 17.6736 MW	None
13	Westinghouse Std. 17 by 17	2.5	18,000	100% 17.6736 MW	None
14	Westinghouse Std. 17 by 17	2.5	30,000	100% 17.6736 MW	None
15	Westinghouse Std. 17 by 17	5.0	30,000	50% 8.8368 MW	None
16	Westinghouse Std. 17 by 17	5.0	30,000	100% 17.6736 MW	None
17	Westinghouse Std. 17 by 17	5.0	30,000	100% 17.6736 MW	Inserted

Table 3-1. Calculational Parameters (pp. 7, 8, Ref. 6.4)

SAS2H/ ORIGEN-S Case Number	Fuel Type	Enrichment (wt% U-235 in U of UO_2)[3]	Burnup (MWd/MTU)[1]	Assembly Power	Control Rods
18	Westinghouse Std. 17 by 17	5.0	63,000	100% 17.6736 MW	None

[1] MWd/MTU = megawatt days per tonne of Uranium
[2] MW = megawatt
[3] wt% = weight percent

4. Principal Isotopes Selected

The selected principle isotope set consists of 14 actinides and 15 fission products. Table 4-1 presents the selected principle isotope set.

Table 4-1. Selected Principal Isotope Set

Actinides				
U-233	U-234	U-235	U-236	U-238
Np-237	Pu-238	Pu-239	Pu-240	Pu-241
Pu-242	Am-241	Am-242m	Am-243	
Fission Products				
Mo-95	Tc-99	Ru-101	Rh-103	Ag-109
Nd-143	Nd-145	Sm-147	Sm-149	Sm-150
Sm-151	Sm-152	Eu-151	Eu-153	Gd-155

5. Conclusions

The set of 29 principal isotopes shown in Table 4-1 were selected based on the results of the calculations and evaluations documented in Reference 6.4 and described in Sections 2 and 3 of this document. The 29 principal isotopes contain 14 actinide and 15 fission product isotopes. The neutronic properties of the principal isotopes should include the majority of the neutron productions and absorptions that are associated with the hundreds of fission products and actinides that are actually in the SNF. Independent of fuel type and operational history, the selected 29 principal isotopes account for at least 96 percent of the total neutron absorption in the more reactive degraded SNF configuration, and at least 92 percent of the total neutron absorption in the less reactive (highly burned) degraded SNF configuration (p. 52, Ref. 6.4). The actinides in the selected principal isotope set represent approximately 99 percent of the total neutron production in the degraded SNF configuration (p. 52, Ref. 6.4).

The selected set of 29 principal isotopes is acceptable for quality affecting activities and for use in analyses affecting procurement, construction, or fabrication. The classification for the repository (which includes the waste package) carries TBV-228 because of the preliminary status of the basis for the Monitored Geologic Repository design. This technical document

conservatively assumes that the resolution of TBV-228 will find the waste package to be quality affecting; consequently, use of any of the data reported herein does not need to carry TBV-228.

6. References

6.1. *Classification of the Preliminary MGDS Repository Design.* Document Identifier Number (DI#): B00000000-01717-0200-00134 REV 00, Civilian Radioactive Waste Management System (CRWMS) Management and Operating Contractor (M&O). MOL.19980211.1192.

6.2. *QAP-2-0 Activity Evaluation.* Activity Evaluation Number: WP-06, Develop Technical Documents, CRWMS M&O, August 3, 1997. MOL.19971215.0080.

6.3. *Quality Assurance Requirements and Description.* DOE/RW-0333P, REV 8, United States Department of Energy Office of Civilian Radioactive Waste Management. MOL.19980601.0022.

6.4. *Principal Isotope Selection Calculation.* DI#: B00000000-01717-0210-00031 REV 00, CRWMS M&O. MOL.19980806.0608.

6.5. *Nuclides and Isotopes, Chart of the Nuclides, Fourteenth Edition.* General Electric Company, 1989. TIC#: 201637.