"Functional Requirements Document for the Naval Spent Fuel Canister (SFC) System (U)," B-REO(GRD)-379 Rev. 9, February 2008 [Redacted]

Ref 6

NAVAL NUCLEAR PROPULSION PROGRAM
LSN REVIEW

NNPI has been redacted.
Document is now unclassified.

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B-MDP(E)DSS-5

February 7, 2008

Manager, Pittsburgh Naval Reactors Office
U. S. Department of Energy
Post Office Box 109
West Mifflin, Pennsylvania 15122-0109

Subject: Revision 9 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Information and Use (U)

Dear Sir:

Enclosed for Naval Reactors' information and use is Revision 9 of the Spent Fuel Canister (SFC) System Functional Requirements Document (FRD).

Discussion

Revision 9 (proposed) was submitted for Naval Reactors approval via Reference (a) and was approved with comments in Reference (b). All comments from Reference (b) have been addressed in the version provided with this document. One additional change requested by NR in Reference (c) has also been incorporated into this version for issue and use. As before, the classified criticality attachment is not provided since no changes are being made to it at this time.

Two versions are provided for NR's information, a marked-up version showing the changes from the version submitted by Reference (a) for approval and a clean version with all markups removed.

Summary

Revision 9 of the SFC System FRD is submitted for NR information and use as an enclosure to this letter.

Very truly yours,

D. J. Rath, Cognizant Engineer
Dry Storage/Repository Support
M-290 / Dry Storage Program

Approved:

C. J. Barney, Manager
Dry Storage/Repository Support
M-290 / Dry Storage Program

Enclosures:

1. B-REO(GRD)-379, Functional Requirements Document for the Naval Spent Fuel Canister (SFC) System, Revision 9 February 2008 with Markups (U)
2. B-REO(GRD)-379, Functional Requirements Document for the Naval Spent Fuel Canister (SFC) System, Revision 9 February 2008 without Markups (U)

References:

(a) B-MDP(E)GRD-0213 dated December 4, 2007
Revision 9 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Approval (U)

(b) NR:RR:DPMerlino G#07-04822 dated January 23, 2008
Spent Fuel Disposal – Changes to Functional Requirements Document for Spent Fuel Canister System; Approval with Comments (U)

(c) NR:RR:FVGalati G#C07-03894 dated December 4, 2007
Spent Fuel Disposal – Processed D1G Spent Fuel Basket Drawings; Approval with Comments (U)

B-REO(GRD)-379, Functional Requirements Document for the Naval Spent Fuel Canister (SFC) System Revision 9 February 2008 with Markups (U)

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FUNCTIONAL REQUIREMENTS DOCUMENT (FRD)

FOR THE

NAVAL SPENT FUEL CANISTER (SFC) SYSTEM (U)

Revision 9

February 2008

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I. PURPOSE

This document identifies the functional requirements for the system which will be used for the management of naval spent nuclear fuel. Justifications are provided for each requirement. Compliance evaluations are to be submitted with equipment designs.

II. BACKGROUND

Naval Reactors issued the Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel in November 1996 and included selection of a dual-purpose canister system (storage and transportation) as the preferred container system. A Record of Decision for the Container System was issued on December 26, 1996 and designated that the dual-purpose canister would be used for storage, transport, and possible disposal of naval spent nuclear fuel. The terminology dual-purpose canister was later changed to Spent Fuel Canisters (SFC).

Attachment A of Reference (a) presented the process and reference design descriptions of the Container System for the Management of Naval Spent Nuclear Fuel. Naval Reactors (NR) approved the conceptual design features of the process in Reference (b).

Prior SFC Functional Requirement Document (FRD) revision submittals are listed in the following table.

FRD Revision	Submittal Document	NR Response
Original	Reference (s)	Reference (t)
1	Reference (u)	
2	Reference (w)	
3	Reference (z)	Reference (ah)
4	Reference (ak)	Reference (al)
Transportation Cask Design Revision	Reference (bb)	Reference (bg)
Basket FROD Revision	Reference (be)	Reference (bf)
Proposed Revision 5	Reference (bq)	Reference (br)
5	Reference (c)	
Change to FROD Item A.7.a	Reference (m)	Reference (n)
FROD Changes to meet 10CFR63	Reference (e)	Reference (f)
Change to FROD Item I.1.b		Reference (o)
6	Reference (d)	
POC Objective Recommendation	Reference (v)	References (y) and (ac)
Add poison to all cells with control rod channels	Reference (g)	References (y) and (ac)
FROD Changes to improve fuel processing rate	Reference (k)	References (y) and (ac)
FROD Changes related to Canister Water Level Control and Water Removal Equipment	Reference (x)	Reference (ab)

7	Reference (by)	
8	Reference (bx)	Reference (bz)
Revision 8 of FRD Resubmitted with NR Comments Incorporated	Reference (cb)	---
Revision 9	Reference (cu)	Reference (cv)

III. CHANGES FROM REVISION 8

Revision 9 incorporates the following NR approved changes to the SFC System FRD:

- Revised Item A.4.d in accordance with comment b. of Reference (cv) and Item A.4.e deleted.
- Revised Item A.6.a in accordance with comment e. of Reference (cv).
- Reference (cj) approved by Reference (cl) defines the corrosion resistant can material for Packaging Method C as Alloy 22 in Item A.8.a. Remaining text of Item A.8.a replaced with text from Reference (cc) that was approved as modified by Reference (ce) in accordance with comment h. of Reference (cv). Necessary references added to listing.
- Wording of Item A.8.b. revised in accordance with comment a. of Reference (cv).
- Reference (ce) comment g. provides revised text to replace the prior version of requirement B.2.a and that text has been modified as requested in comment d. of Reference (cp).
- Typographical error in Item B.2.b to ANSI N14.5 corrected as approved by Reference (cv).
- Revised Item B.2.c in accordance with comments d. and f. of Reference (cv).
- Item B.3 revised in accordance with comment b. of Reference (cy) and detailed descriptions removed from the associated justification paragraph.
- Basket radial CG control added to Item B.4.g in accordance with comment c(2) of Reference (co).
- Item B.6.a revised in accordance with comment g. of Reference (cv)
- Requirement B.7.g has been deleted in accordance with comment c. of Reference (cp).

IV. SFC FRD ORGANIZATION

Section V identifies each requirement for the SFC system per the subsections identified below.

A. General SFC System Criteria
B. Basket Criteria
C. ~~Canister Criteria~~ (Excluded from Revision 6)
D. ~~Welding and Cutting Equipment Criteria~~ (Excluded from Revision 6)
E. ~~Canister Preparation Equipment Criteria~~ (Excluded from Revision 8)
F. ~~Storage Overpack Criteria~~ (Excluded from Revision 5)
G. ~~Transportation Cask Criteria~~ (Excluded from Revision 8)
H. ~~Transportation Cask Rail Car Criteria~~ (Excluded from Revision 8)
I. Control Rod/Poison Fixture Attachment Criteria

V. FUNCTIONAL REQUIREMENTS FOR THE NAVAL DUAL-PURPOSE CANISTER SYSTEM.

A. General SFC System Criteria

A.1 SFC system design criteria.

a. Requirement: The SFC system shall respectively meet the requirements of 10 CFR 72 for storage, 10 CFR 71 for transportation, and 10 CFR 63 for repository disposal.

Justification: The storage requirements of 10 CFR 72 and the transportation requirements of 10 CFR 71 are specified for the SFC system since they are the base documents for the storage and transportation of spent nuclear fuel. The storage system will be designed to 10 CFR 72 in the event that a Nuclear Regulatory Commission (NRC) certification and license will be needed in the future for storage in a monitored retrievable storage (MRS) installation at the repository. For transportation, the requirements of 10 CFR 71 will be applied as has been past practice for off-site shipments within the Naval Reactors Program. The requirements of 10 CFR 63 are specified for permanent emplacement of the loaded SFCs in the monitored geologic repository (MGR).

b. Deleted

A.2 Process

a. Deleted

b. Deleted

A.3 SFC System fuel type requirements.

a. Deleted. Deleted because the canister design is complete. Refer to Revision 4 of the FRD for documentation.

A.4 Additional SFC system thermal and shielding design criteria.

a. Requirement: The SFC system components shall be designed to ensure that acceptable spent fuel thermal performance can be demonstrated during all periods when the fuel is in a dry condition

Justification:

Interim limits, , are available and are also being used to demonstrate acceptable spent fuel thermal performance.

b. Deleted.

c. Requirement: The total canister decay heat load at the time of acceptance is less than 11.8 kW.

Justification: This heat load limit is specified in Item 11 of the TBCD, Reference (as).

d. Requirement: The spent fuel thermal hold times should be submitted to Naval Reactors for information with the basket design, along with a strategy to ensure that the Idaho agreement is met and there are adequate storage ports available in the NRF water pits.

Justification: Unless as-built usage conditions warrant, some amount of spent fuel thermal hold time after reactor shutdown will be necessary before placement into dry storage and before transportation to the repository will be permitted.

e. Requirement: Deleted.

Justification: Spent fuel thermal hold time after reactor shutdown for transportation is now covered by Item A.4.d.

A.5 Additional SFC system criticality control design criteria.

a. Requirement:

Justification: The equipment should be designed such that it will provide margin to criticality during operations.

b. Requirement: Attachment A defines the conditions for which analyses must be performed to demonstrate that spent fuel will maintain margin to criticality during canister loading and handling, dry storage, and transportation. If meeting the applicable requirements of , 10CFR72, or 10CFR71 would require additional or different analyses, Bettis or KAPL shall obtain NR approval of the necessary changes to Attachment A before beginning the analyses.

Justification: Attachment A details the criticality analysis methods used to demonstrate criticality safety under the various conditions for which the basket, installed poison, and poison attachment are designed. The criticality modeling details in Attachment A provide expectations and/or previously approved methods, models, and assumptions for the corresponding analysis. NR shall be informed if alternate methods, models, and assumptions are needed to demonstrate compliance or if the specific details in Attachment A are non-conservative for the specific application.

A.6 Additional SFC system shielding design criteria.

a. Requirement: Gamma and neutron fluxes on the surface of the canister shall not exceed those listed in Reference (cz) at time of shipment to the repository.

Justification: This requirement is previously given in Item 21 of the TBCD (Reference (as)). Based on a repository request, a revised source was developed to support surface facility design at the repository and bounding gamma and neutron flux values provided to them in Reference (cz).

A.7 SFC system lifting and handling criteria.

a. Requirement: The canister, transportation cask, and associated lifting adapters to be used at an interim storage facility or permanent repository shall meet the requirements of ANSI N14.6.

Justification: ANSI N14.6 is the lifting device design criteria which most commercial vendors and utilities apply for their equipment. Also, use of the commercial criteria is consistent with the direction of the program to use commercial specifications. Per Reference (t), the SFC system (including lifting and handling features) will be designed to the more conservative of the Naval Reactors or commercial requirements.

b. Deleted

A.8 Repository requirements

a. Requirement: Baskets must be fabricated from dual certified Type 316/316L stainless steel, poison must be wrought core-grade or equivalent hafnium, and poison attachment devices must be core-grade or equivalent Zircaloy. Sealed cans must be fabricated from Alloy 22.

Justification: As approved in Reference (cw), accounting for the effects of local and general corrosion and the available axial space in the SFC after corrosion, the all stainless steel 316/316L S5G design (including a solid tie rod assembly) improves the basket's ability to maintain as-emplaced fuel separation in the repository. The S5G tie rod assembly is comprised of one solid tie rod with spacer sleeves to provide separation and alignment of the plates. The advantage of the solid tie-rod design is that it eliminates the joints between the plates (previous requirement dictated segmented-interlocking design), and precludes failure of the joint due to local and general corrosion in the repository. Use of this design is simpler and uses less expensive materials (i.e. no Alloy 22 or Zircaloy) and also results in a reduction in engineering design and manufacturing costs. Reference (cx) contains a detailed discussion of the benefits of all stainless steel basket and solid tie rod design. Sealed can material recommendation made in Reference (cj) was approved in Reference (cl).

b. Requirement: Design recommendations for baskets shall include analyses (except criticality analyses which are covered in Requirement A.8.c) validating that for preclosure

and postclosure, the proposed design is consistent with the assumptions of the repository safety analyses.

If meeting this requirement would require additional design work or increase equipment cost beyond the work and cost to meet the other requirements of this document, Bettis or KAPL shall obtain NR approval of the additional or revised requirements before beginning the additional design work.

Justification: The requirement concerning radionuclide inventory recognizes that the individual canister radionuclide inventory may change as basket designs evolve and that repository safety assessment specifications must be met.

c. Requirement: Design recommendations for spent fuel baskets, poison, and poison attachment devices shall include criticality analyses for repository conditions per Attachment A. If meeting the acceptance criteria of Attachment A would require additional design work or increase equipment cost beyond the work and cost to meet the other requirements of this document, NR approval shall be obtained for the additional or revised requirements before beginning the additional design work.

   Justification: Attachment A details the criticality analysis methods used to demonstrate criticality safety under the various conditions for which the basket, installed poison, and poison attachment are designed. The criticality modeling details in Attachment A provide expectations and/or previously approved methods, models, and assumptions for the corresponding analysis. NR shall be informed if alternate methods, models, and assumptions are needed to demonstrate compliance or if the specific details in Attachment A are non-conservative for the specific application.

d. Deleted

e. Requirement: Structural analyses must evaluate each basket and poison retention hardware for a 114g radial acceleration of a loaded canister inside a waste package. For this analysis, fuel, poison, and Zircaloy poison attachment devices are per drawings. For this analysis, baskets and canisters are per drawings minus 0.1" (based on corrosion of 316/316L stainless steel) of material from all stainless steel surfaces. Acceptance criteria per requirements B.13.a, B.13.b, and I.1.b.

   Justification: The radial acceleration value is developed in BEAR 14.2.6. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less that that for stainless steel.

f. Requirement: Structural analyses must evaluate each basket and poison retention hardware for axial impact of a loaded canister with a flat unyielding surface at 6.5 meters per second. For this analysis, fuel, poison, and Zircaloy poison attachment devices are per drawings. For this analysis, baskets and canisters are per drawings minus 0.1" (based on corrosion of 316/316L stainless steel) of material from all stainless steel surfaces. Acceptance criteria per requirements B.13.a, B.13.b, and I.1.b.

Justification: The axial impact value is from BEAR 14.3. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less than that for stainless steel.

g. Requirement: Structural analyses must evaluate a sealed can (see B.2.b) for an explosion of a mixture of hydrogen and oxygen in the sealed can with no other structural support. For this analysis, the can is per drawings. Acceptance criteria per requirement B.13.a.

Justification: The criticality analysis, as outlined in BEAR 10.10, relies on the fuel being retained within the port. Ingress of water into the canister during repository storage could result in generation of hydrogen inside the waste package and/or corrosion-resistant can. If a hydrogen explosion occurs, the corrosion-resistant can must retain the material within the envelope of the can.

h. Requirement: After closure, the canister shall not have detectable amounts of organic materials present except that minimal amounts of substances such as thread lubricants and thread adhesives that may contain organics may have been used.

Justification: The following excerpt from item 12 of the Technical Baseline Compliance Document (TBCD) provides justification and documentation: ..."No organic materials are present in the NNPP fuel assemblies or control rods. A minimal amount of thread lubricant (that may contain organics) may be utilized on the canister and/or internal components. The NNPP has concluded that the small amount of lubricant needed to prevent galling does not degrade the material performance."

i. Requirement: NNPP spent fuel shall be shipped in containers that have an intact, properly installed tamper-indicating seal that is NRC-approved in accordance with NRC Material Control and Accounting requirements in 10 CFR Part 70.51 and meet the guidance in 10 CFR Part 73.26 and NRC Regulatory Guide 5.15, Tamper-Indicating Seals for the Protection and Control of Special Nuclear Material. The containers also shall be locked if they are not in another locked container or transport. The outermost container or transport shall be protected by tamper indicating seals.

Justification: This requirement is given in Item 15 of the TBCD (Reference (as)).

j. Requirement: Key features for disposal of A1G, A1W-3, D1G-2, D2W, S3G-3, S5G, S6W, S8G, and ASNPP fuel are

(1) These fuel types will be disposed in specially-designed baskets.

(2) All cells with control rod channels will contain control rods or poison pieces.

(3) All control rods and poison pieces will be secured in the cells using poison attachment devices, except for S8G,and D1G-2.

Justification: This requirement is consistent with the NNPP Technical Support Document for the Yucca Mountain License Application and references (g) and (k).

k. Requirement: Structural analyses must evaluate the sealed can for axial impact of a loaded canister with a flat unyielding surface at 1.05 meters per second. For this analysis, the can is per drawings. The containment boundary of the can must not fail during this impact.

Justification: The axial impact value is from Reference (bw). The impact velocity of 1.05 m/sec represents the peak ground velocity above which 100% fuel cladding failure is predicted for commercial fuel (release for NNPP fuel is assumed the same above this velocity). It is conservatively assumed that no release, as defined by no external loading of the fuel, by the basket, is permitted at a velocity equal to or less than 1.05 m/sec. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less than that for stainless steel.

A.9 General SFC system design requirements.

a. Requirement: The weight of all SFC system components shall be minimized to the maximum extent possible.

Justification: As noted in Reference (a), the most limiting design parameter appears to be weight; therefore, a general requirement has been included to minimize component weights to the maximum extent possible.

b. Requirement: The SFC system design and operation shall ensure that occupational and public doses are maintained as low as reasonably achievable (ALARA).

Justification: ALARA is a standard design practice in the naval program.

c. Deleted

d. Requirement: The design of the components and equipment which comprise the SFC system shall allow maintenance to be performed, to the maximum extent practical, using standard tools, cleaners, and test equipment. The equipment should be accessible for maintenance by personnel wearing protective clothing and/or rubber gloves. Equipment servicing and replacement of parts such as valves, fittings, connectors, plugs, penetration covers, fasteners, seals, gaskets, instrumentation, and controls shall be accomplished with no cutting of strength welds or damage to the equipment affecting the equipment performance, reliability, or interchangeability.

Justification: The SFC system components will need to be maintained and cleaned.

e. Requirement: Where possible, standard commercial parts, fittings and hardware shall be specified.

Justification: Use of standard commercial parts and hardware will reduce costs.

f. Deleted

g. Requirement: The SFC system shall permit the repackaging of naval spent nuclear fuel. Specifically, the canister shall be capable of being opened, the fuel and baskets shall be capable of being removed, and the fuel shall be capable of being repackaged. Basket lifting operations from the SFC that are used in contingency reverse operations may require more than one attempt to avoid hang-up on lifting and to successfully grapple the basket.

Justification: Although remote and undesirable, there is a possibility that fuel which has been loaded into a canister will need to be unloaded and repackaged in a new canister. The possibility of repackaging would most likely be attributed to the uncertainties associated with the repository. Thus, if the SFC system is capable of being repackaged, the canisters could be opened and fuel removed and repackaged for disposal if repository requirements change.

h. Requirement: The design, fabrication, inspection, testing, and operation of all SFC system components shall meet the commercial requirements specified in the functional requirements. Resolution of inconsistencies between commercial and Naval Reactors requirements shall be approved by Naval Reactors.

Justification: The SFC system process requires use of the system at NRF to Naval Reactors requirements and use of the system at the repository to commercial requirements. Thus, both Naval Reactors and commercial requirements are applicable. Per Reference (t), Naval Reactors considers that implementation of the more conservative of the Naval Reactor requirements or commercial requirements are acceptable.

i. Requirement: The preparation of the fuel for dry storage and the basket shall maximize the cargo capacity to the maximum extent possible within the system design constraints.

Justification: Maximizing cargo capacity reduces the total number of canisters which reduces costs, handling efforts, and radiation exposure.

B. Basket Criteria

B.1 Function.

a. Deleted

b. Requirement: SFC baskets to be used in the Large Cell Cask (LCC) shall support intact fuel assemblies such that fuel-cladding integrity is preserved (i.e., no breach of fuel cladding) for accident conditions of transport in the LCC.

Justification: The LCC as originally fabricated had the capability to serve as a primary containment boundary even under accident conditions. The modification to the LCC for production dry storage has eliminated this capability to function as a primary containment boundary under accident conditions. Thus, for LCC transport, the cladding must serve as the primary boundary. Required performance under on-site transport accident conditions is specified in DOE Order 460.1, which defaults to 10 CFR 71 for release limits. If meeting the LCC accident G-loads results in excessive basket structure (e.g., a large number of basket support plates which decreases basket cargo capacity) to preclude clad damage, consideration will be given to revising the LCC impact-limiter design to lessen the accident loading. Such consideration would be driven by a cost/benefit evaluation of the two options (i.e. many robust, reduced module capacity baskets vice new impact limiters for two LCCs).

B.2 Key features

a. Requirement: Baskets shall include a bottom plate, support plates with holes (i.e., ports) for fuel cells, tie rods to support the basket axially, and spacer tubes to separate the support plates. Each basket must include at least three support plates and six tie rods. Each bottom plate, support plate, or tie rod must be at least two inches thick. Each spacer tube must be at least 0.4-inch thick.

Justification: Redundancy of support plates and tie rods, the two inch basket plate thickness, and the tie rod design support the assumptions of BEAR 8 which provides the probability of basket failure and therefore the probability of the cargo slumping assigned in the BEAR 9 Probabilistic Safety Assessment.

b. Requirement: To satisfy requirement B.13.a, some baskets will include sleeves and sealed cans. Three such basket designs will be developed.

(1)

thickness of 0.75 inches, while the large-port basket shall have a sleeve thickness of 1 inch.

(2) Sleeves will have locking lids. The lids will be designed such that proper installation and locking can be confirmed visually from directly above the sleeve.

(3) Only one sealed can will fit in one small basket port.

(4) Sealed cans will have lids that can be locked and sealed. The can will be leaktight per ANSI N14.5. The lid restraint(s) will be threaded and the seal will be a stainless steel gasket or ring.

(5) No more than 750 equivalent grams of ^{235}U will be loaded into each sealed can.

Justification: The number of sleeves, spacing of the sleeves, the requirement for one can per small sleeve, and the gram limit were used in the criticality evaluations of method B and C packaging. Application of these requirements ensure that the design is consistent with the criticality analyses of BEAR 10.9.

For packaging method B, criticality control is dependent on maintaining separation between fuel modules and assumes that the fuel remains in the sleeve in which it was installed; therefore, sleeves will have locking lids and will be designed so locking can be confirmed.

The can being leaktight per ANSI N14.5 assures that water will not leak into the can during basket or canister loading and violate shipping and repository requirements.

c. Requirement: The number of fuel ports per basket and baskets per canister for each fuel type are shown in the following table. Specially designed baskets will be provided for each fuel type shown in the table.

Justification: The numbers in the table are consistent with recommendations or approvals in References (g), (k), (cp), and (cq).

B.3 Basket weight.

a. Deleted

b. Requirement: The weight of one canister set of loaded baskets, including any spacers shall not exceed 34 tons and shall not be less than 16 tons.

Justification: This criterion is specified as a requirement so that the canister, storage overpack, and transportation cask designs can be completed prior to finalizing the basket designs for all naval fuel types.

c. Requirement: The weight of a fully loaded basket (without any rigging or grappling devices attached) shall not exceed 32,000 pounds.

Justification: This is the maximum allowable weight permitted by the Shielded Basket Transfer Container (SBTC) and tool column designs.

d. Deleted

B.4 Basket design criteria.

a. Requirement: The basket design and fabrication shall comply with the following criteria.

1. The design, fabrication, examination (inspection), and testing of the basket components which are important to criticality control shall be in accordance with the ASME Boiler and Pressure Vessel (B&PV) Code, Section III, Division I, Subsection NG for Core Support Structures. Buckling criteria for the criticality safety components shall be obtained from ASME B&PV Code, Section III and NUREG/CR-6322. No Code stamp will be required.
2. All criticality safety component welding and related operations shall be in accordance with ASME B&PV Code, Section III, Division 1, Subsection NG; ASME B&PV Code, Section V; and ASME B&PV Code, Section IX as recommended by NUREG/CR-3019. Any specific welding requirement in ASME B&PV Code, Section III shall take

precedence over an ASME B&PV Code, Section IX requirement if such requirements conflict.

3. The design, fabrication, examination (inspection), and testing of non-criticality safety related components shall be in accordance with the ASME B&PV Code, Section III, Division I, Subsection NF for Component Supports.
4. Drawings shall invoke material control requirements of MCS-6, level B.

Justification: The fabrication criteria specified in B.4.a.1 through 3 were derived from the guidance of NUREG/CR-3854 (Reference (h)), which recommends fabrication criteria for shipping containers, and NUREG-1536 (Reference (i)) which is the Standard Review Plan for Dry Cask Storage Systems. NUREG/CR-3854 specifies the use of the ASME B&PV Code which is the recognized standard for the design and fabrication of nuclear shipping containers. Thus, it is appropriate to apply these requirements to the naval basket design so that the naval basket is similar to the other baskets at the repository. Note, that the requirement permits the use of the Subsection NF rather than NG if the basket is not required for criticality safety.

By invoking MCS-6, vendor certification and material tracking is invoked. This provides a high level of assurance that incorrect materials will not be used.

b. Requirement: The basket shall be designed such that the calculated center of gravity (CG) of the loaded canister falls within the following limits:

Short canister:	90 – 107 inches
Long canister:	103 – 123 inches

As measured from the external bottom of the canister.

Justification: This information is needed by the repository and NRF for analysis of the uprighting and downending operations. These limits are also needed for performing oblique impact analyses of the loaded transportation cask. The ranges are based on a conservative analysis of preliminary basket design concepts for all naval core types. The CG values specified in this requirement have been and are being used to justify acceptance in the storage Safety Analysis Report (SAR) and the Safety Analysis Report for Packaging (SARP). Use of other values will necessitate reevaluation.

c. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the unloaded basket shall not prevent or significantly impede basket installation into canal and water pit loading stations.

Justification: Excessive radial CG offset could result in unacceptable basket tilt, potentially resulting in basket hang-up during loading operations in the canal or water pit.

d. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the loaded basket shall not prevent or significantly impede basket grappling and SBTC loading and discharge operations.

Justification: Excessive radial CG offset could result in unacceptable basket tilt and out-of-plumb basket grapple conditions potentially resulting in grapple binding or basket hang-up during loading or discharge operations. Deviation from the tolerance and alignment limits used in the basket grapple study (Reference (au)) will necessitate reevaluation.

e. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the loaded SFC shall not prevent or significantly impede concrete overpack loading and discharge operations.

Justification: Excessive radial CG offset (related in part to loaded basket CG offset and basket diameter) could result in unacceptable SFC tilt and out-of-plumb conditions for SFC handling equipment potentially resulting in unacceptable loading of the handling equipment and the study is published in Reference (cs). Deviation from the tolerance and alignment limits used in the overpack loading study in Reference (ct) will necessitate reevaluation.

f. Deleted

g. Requirement: The basket shall be designed that the calculated CG maximum radial offset of the loaded basket shall not cause the loaded canister to exceed the CG maximum radial offset identified on the repository interface drawing 6285E07.

Justification: The referenced interface drawing identifies the worst-case CG radial offset condition that the repository may receive from the NNPP.

B.5 Special lifting and handling.

a. Deleted

b. Relocated as A.7.b.

B.6. Basket Shielding Design.

a. Requirement: For normal operations, the basket design shall ensure that fuel can not be positioned directly under the canister shield plug-to-shell gap or the canister shield plug notch for the WLCE or that the basket design shall provide sufficient shielding such that the fuel handling system requirements for radiation levels, , are met.

Justification: Preliminary shielding analyses with fuel directly beneath the gap indicate that the radiation levels in the shield plug recess . However, this is dependent on the basket design and individual fuel type. Based on the reference basket designs, the outside basket ligaments are large enough to prevent the fuel from being positioned directly under the gap or there is sufficient cavity length to add shielding above the outside fuel modules to reduce the radiation levels if the modules could be positioned under the gap. Increasing the shield plug flange to reduce radiation levels would reduce the clearance for remote removal and installation operations of the shield plug.

b. Requirement: The basket design shall provide sufficient shielding such that the fuel handling system requirements for radiation levels,
, are met beneath the closed SBTC containing a loaded basket.

Justification: The fuel handling system FRD specification given by Reference (ax) assures a safe radiation work environment. Potential methods of reducing the subject radiation levels include increasing basket bottom plate thickness and minimizing hole size in the bottom plate.

B.7. Length and Diameter.

a. Requirement: The final basket assembly for fuel types not stored at INTEC shall fit inside (with zero clearance permitted) a perfect form cylinder of 61.52 inches maximum diameter.

Justification: Functional testing with an S5G basket has demonstrated that a basket built to this requirement can be installed into a canister. A diameter of 61.52 inches may be needed to maximize the packing efficiency and meet transportation, storage, and repository requirements.

b. Deleted

c. Requirement: Baskets for fuel types stored at INTEC or to be transported in the modified Large Cell Cask (LCC) shall fit inside (with zero clearance permitted) a perfect form cylinder of 61.00 inches maximum diameter.

Justification: The modified Large Cell Cask will have a bore diameter of 61.25 inches. A minimum 0.25 inch diametral clearance is needed for installation of SFC baskets.

d. Requirement: When loaded with prepared fuel modules, the overall height of the basket and modules and, as applicable, spacers and grapple assemblies shall be compatible with the cargo height capacity of the SBTC, the SFC and if transport in the LCC is applicable, the LCC.

Justification: All of these containers must accommodate the loaded baskets with allowance for maximum tolerance stackups and differential thermal expansion effects considered.

e. Requirement: The basket shall have a bottom support plate with a general diameter of no less than 60.50 inches and a general thickness no less than 2.0 inches.

Justification: These values have been used in existing shielding and pump down volume calculations used to support other system component designs. Using values outside of the specified ranges may require labor intensive redesign or recalculation to ensure that other critical design requirements are met.

f. Requirement: The thickness of the full diameter portion of any basket plate shall be no less than 1.25 inches.

Justification: This applies to the remaining thickness of the plates when chamfers are considered. A smaller thickness could enter the clearance gap reserved for design of the WLCE and risk damage to the equipment. This dimension will also provide the basis for load concentrations during basket loading operations. This requirement is consistent with the final design of the Canister Loading Station Universal Transition Equipment (UTE), submitted for NAVSEA approval via Reference (bs) and approved via Reference (bt).

g. Requirement: Deleted.

Justification: Requirement eliminated in accordance with comment c. of Reference (cp).

B.8. Water Draining.

a. Requirement: The baskets and spacers shall incorporate features which promote water filling and draining of baskets, spacers, and cargo voids.

Justification: The basket will be discharged into and withdrawn from water. On basket immersion, flooding void spaces assures water occupies voids which are assumed water-filled in thermal, shielding and water displacement analyses. Drainage from module cavities relieves preferential flooding concerns for criticality analyses. Drainage from basket cavities maximizes water movement to the SFC bottom where it is available for pump-down evacuation.

b. Requirement: The basket design shall minimize drainage over the basket plate peripheries.
Justification: Water drained from the basket contains radioactive materials that can contaminate surfaces that it drains onto. Most surfaces that the contaminated water might drain onto are susceptible to peripheral basket drainage; including the Shielded Basket Transfer Cask (SBTC) internal cylindrical surface, the horizontal circular cutouts integral with the SBTC door, and the Shield Door. Therefore, drainage over the basket plate peripheral edges should be minimized.

c. Requirement: The WLCE and WRE should be compatible with basket designs, canister designs and the canister loading processes for all fuel types.

Justification: It is preferred to have single system designs that could be used for all basket designs and canister loading operations.

B.9. Grapple Interface.

a. Requirement: The basket shall incorporate lifting features that will permit lifting the basket using the or universal grapple, the universal grapple being preferred over the grapple.

Justification: Use of existing grapples will save the costs of designing and procuring new grapples and promotes operational efficiency by minimizing grapple change out effort.

This item is a requirement because basket packing efficiency (cargo capacity) should, in general, dictate grapple design, for reasons of economy.

B.10. Geometry Interfaces.

a. Requirement: The required minimum envelope of each fuel port shall be verified at time of basket fabrication by use of a gauge.

Justification: The specified gauging will assure proper fit of the prepared fuel assemblies.

b. Requirement: The basket shall incorporate features which minimize the potential for basket hang-up during loading into and/or removal from the LCC and SFC. All interfaces with the production dry storage system (shield door, Canal Basket Bucket Assembly (CBBA), SBTC, etc.) are pertinent.

Justification: The openings in the LCC and SFC have ledges which could be caught by the peripheries of the basket plates. Chamfers, attached guide plates, or some other feature on the basket or basket plates could minimize or eliminate such hang-up potential.

c. Requirement: The basket assembly for fuel types stored at NRF shall be designed to be compatible with the basket bucket adapter plate assembly (KAPL Drawing 110E2954).

Justification: The basket bucket adapter plate assembly is installed in the basket bucket in the NRF water pits. The adapter plate design includes pins which are designed to engage mating holes in the basket bottom plate to provide rotational alignment with the SBTC. Since the basket is landed on the top of the adapter plate, holes must be located and sized properly on the basket bottom plate to accept the alignment pins.

B.11. Centering and Rotational Alignment.

a. Requirement: The basket shall incorporate centering and rotational alignment and grapple levelness features which are compatible with the corresponding mating features in the production dry storage system. Alignment marking on the top surface of the basket shall be applied as necessary to permit engagement of the basket alignment features.

Justification: Centering and rotational alignment of the basket and levelness of the basket grapple features is required to accomplish blind grappling of the basket for loading into the SBTC and to discharge the basket from the SBTC into the SFC.

B.12. Fuel Module Engagement.

a. Requirement: The basket design shall ensure that the prepared fuel modules remain supported (engaged) by all basket support plates (accounting for the worst case tolerance stack-up of all cargo within the canister and the canister itself) for all conditions associated with handling, storage, and transportation.

Justification: Keeping the fuel modules engaged in the support plates will avoid damage under worst case loading conditions.

B.13. Fuel Module Structural Support.

a. Requirement: The basket design should sufficiently support the fuel and poison assemblies such that the assemblies remain within their basket ports during all conditions specified for handling, storage, transport, and repository disposal. For baskets with sealed cans, this requirement applies to all fuel larger than 0.06 inches in diameter. Local deformation of the fuel is permitted.

Justification: Maintenance of the fuel within the port geometry will result in the minimum potential impacts on the results of any criticality, shielding, and thermal analyses. It will also eliminate the need for additional structural analyses of other loading conditions. This requirement prevents catastrophic failure of the fuel while allowing some permanent deformation.

The primary function for the corrosion-resistant cans is to prevent fuel from migrating and rearranging into a critical configuration. Nuclear analysis demonstrated that fines could escape and the corrosion resistant can and the package would remain subcritical. A 0.06 inch dimension ensures that larger test specimens will not escape from the can and invalidate the nuclear analysis.

b. Requirement: The basket shall be designed such that either (1) the basket will not deform enough to totally close the clearance between the fuel and poison assemblies and their ports in the basket or (2) if the clearance does close, the basket will satisfy the design criteria of Requirement B.4.a without relying on the fuel for structural support. This requirement applies for all conditions specified for handling, storage, transport, and repository disposal.

Justification: The baskets must be self-supporting without reliance on the spent fuel cargo since all baskets will not contain a full complement of cargo. This requirement also limits the axial and lateral loads applied to the fuel cargo.

B.14. Marking.

a. Requirement: Each basket port shall be conspicuously marked with an alphabetic character on the top surface of the basket.

Justification: Serialization of the basket ports permits tracking of each fuel module for fuel accountability.

b. Requirement: The top basket support plate, or similar feature viewable when looking down on the basket, shall have the alphabetic basket type designator and the basket serial number clearly visible. Characters shall be a minimum of 1 inch in height.

Justification: Serialization of the basket on the top features permits verification that the correct basket is being used during loading. A 1 inch minimum height is needed so that the characters can be read underwater. A 2-inch height is preferred if adequate room exists.

C. Canister Criteria

Section C is excluded in Revision 6 of the FRD because the design is complete.

D. Welding and Cutting Equipment Criteria

Section D is excluded in Revision 6 of the FRD because the design is complete.

E. Canister Preparation and Canister Water Level Control and Water Removal Equipment Criteria

Section E is excluded in Revision 8 of the FRD because the design is complete and no further design changes are planned or required.

F. Storage Overpack Criteria

Section F is excluded in Revision 5 of the FRD because the storage overpack design is complete, the equipment has been used, and no further design changes are planned or required. Much of the material in section IV.F of Revision 4 of the FRD is dated. The SFC Storage SAR, Reference (aa), contains up-to-date documentation of compliance with 10 CFR 72.

G. Transportation Cask Criteria

Section G is excluded in Revision 8 of the FRD because the M-290 Shipping Container and railcar will be used to ship spent fuel canisters and the M-290 system has a separate functional requirements document.

H. Transportation Cask Rail Car Criteria

Section H is excluded in Revision 8 of the FRD because the M-290 Shipping Container and railcar will be used to ship spent fuel canisters and the M-290 system has a separate functional requirements document.

I. Control Rod/Poison Fixture Attachment Criteria

I.1 General Requirements for Structural Attachment of the Control Rod/Poison Fixture.

a. Deleted

b. Requirement: The poison attachment hardware must retain the control rod or poison within the fuel assembly during all conditions specified for handling, loading, storage, transport, and repository disposal. One exception for Large Cell Cask handling and shipping accidents: An objective is that the poison attachment devices not fail; however, failure of the poison attachment devices is permitted provided that the Cask, baskets, and spacers retain the poison in the fuel.

Justification: As documented in Enclosure (1) to Reference (l), failure of poison attachment devices in the LCC will not result in criticality because the LCC, baskets, and spacers would limit motion of the poison. Unlike the spent fuel canister transportation cask, the LCC will not be certified per 10CFR71 for public shipment. Therefore, per the LCC functional requirements, the LCC will not be evaluated for multiple sequential accidents and the conservatism of requiring the poison attachment devices to retain the poison in the fuel is not necessary.

c. Requirement: The allowable stresses shall be based on the material properties at the temperature(s) for the environment in which the fuel will be handled and shipped.

a) 70°F for lifting and handling in water pits.

b) Elevated fuel temperature for storage and shipment.

c) 600°F for potential handling at the Geologic Repository.

Justification: During shipping and storage of the fuel, the cluster is at elevated temperature(s) due to decay heat. During handling, the fuel is at a reduced temperature in the water pit. The 600°F value has been used to date for poison attachment hardware designs and is considered conservative. NRF water pit temperatures are approximately 50°F.

d. Requirement: The installed control rod/poison fixture and structural attachment device shall allow for installation of a fuel cluster lifting/handling device if that device is separate from the structural attachment device.

Justification: Fuel clusters must be lifted/handled at NRF and INTEC and must also be capable of being retrieved at the geologic repository.

e. Requirement: The control rod/poison fixture, structural attachment device, lifting/handling feature, and if applicable a separate lifting/handling device shall be capable of remote installation in water pits. Established remote operations should be employed.

Justification: The radiation level of the fuel clusters requires remote handling under shielded conditions (either water cover or concrete/steel shielding at NRF). Consistency with established operations is a productivity and cost minimization requirement.

f. Requirement: The installed control rod/poison fixture, structural attachment device, and lifting/handling feature shall allow for vertical stacking of fuel clusters. This is an interface rather than a length requirement.

Justification: As a contingency, it may be necessary to temporarily store fuel in the water pit. Therefore vertical stacking of fuel clusters to maximize use of water pit storage space should be considered.

g. Requirement: The control rod/poison fixture, structural attachment device, and lifting/handling feature should be compatible with appropriate water pit operations fixtures.

Justification: Since different fuel cluster types have different cross sections, different fixtures are required for each fuel type. The structural attachment device must be compatible with the appropriate fixtures to allow easy installation of the device on the module while the module is still in the fixture. This will reduce the need for additional fixtures.

h. Deleted

i. Requirement: Structurally attaching a control rod or poison shall not inhibit verification/certification of the fuel cluster identity and presence of a control rod.

Justification: Identity of a fuel cluster must be maintained throughout the cluster's life, for accountability and criticality control purposes. In addition, verification of the presence of a control rod or poison in the cluster is required to meet modeling assumptions for the NNPP Yucca Mountain Geologic Repository Probabilistic Safety Assessment.

j. Requirement: Each structural attachment device and poison fixture shall have unique permanent identification, including drawing and serial number.

Justification: Identification of the structural attachment device will provide for the control of hardware for record keeping purposes.

k. Requirement: Poison and retention devices should be visible after all processing is completed.

Justification: Requirement is needed to certify fuel is safely configured and to satisfy repository requirements.

l. Requirement: The control rod/poison fixture/structural attachment device design and fabrication shall consider the long term effect of elevated temperatures on the dimensional stability of the components.

Justification: Structural attachment devices that rely on design interferences for captivation should consider the long term temperature effects of dry storage or a repository on the stability of the parts, especially those that are not annealed after fabrication. This evaluation will ensure the integrity of the design throughout the anticipated life.

m. Deleted

n. Requirement: Minimize the number of cuts required to prepare the module for shipment. When practical, structural members at the bottom of the fuel should be retained to provide redundant means to assure that the control rod or poison remains within the module during postulated handling accidents.

Justification: Minimizing the number of cuts reduces the overall preparation time. In addition, not cutting the bottom of the cluster will minimize the possibility for creating greater than class C waste as well as potentially providing a physical obstruction for the control rod to pass out the bottom of the cluster.

o. Deleted

p. Requirement: Structural attachment devices and poison drawings shall invoke material control requirements of MCS-6, level A.

Justification: To maintain a high degree of confidence in the material used for the fixtures being the correct material, the requirements of MCS-6 are appropriate.

q. Requirement: A fuel cell with a poison fixture, a lifting / handling feature installed, and, if applicable, a separate handling tool installed, shall be capable of being freely (without interference) installed into the corresponding Spent Fuel Canister basket and NRF/INTEC storage racks.

Justification: The poison attachment hardware will engage the cluster in the NRF/INTEC storage racks. The module with the attached hardware will be placed in an SFC basket.

r. Requirement: The poison attachment hardware (along with associated grapples and support equipment) shall be designed to handle the operational loads (i.e. torque) expected during normal use.

Justification: Operational loads will be applied to the poison attachment hardware, grapples, and associated tooling. NRF and INTEC have stated, based on past experience, that a minimum torque capability of 10 ft-lbs is required (a minimum of 15 ft-lbs of capability is recommended as a design basis).

VI. REFERENCES

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Technical Requirements Package for the Design and Lead Unit Fabrication of the Container System for the Management of Naval Spent Nuclear Fuel, For Approval

(b) G#97-03412 dated January 22, 1997
Dry Storage Container System for Naval Spent Nuclear Fuel - Technical Requirements Package for the Design and Lead Unit Fabrication of a Dual Purpose Canister System

(c) B-REO(GRD)-955 dated May 4, 2004
Revision 5 of the Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD)

(d) B-REO(GRD)-1066 dated September 16, 2005
Revision 6 of the Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD)

(e) B-REO(GRD)-984 dated December 23, 2004
Proposed Revision of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD) to Meet 10CRF63

(f) G#05-00525 dated April 13, 2005
Spent Fuel Disposal - Changes to Functional Requirements for Spent Fuel Canister System to Add Requirements from Repository Safety Analyses

(g) B-MER(YM)-71 dated August 19, 2005
Recommendation of Strategy for Representing Packaging Method A Spent Nuclear Fuel Types in Yucca Mountain Naval Nuclear Propulsion Program Probabilistic Safety Assessment and Strategy for Handling the Effect of an Intrusive Igneous Event on the Probability of Criticality for all Packaging Methods

(h) NUREG/CR-3854 dated March 1985
Fabrication Criteria for Shipping Containers

(i) NUREG-1536 dated February 1996
Standard Review Plan for Dry Cask Storage Systems

(j) ANSI N14.5-1987 dated January 1987
American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment

(k) KAPL letter RSO-84310-05-255 dated August 19, 2005
ECF Servicing: Strategy for Improving Fuel Processing Rate at ECF

(l) NR letter G#05-01399 dated April14, 2005
Spent Fuel Disposal - Functional Requirements and Development Plans for Spent Fuel Containers and Processing Equipment; Forwarding of Meeting Report and Spent Fuel Disposal - Funding For Check-Out of Basket Handling and Transfer Equipment and Testing of A1G Cell Rotating Devices

(m) B-REO(GRD)-976 dated October 15, 2004
Basket Drawing Changes to Resolve an Interference During Loading Into the Spent Fuel Canister and Change to the Functional Requirement for Basket Proof Test Load Requirements

(n) G#04-03810 dated October 28, 2004
Spent Fuel Disposal - Change to the Spent Fuel Canister Functional Requirements

(o) G#05-01399 dated April 14, 2005
Spent Fuel Disposal - Functional Requirements and Development Plans for Spent Fuel Containers and Processing Equipment; Forwarding of Meeting Report

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(q) NUREG/CR-6007 dated January 1993
Stress Analysis of Closure Bolts for Shipping Casks

(r) M-1001
Association of American Railroads Specifications for Design, Fabrication and Construction of Freight Cars

(s) WAPD-REO(GRD)-211 dated April 7, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, For Approval

(t) G#97-03489 dated June 2, 1997
Dual Purpose Canister System for Naval Spent Fuel - Functional Requirements and Objectives

(u) WAPD-REO(GRD)-255 dated July 31, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, Revision 1; For Information

(v) B-CT(EA)-86 dated May 6, 2005
Recommendation of Objectives for the NNPP Probability of Criticality for Naval Spent Nuclear Fuel at the Geologic Repository

(w) WAPD-REO(GRD)-296 dated December 4, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, Revision 2; For Information

(x) B-REO(GRD)-1075 dated September 15, 2005
ECF Canister Loading Station Universal Transition Equipment Concept Design and Associated Functional Requirement and Objectives Documents (FROD)

(y) NR letter G#05-03859 dated October 12, 2005
Spent Fuel Disposal – Changes to the Functional Requirements and Safety Analyses to Avoid Processing S8G and D1G-2 Fuel and to Reduce the Probability of Criticality Due to Basket Failure in the Repository

(z) B-REO(GRD)-375 dated March 5, 1999
Naval Dual-Purpose Canister and Storage Overpack Designs and Technical Requirements Packages (TRPs), Welding Equipment Design and Build TRP, and Revised Functional Requirements and Objectives, for Technical and Funding Approval

(aa) B-REO(C)-2525
Naval Spent Fuel Canister System Storage Safety Analysis Report

(ab) NR letter G#05-04222 dated October 18, 2005
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(ac) NR letter Z#C05-03756 dated November 11, 2005
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Dual Purpose Canister System – Detailed Design of Dual Purpose Canister, Technical Requirements Packages for the Canister and canister Welding Equipment, and Revision to the Functional Requirements and Objectives Document
Dual Purpose Canister System – Detailed Design and Technical Requirements Packages for the Storage Overpack

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(aj) Integrated Interface Control Document Volume 1: U.S. Department of Energy Spent Nuclear Fuel and High Level Radioactive Waste to the Monitored Geologic, DOE/RW-0511, Revision 1, dated March 2002

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Functional Requirements and Objectives for the Naval Spent Fuel Canister System, transmitted as Enclosure 5 to
B-REO(CD)-2066, dated June 4, 1999
Spent Fuel Management – Naval Dual Purpose Canister Transportation Cask Conceptual Design for Information; Revision to Functional Requirements and Objectives and Change to Detail Design Submittal Date, for Technical Approval

(al) G#99-03556 dated July 9, 1999
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(ax) B-REO(FED)-0001, Revision A, transmitted as Enclosure 11 to RSO-84310-02-008 dated June 28, 2002
Functional Requirements and Objectives Document for the Fuel Handling System to Load Naval Spent Fuel Canisters

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(bb) B-REO(CD)-2222 dated 6/16/2000
Spent Fuel Canister Transportation Cask - Detailed Design and Revisions to Functional Requirements and Objectives, for Technical Approval; Proposed Technical Requirements Package and Auxiliary Equipment Preliminary Designs, for Information

(bc) Deleted

(bd) ASME Boiler and Pressure Vessel Code Section III Division 3, Containment Systems and Transport Packagings for Spent Nuclear Fuel and High Level Radioactive Waste

(be) B-CT(EA)-9 dated May 16, 2003
BETTIS, KAPL, and BPMI Recommendation for the Design Basis and Implementing Approach for Criticality Control at the Proposed Geologic Repository for Naval Reactors Approval

(bf) G#03-01733 dated July 11, 2003
Spent Fuel Disposal - Changes to Design Requirements for Canister Baskets

(bg) G#00-10925 dated August 16, 2000
Naval Spent Fuel Canister System - Drawings and Operating Requirements for Transportation Cask, Changes to Functional Requirements and Objectives Document Based on Transportation Cask Design, Safety Analysis Report for Packaging for Transportation Cask

(bh) G#03-01077 dated April 15, 2003
Spent Fuel Disposal - Preparations for Continuing Dry Storage of Spent Fuel

(bi) G#02-0780 dated May 16, 2002
Expended Core Facility - Radiological Controls - Facility Features, and Quality Assurance for Dry Storage of Spent Fuel

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(br) G#03-04245 dated February 18, 2004
Spent Fuel Disposal - Update to Functional Requirements for Spent Fuel Canister System

(bs) B-REO(GRD)-1132 dated April 4, 2006
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(bt) G#06-01879 dated May 22, 2006
Spent Fuel Disposal – New Drawings, Drawing Changes, Field Change, Functional Requirement Change, and Funding for Spent Fuel Canister Loading Station Water Level Control Equipment; Approval of With Comments

(bu) G#06 – 01106 dated April 10, 2006
Spent Fuel Disposal – Drawings, Procurement Specification, Technical Manual Changes, and Additional Funding for Baskets to Hold A1G Fuel Cells; Approval with Comments

(bv) G#05 – 03859 dated October 12, 2005
Spent Fuel Disposal – Changes to Functional Requirements and Disposal Safety Analyses to Avoid Processing S8G and D1G-2 Fuel and to Reduce the Probability of Criticality due to Basket Failure in the Repository; Approval with Comments

(bw) Table 6.5-10 of MDL-WIS-PA-000003, Rev 02D dated May 2005

(bx) B-MDP(E)GRD-0042
Proposed Revision of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD) to meet Repository Requirements, for Approval (U)

(by) B-REO(GRD)-1111 dated November 18, 2005
Revision 7 of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD), for Information (U).

(bz) G#C06-03307 dated September 26, 2006
Spent Fuel Disposal – Changes to Functional Requirements Document to Specify Criticality Analysis Conditions and Add New Disposal-Related Requirements; Approval with Comments and Request for Action. (U)

(ca) G#C06-02651 dated August 1, 2006
Spent Fuel Disposal – Change to Material in Miscellaneous Fuel Baskets; Approval with Comments. (U)

(cb) B-MDP(E)GRD-0064 dated December 15, 2006
Revision 8 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Information (U)

(cc) MDP-85310-07-0036 dated February 23, 2007
Recommendation of Specific Changes to the Functional Requirements Document (FRD) to Incorporate Spent Fuel Canister (SFC) Standard Basket Design Features and Plan to Maintain Current FRD Design Criteria for Basket Design, for Approval (U)

(cd) RSO-84310-07-039 dated March 8, 2007
ECF Projects: Naval Spent Nuclear Fuel Loading Strategy Modifications for Dry Storage – For Approval (U)

(ce) NR:RR:RGPratt G#07-01032 dated March 26, 2007
Spent Fuel Disposal – Changes to Functional Requirements for Spent Fuel Baskets; Approval with Comments (U)

(cf) NR:RR:RGPratt G#07-01392 dated April 20, 2007
Spent Fuel Disposal – Changes to Cargo Requirements for Spent Fuel Baskets; Disapproval of (U)

(cg) MDP-85310-07-0013 dated July 3, 2007
As-Received S8G Spent Fuel Canister Basket Design, For Approval (U)

(ch) B-MDP(E)GRD-0151 dated August 2, 2007
Technical Manual, Functional Requirements Document, Technical Requirements Package (TRP) Documents, and Revised Drawings for Process Changes in the Naval Spent Nuclear Fuel (SNF) Canister Evacuation Process; Request for Technical and Funding Approval (U)

(ci) B-MDP(E)GRD-0163 dated August 13, 2007
Request to change the Naval Spent Fuel Canister (SFC) Functional Requirements Document (FRD) in support of A1W-3 poison design, for Approval. (U)

(cj) B-MDP(E)DSO-0236 dated July 31, 2007
Dry Storage – Miscellaneous Naval Spent Nuclear Fuel, Packaging Method C, Corrosion Resistant Can Key Features, For Naval Reactors Action (U)

(ck) B-SEA(SH(SA)-1427 dated June 6, 2007
Submittal of Revision B of Background, Evaluation, and Analysis Report 5, "Preclosure Radiation Level Analysis for the Naval Spent Nuclear Fuel Canister" for Naval Reactors Approval (U)

(cl) NR:RR:SDJohnson G#07-03137 dated October 22, 2007
Spent Fuel Disposal – Material Selection for Container that Holds Fuel with Non-Intact Cladding in a Basket; Approval with Comment (U)

(cm) NR:RR:FVGalati G#07-03308 dated October 22, 2007
Spent Fuel Disposal – Deletion of Functional Requirement that Requires Securing A1W-3 Poison to the Fuel Cells; Withholding of Approval (U)

(cn) NR:RS:DJTalavera Z#C07-03246 dated September 6, 2007
S3G Revision to the Naval Spent Fuel Canister (SFC) System Storage Safety Analysis Report (SAR) for Bettis Cognizant Cargoes; Approval with Comment and Request for Bettis Action (U)

(co) NR:RR:FVGalati G#C07-00344 dated March 8, 2007
Spent Fuel Disposal – Release of Four S5G Fuel Cells for Disposal; Approval with Comments (U)

(cp) NR:RR:FVGalati G#C07-02774 dated October 9, 2007
Spent Fuel Disposal – S8G Spent Fuel Basket Drawings; Approval with Comments and Request for Action (U)

(cq) MDP-85310-07-0184 dated August 11, 2007
Processed D1G Spent Fuel Canister Basket Design, for Approval (U)

(cr) NR:RR:FVGalati G#C07-03291 dated September 14, 2007
Spent Fuel Disposal – Procurement Specification and Drawing Changes and Funding to Perform Alloy Identity Testing of Spent Fuel Canisters; Approval of

Spent Fuel Disposal – Changes to Technical Manual Requirements for Removing Water from Spent Fuel Canisters; Approval with Comments (U)

(cs) BPMI-REF-ENG-01089 dated September 28, 2006, Enclosure 5
Dry Storage Program, Loaded Canister Handling Equipment, Modification of Rod End Yield Strength., Submittal of Revision to Drawing 9034C09, Revised Drawing List, Revised Fit-up Study and Revised Structural Analysis for NAVSEA Information (U)

(ct) B-MDP(E)DSO-0074 dated August 9, 2006; Enclosure 1
Expended Core Facility (ECF) Production Dry Storage – Dynamic Alignment Study for Overpack Loading Operations, Revision of Vertical Gap Calculations, and Revision of Shielding Evaluation for Canister Loading Operations, for Information, Revision of TWR 4055 for Approval (U)

(cu) B-MDP(E)GRD-0213 dated December 4, 2007
Revision 9 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Approval (U)

(cv) NR:RR:DPMerlino G#07-04822 dated January 23, 2008
Spent Fuel Disposal – Changes to Functional Requirements Document for Spent Fuel Canister System; Approval with Comments (U)

(cw) MDP-85310-06-0187 dated October 31, 2006
Spent Fuel Canister (SFC) Basket Standard Design and Changes to Functional Requirements and Objectives Document (FROD) to Include Standard SFC Basket Design; for Approval (U)

(cx) NR:RR:RGPratt G#06-04591 dated November 29, 2006
Spent Fuel Disposal – Changes to Standard Basket Features in Function al Requirements Document; Withholding of Approval (U)

(cy) NR:RR:FVGalati G#C07-03894 dated December 4, 2007
Spent Fuel Disposal – Processed D1G Spent Fuel Basket Drawings; Approval with Comments (U)

(cz) NR:RA:GFHolden U#07-01495 dated May 24, 2007
Letter to Edward F. Sproat, III, Director, Office of Civilan Radioactive Waste Management, U.S.Department of Energy from J. M. McKenzie, Director, Regulatory Affairs, Naval Reactors providing gamma and neutron fluxes on the surface of the naval SNF canister.(U)

VII. Attachments

(A) Criticality Implementation Procedure (U)

VIII. Open Items List

1. Propose design loads for transportation. (Collopy) Status: **Open**
2. Modeling assumptions and acceptance criteria for miscellaneous fuel cells – specifically any poison needed to demonstrate an acceptably-low probability of criticality during and after an igneous event in the repository will be incorporated within 1 month of B-MDP(E)DSO-0154 being issued. (Weir / Tomko) Status: **Open**.
3. Perform a dimensional analysis to demonstrate that fuel cells cannot translate out of one basket if an adjacent basket fails for a generic basket design as part of the BEAR 8 revision. (Matyko / Meyers for BEAR 8 and Weir for dimensional analysis. Status: **Open**
4. ~~Evaluate revising FRD requirement A.8.a to better define the intent of the Hastelloy C-22 material option in future basket designs. (Weir and Der Gurahian)~~ Status: **Closed.**
5. Transportation cask RESERVED items. (Collopy, These items will be updated after the transportation cask redesign plan is developed) Status: **Open**.
6. Re-evaluate the repository seismic impact values to ensure conservative basket analyses are performed. (Weir and Der Gurahian) Status: **Open**
7. ~~Revise requirement B.14.b to include the alphabetic basket type designator in the serialization and that all characters be a minimum of 1.00 inches tall (2.00 inches preferred).~~ Status:**Closed**
8. Address additional packaging flexibility recommended in (cd) and disapproved in (cf) with comment to retain flexibility in LA Status: **Open**
9. ~~Provide additional basket alphabetic character designators for other basket and core types not yet identified,~~ Status: **Closed**
10. ~~Evaluate change to B.7.g for distance of fuel to shield plug following reduction of water level efforts and recommended changes at NRF.~~ Status: **Closed**
11. Evaluate whether combined seismic conditions must be added once response to BEAR 14 [B-REO(C)-3069] is issued. Status: **Open**
12 Evaluate addition of materials after recommendation from Comment e of Reference (cp) is completed (Scheduled for 1/11/08). Status: **Open**

B-REO(GRD)-379, Functional Requirements Document for the Naval Spent Fuel Canister (SFC) System Revision 9 February 2008 without Markups (U)

(Document is provided without its classified attachment)

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FUNCTIONAL REQUIREMENTS DOCUMENT (FRD)

FOR THE

NAVAL SPENT FUEL CANISTER (SFC) SYSTEM (U)

Revision 9

February 2008

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I. PURPOSE

This document identifies the functional requirements for the system which will be used for the management of naval spent nuclear fuel. Justifications are provided for each requirement. Compliance evaluations are to be submitted with equipment designs.

II. BACKGROUND

Naval Reactors issued the Final Environmental Impact Statement for a Container System for the Management of Naval Spent Nuclear Fuel in November 1996 and included selection of a dual-purpose canister system (storage and transportation) as the preferred container system. A Record of Decision for the Container System was issued on December 26, 1996 and designated that the dual-purpose canister would be used for storage, transport, and possible disposal of naval spent nuclear fuel. The terminology dual-purpose canister was later changed to Spent Fuel Canisters (SFC).

Attachment A of Reference (a) presented the process and reference design descriptions of the Container System for the Management of Naval Spent Nuclear Fuel. Naval Reactors (NR) approved the conceptual design features of the process in Reference (b).

Prior SFC Functional Requirement Document (FRD) revision submittals are listed in the following table.

FRD Revision	Submittal Document	NR Response
Original	Reference (s)	Reference (t)
1	Reference (u)	
2	Reference (w)	
3	Reference (z)	Reference (ah)
4	Reference (ak)	Reference (al)
Transportation Cask Design Revision	Reference (bb)	Reference (bg)
Basket FROD Revision	Reference (be)	Reference (bf)
Proposed Revision 5	Reference (bq)	Reference (br)
5	Reference (c)	
Change to FROD Item A.7.a	Reference (m)	Reference (n)
FROD Changes to meet 10CFR63	Reference (e)	Reference (f)
Change to FROD Item I.1.b		Reference (o)
6	Reference (d)	
POC Objective Recommendation	Reference (v)	References (y) and (ac)
Add poison to all cells with control rod channels	Reference (g)	References (y) and (ac)
FROD Changes to improve fuel processing rate	Reference (k)	References (y) and (ac)
FROD Changes related to Canister Water Level Control and Water Removal Equipment	Reference (x)	Reference (ab)

7	Reference (by)	
8	Reference (bx)	Reference (bz)
Revision 8 of FRD Resubmitted with NR Comments Incorporated	Reference (cb)	---
Revision 9	Reference (cu)	Reference (cv)

III. CHANGES FROM REVISION 8

Revision 9 incorporates the following NR approved changes to the SFC System FRD:

- Revised Item A.4.d in accordance with comment b. of Reference (cv) and Item A.4.e deleted.
- Revised Item A.6.a in accordance with comment e. of Reference (cv).
- Reference (cj) approved by Reference (cl) defines the corrosion resistant can material for Packaging Method C as Alloy 22 in Item A.8.a. Remaining text of Item A.8.a replaced with text from Reference (cc) that was approved as modified by Reference (ce) in accordance with comment h. of Reference (cv). Necessary references added to listing.
- Wording of Item A.8.b. revised in accordance with comment a. of Reference (cv).
- Reference (ce) comment g, provides revised text to replace the prior version of requirement B.2.a and that text has been modified as requested in comment d. of Reference (cp).
- Typographical error in Item B.2.b to ANSI N14.5 corrected as approved by Reference (cv).
- Revised Item B.2.c in accordance with comments d. and f. of Reference (cv).
- Item B.3 revised in accordance with comment b. of Reference (cy) and detailed descriptions removed from the associated justification paragraph.
- Basket radial CG control added to Item B.4.g in accordance with comment c(2) of Reference (co).
- Item B.6.a revised in accordance with comment g. of Reference (cv)
- Requirement B.7.g has been deleted in accordance with comment c. of Reference (cp).

IV. SFC FRD ORGANIZATION

Section V identifies each requirement for the SFC system per the subsections identified below.

A. General SFC System Criteria
B. Basket Criteria
C. ~~Canister Criteria~~ (Excluded from Revision 6)
D. ~~Welding and Cutting Equipment Criteria~~ (Excluded from Revision 6)
E. ~~Canister Preparation Equipment Criteria~~ (Excluded from Revision 8)
F. ~~Storage Overpack Criteria~~ (Excluded from Revision 5)
G. ~~Transportation Cask Criteria~~ (Excluded from Revision 8)
H. ~~Transportation Cask Rail Car Criteria~~ (Excluded from Revision 8)
I. Control Rod/Poison Fixture Attachment Criteria

V. FUNCTIONAL REQUIREMENTS FOR THE NAVAL DUAL-PURPOSE CANISTER SYSTEM.

A. General SFC System Criteria

A.1 SFC system design criteria.

a. Requirement: The SFC system shall respectively meet the requirements of 10 CFR 72 for storage, 10 CFR 71 for transportation, and 10 CFR 63 for repository disposal.

Justification: The storage requirements of 10 CFR 72 and the transportation requirements of 10 CFR 71 are specified for the SFC system since they are the base documents for the storage and transportation of spent nuclear fuel. The storage system will be designed to 10 CFR 72 in the event that a Nuclear Regulatory Commission (NRC) certification and license will be needed in the future for storage in a monitored retrievable storage (MRS) installation at the repository. For transportation, the requirements of 10 CFR 71 will be applied as has been past practice for off-site shipments within the Naval Reactors Program. The requirements of 10 CFR 63 are specified for permanent emplacement of the loaded SFCs in the monitored geologic repository (MGR).

b. Deleted

A.2 Process

a. Deleted

b. Deleted

A.3 SFC System fuel type requirements.

a. Deleted. Deleted because the canister design is complete. Refer to Revision 4 of the FRD for documentation.

A.4 Additional SFC system thermal and shielding design criteria.

a. Requirement: The SFC system components shall be designed to ensure that acceptable spent fuel thermal performance can be demonstrated during all periods when the fuel is in a dry condition

Justification:

Interim limits, , are available and are also being used to demonstrate acceptable spent fuel thermal performance.

b. Deleted.

c. Requirement: The total canister decay heat load at the time of acceptance is less than 11.8 kW.

Justification: This heat load limit is specified in Item 11 of the TBCD, Reference (as).

d. Requirement: The spent fuel thermal hold times should be submitted to Naval Reactors for information with the basket design, along with a strategy to ensure that the Idaho agreement is met and there are adequate storage ports available in the NRF water pits.

Justification: Unless as-built usage conditions warrant, some amount of spent fuel thermal hold time after reactor shutdown will be necessary before placement into dry storage and before transportation to the repository will be permitted.

e. Requirement: Deleted.

Justification: Spent fuel thermal hold time after reactor shutdown for transportation is now covered by Item A.4.d.

A.5 Additional SFC system criticality control design criteria.

a. Requirement:

Justification: The equipment should be designed such that it will provide margin to criticality during operations.

b. Requirement: Attachment A defines the conditions for which analyses must be performed to demonstrate that spent fuel will maintain margin to criticality during canister loading and handling, dry storage, and transportation. If meeting the applicable requirements of , 10CFR72, or 10CFR71 would require additional or different analyses, Bettis or KAPL shall obtain NR approval of the necessary changes to Attachment A before beginning the analyses.

Justification: Attachment A details the criticality analysis methods used to demonstrate criticality safety under the various conditions for which the basket, installed poison, and poison attachment are designed. The criticality modeling details in Attachment A provide expectations and/or previously approved methods, models, and assumptions for the corresponding analysis. NR shall be informed if alternate methods, models, and assumptions are needed to demonstrate compliance or if the specific details in Attachment A are non-conservative for the specific application.

A.6 Additional SFC system shielding design criteria.

a. Requirement: Gamma and neutron fluxes on the surface of the canister shall not exceed those listed in Reference (cz) at time of shipment to the repository.

Justification: This requirement is previously given in Item 21 of the TBCD (Reference (as)). Based on a repository request, a revised source was developed to support surface facility design at the repository and bounding gamma and neutron flux values provided to them in Reference (cz).

A.7 SFC system lifting and handling criteria.

a. Requirement: The canister, transportation cask, and associated lifting adapters to be used at an interim storage facility or permanent repository shall meet the requirements of ANSI N14.6.

Justification: ANSI N14.6 is the lifting device design criteria which most commercial vendors and utilities apply for their equipment. Also, use of the commercial criteria is consistent with the direction of the program to use commercial specifications. Per Reference (t), the SFC system (including lifting and handling features) will be designed to the more conservative of the Naval Reactors or commercial requirements.

b. Deleted

A.8 Repository requirements

a. Requirement: Baskets must be fabricated from dual certified Type 316/316L stainless steel, poison must be wrought core-grade or equivalent hafnium, and poison attachment devices must be core-grade or equivalent Zircaloy. Sealed cans must be fabricated from Alloy 22.

Justification: As approved in Reference (cw), accounting for the effects of local and general corrosion and the available axial space in the SFC after corrosion, the all stainless steel 316/316L S5G design (including a solid tie rod assembly) improves the basket's ability to maintain as-emplaced fuel separation in the repository. The S5G tie rod assembly is comprised of one solid tie rod with spacer sleeves to provide separation and alignment of the plates. The advantage of the solid tie-rod design is that it eliminates the joints between the plates (previous requirement dictated segmented-interlocking design), and precludes failure of the joint due to local and general corrosion in the repository. Use of this design is simpler and uses less expensive materials (i.e. no Alloy 22 or Zircaloy) and also results in a reduction in engineering design and manufacturing costs. Reference (cx) contains a detailed discussion of the benefits of all stainless steel basket and solid tie rod design. Sealed can material recommendation made in Reference (cj) was approved in Reference (cl).

b. Requirement: Design recommendations for baskets shall include analyses (except criticality analyses which are covered in Requirement A.8.c) validating that for preclosure

and postclosure, the proposed design is consistent with the assumptions of the repository safety analyses.

If meeting this requirement would require additional design work or increase equipment cost beyond the work and cost to meet the other requirements of this document, Bettis or KAPL shall obtain NR approval of the additional or revised requirements before beginning the additional design work.

Justification: The requirement concerning radionuclide inventory recognizes that the individual canister radionuclide inventory may change as basket designs evolve and that repository safety assessment specifications must be met.

c. Requirement: Design recommendations for spent fuel baskets, poison, and poison attachment devices shall include criticality analyses for repository conditions per Attachment A. If meeting the acceptance criteria of Attachment A would require additional design work or increase equipment cost beyond the work and cost to meet the other requirements of this document, NR approval shall be obtained for the additional or revised requirements before beginning the additional design work.

   Justification: Attachment A details the criticality analysis methods used to demonstrate criticality safety under the various conditions for which the basket, installed poison, and poison attachment are designed. The criticality modeling details in Attachment A provide expectations and/or previously approved methods, models, and assumptions for the corresponding analysis. NR shall be informed if alternate methods, models, and assumptions are needed to demonstrate compliance or if the specific details in Attachment A are non-conservative for the specific application.

d. Deleted

e. Requirement: Structural analyses must evaluate each basket and poison retention hardware for a 114g radial acceleration of a loaded canister inside a waste package. For this analysis, fuel, poison, and Zircaloy poison attachment devices are per drawings. For this analysis, baskets and canisters are per drawings minus 0.1" (based on corrosion of 316/316L stainless steel) of material from all stainless steel surfaces. Acceptance criteria per requirements B.13.a, B.13.b, and I.1.b.

   Justification: The radial acceleration value is developed in BEAR 14.2.6. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less that that for stainless steel.

f. Requirement: Structural analyses must evaluate each basket and poison retention hardware for axial impact of a loaded canister with a flat unyielding surface at 6.5 meters per second. For this analysis, fuel, poison, and Zircaloy poison attachment devices are per drawings. For this analysis, baskets and canisters are per drawings minus 0.1" (based on corrosion of 316/316L stainless steel) of material from all stainless steel surfaces. Acceptance criteria per requirements B.13.a, B.13.b, and I.1.b.

Justification: The axial impact value is from BEAR 14.3. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less than that for stainless steel.

g. Requirement: Structural analyses must evaluate a sealed can (see B.2.b) for an explosion of a mixture of hydrogen and oxygen in the sealed can with no other structural support. For this analysis, the can is per drawings. Acceptance criteria per requirement B.13.a.

Justification: The criticality analysis, as outlined in BEAR 10.10, relies on the fuel being retained within the port. Ingress of water into the canister during repository storage could result in generation of hydrogen inside the waste package and/or corrosion-resistant can. If a hydrogen explosion occurs, the corrosion-resistant can must retain the material within the envelope of the can.

h. Requirement: After closure, the canister shall not have detectable amounts of organic materials present except that minimal amounts of substances such as thread lubricants and thread adhesives that may contain organics may have been used.

Justification: The following excerpt from item 12 of the Technical Baseline Compliance Document (TBCD) provides justification and documentation: ..."No organic materials are present in the NNPP fuel assemblies or control rods. A minimal amount of thread lubricant (that may contain organics) may be utilized on the canister and/or internal components. The NNPP has concluded that the small amount of lubricant needed to prevent galling does not degrade the material performance."

i. Requirement: NNPP spent fuel shall be shipped in containers that have an intact, properly installed tamper-indicating seal that is NRC-approved in accordance with NRC Material Control and Accounting requirements in 10 CFR Part 70.51 and meet the guidance in 10 CFR Part 73.26 and NRC Regulatory Guide 5.15, Tamper-Indicating Seals for the Protection and Control of Special Nuclear Material. The containers also shall be locked if they are not in another locked container or transport. The outermost container or transport shall be protected by tamper indicating seals.

Justification: This requirement is given in Item 15 of the TBCD (Reference (as)).

j. Requirement: Key features for disposal of A1G, A1W-3, D1G-2, D2W, S3G-3, S5G, S6W, S8G, and ASNPP fuel are

(1) These fuel types will be disposed in specially-designed baskets.

(2) All cells with control rod channels will contain control rods or poison pieces.

(3) All control rods and poison pieces will be secured in the cells using poison attachment devices, except for S8G,and D1G-2.

Justification: This requirement is consistent with the NNPP Technical Support Document for the Yucca Mountain License Application and references (g) and (k).

k. Requirement: Structural analyses must evaluate the sealed can for axial impact of a loaded canister with a flat unyielding surface at 1.05 meters per second. For this analysis, the can is per drawings. The containment boundary of the can must not fail during this impact.

Justification: The axial impact value is from Reference (bw). The impact velocity of 1.05 m/sec represents the peak ground velocity above which 100% fuel cladding failure is predicted for commercial fuel (release for NNPP fuel is assumed the same above this velocity). It is conservatively assumed that no release, as defined by no external loading of the fuel, by the basket, is permitted at a velocity equal to or less than 1.05 m/sec. The corrosion allowance is from the mean value for general corrosion for 10,000 years in freshwater service documented in BEAR 17.4. Design corrosion allowance is not needed for Alloy 22 since general corrosion is substantially less than that for stainless steel.

A.9 General SFC system design requirements.

a. Requirement: The weight of all SFC system components shall be minimized to the maximum extent possible.

Justification: As noted in Reference (a), the most limiting design parameter appears to be weight; therefore, a general requirement has been included to minimize component weights to the maximum extent possible.

b. Requirement: The SFC system design and operation shall ensure that occupational and public doses are maintained as low as reasonably achievable (ALARA).

Justification: ALARA is a standard design practice in the naval program.

c. Deleted

d. Requirement: The design of the components and equipment which comprise the SFC system shall allow maintenance to be performed, to the maximum extent practical, using standard tools, cleaners, and test equipment. The equipment should be accessible for maintenance by personnel wearing protective clothing and/or rubber gloves. Equipment servicing and replacement of parts such as valves, fittings, connectors, plugs, penetration covers, fasteners, seals, gaskets, instrumentation, and controls shall be accomplished with no cutting of strength welds or damage to the equipment affecting the equipment performance, reliability, or interchangeability.

Justification: The SFC system components will need to be maintained and cleaned.

e. Requirement: Where possible, standard commercial parts, fittings and hardware shall be specified.

Justification: Use of standard commercial parts and hardware will reduce costs.

f. Deleted

g. Requirement: The SFC system shall permit the repackaging of naval spent nuclear fuel. Specifically, the canister shall be capable of being opened, the fuel and baskets shall be capable of being removed, and the fuel shall be capable of being repackaged. Basket lifting operations from the SFC that are used in contingency reverse operations may require more than one attempt to avoid hang-up on lifting and to successfully grapple the basket.

Justification: Although remote and undesirable, there is a possibility that fuel which has been loaded into a canister will need to be unloaded and repackaged in a new canister. The possibility of repackaging would most likely be attributed to the uncertainties associated with the repository. Thus, if the SFC system is capable of being repackaged, the canisters could be opened and fuel removed and repackaged for disposal if repository requirements change.

h. Requirement: The design, fabrication, inspection, testing, and operation of all SFC system components shall meet to the commercial requirements specified in the functional requirements. Resolution of inconsistencies between commercial and Naval Reactors requirements shall be approved by Naval Reactors.

Justification: The SFC system process requires use of the system at NRF to Naval Reactors requirements and use of the system at the repository to commercial requirements. Thus, both Naval Reactors and commercial requirements are applicable. Per Reference (t), Naval Reactors considers that implementation of the more conservative of the Naval Reactor requirements or commercial requirements are acceptable.

i. Requirement: The preparation of the fuel for dry storage and the basket shall maximize the cargo capacity to the maximum extent possible within the system design constraints.

Justification: Maximizing cargo capacity reduces the total number of canisters which reduces costs, handling efforts, and radiation exposure.

B. Basket Criteria

B.1 Function.

a. Deleted

b. Requirement: SFC baskets to be used in the Large Cell Cask (LCC) shall support intact fuel assemblies such that fuel-cladding integrity is preserved (i.e., no breach of fuel cladding) for accident conditions of transport in the LCC.

Justification: The LCC as originally fabricated had the capability to serve as a primary containment boundary even under accident conditions. The modification to the LCC for production dry storage has eliminated this capability to function as a primary containment boundary under accident conditions. Thus, for LCC transport, the cladding must serve as the primary boundary. Required performance under on-site transport accident conditions is specified in DOE Order 460.1, which defaults to 10 CFR 71 for release limits. If meeting the LCC accident G-loads results in excessive basket structure (e.g., a large number of basket support plates which decreases basket cargo capacity) to preclude clad damage, consideration will be given to revising the LCC impact-limiter design to lessen the accident loading. Such consideration would be driven by a cost/benefit evaluation of the two options (i.e. many robust, reduced module capacity baskets vice new impact limiters for two LCCs).

B.2 Key features

a. Requirement: Baskets shall include a bottom plate, support plates with holes (i.e., ports) for fuel cells, tie rods to support the basket axially, and spacer tubes to separate the support plates. Each basket must include at least three support plates and six tie rods. Each bottom plate, support plate, or tie rod must be at least two inches thick. Each spacer tube must be at least 0.4-inch thick.

Justification: Redundancy of support plates and tie rods, the two inch basket plate thickness, and the tie rod design support the assumptions of BEAR 8 which provides the probability of basket failure and therefore the probability of the cargo slumping assigned in the BEAR 9 Probabilistic Safety Assessment.

b. Requirement: To satisfy requirement B.13.a, some baskets will include sleeves and sealed cans. Three such basket designs will be developed.

(1)

(2) Sleeves will have locking lids. The lids will be designed such that proper installation and locking can be confirmed visually from directly above the sleeve.

(3) Only one sealed can will fit in one small basket port.

(4) Sealed cans will have lids that can be locked and sealed. The can will be leaktight per ANSI N14.5. The lid restraint(s) will be threaded and the seal will be a stainless steel gasket or ring.

(5) No more than 750 equivalent grams of ^{235}U will be loaded into each sealed can.

Justification: The number of sleeves, spacing of the sleeves, the requirement for one can per small sleeve, and the gram limit were used in the criticality evaluations of method B and C packaging. Application of these requirements ensure that the design is consistent with the criticality analyses of BEAR 10.9.

For packaging method B, criticality control is dependent on maintaining separation between fuel modules and assumes that the fuel remains in the sleeve in which it was installed; therefore, sleeves will have locking lids and will be designed so locking can be confirmed.

The can being leaktight per ANSI N14.5 assures that water will not leak into the can during basket or canister loading and violate shipping and repository requirements.

c. Requirement: The number of fuel ports per basket and baskets per canister for each fuel type are shown in the following table. Specially designed baskets will be provided for each fuel type shown in the table.

Justification: The numbers in the table are consistent with recommendations or approvals in References (g), (k), (cp), and (cq).

B.3 Basket weight.

a. Deleted

b. Requirement: The weight of one canister set of loaded baskets, including any spacers shall not exceed 34 tons and shall not be less than 16 tons.

Justification: This criterion is specified as a requirement so that the canister, storage overpack, and transportation cask designs can be completed prior to finalizing the basket designs for all naval fuel types.

c. Requirement: The weight of a fully loaded basket (without any rigging or grappling devices attached) shall not exceed 32,000 pounds.

Justification: This is the maximum allowable weight permitted by the Shielded Basket Transfer Container (SBTC) and tool column designs.

d. Deleted

B.4 Basket design criteria.

a. Requirement: The basket design and fabrication shall comply with the following criteria.

1. The design, fabrication, examination (inspection), and testing of the basket components which are important to criticality control shall be in accordance with the ASME Boiler and Pressure Vessel (B&PV) Code, Section III, Division I, Subsection NG for Core Support Structures. Buckling criteria for the criticality safety components shall be obtained from ASME B&PV Code, Section III and NUREG/CR-6322. No Code stamp will be required.
2. All criticality safety component welding and related operations shall be in accordance with ASME B&PV Code, Section III, Division 1, Subsection NG; ASME B&PV Code, Section V; and ASME B&PV Code, Section IX as recommended by NUREG/CR-3019. Any specific welding requirement in ASME B&PV Code, Section III shall take

precedence over an ASME B&PV Code, Section IX requirement if such requirements conflict.

3. The design, fabrication, examination (inspection), and testing of non-criticality safety related components shall be in accordance with the ASME B&PV Code, Section III, Division I, Subsection NF for Component Supports.
4. Drawings shall invoke material control requirements of MCS-6, level B.

Justification: The fabrication criteria specified in B.4.a.1 through 3 were derived from the guidance of NUREG/CR-3854 (Reference (h)), which recommends fabrication criteria for shipping containers, and NUREG-1536 (Reference (i)) which is the Standard Review Plan for Dry Cask Storage Systems. NUREG/CR-3854 specifies the use of the ASME B&PV Code which is the recognized standard for the design and fabrication of nuclear shipping containers. Thus, it is appropriate to apply these requirements to the naval basket design so that the naval basket is similar to the other baskets at the repository. Note, that the requirement permits the use of the Subsection NF rather than NG if the basket is not required for criticality safety.

By invoking MCS-6, vendor certification and material tracking is invoked. This provides a high level of assurance that incorrect materials will not be used.

b. Requirement: The basket shall be designed such that the calculated center of gravity (CG) of the loaded canister falls within the following limits:

Short canister:	90 – 107 inches
Long canister:	103 – 123 inches

As measured from the external bottom of the canister.

Justification: This information is needed by the repository and NRF for analysis of the uprighting and downending operations. These limits are also needed for performing oblique impact analyses of the loaded transportation cask. The ranges are based on a conservative analysis of preliminary basket design concepts for all naval core types. The CG values specified in this requirement have been and are being used to justify acceptance in the storage Safety Analysis Report (SAR) and the Safety Analysis Report for Packaging (SARP). Use of other values will necessitate reevaluation.

c. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the unloaded basket shall not prevent or significantly impede basket installation into canal and water pit loading stations.

Justification: Excessive radial CG offset could result in unacceptable basket tilt, potentially resulting in basket hang-up during loading operations in the canal or water pit.

d. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the loaded basket shall not prevent or significantly impede basket grappling and SBTC loading and discharge operations.

Justification: Excessive radial CG offset could result in unacceptable basket tilt and out-of-plumb basket grapple conditions potentially resulting in grapple binding or basket hang-up during loading or discharge operations. Deviation from the tolerance and alignment limits used in the basket grapple study (Reference (au)) will necessitate reevaluation.

e. Requirement: The basket shall be designed such that the calculated CG maximum radial offset of the loaded SFC shall not prevent or significantly impede concrete overpack loading and discharge operations.

Justification: Excessive radial CG offset (related in part to loaded basket CG offset and basket diameter) could result in unacceptable SFC tilt and out-of-plumb conditions for SFC handling equipment potentially resulting in unacceptable loading of the handling equipment and the study is published in Reference (cs). Deviation from the tolerance and alignment limits used in the overpack loading study in Reference (ct) will necessitate reevaluation.

f. Deleted

g. Requirement: The basket shall be designed that the calculated CG maximum radial offset of the loaded basket shall not cause the loaded canister to exceed the CG maximum radial offset identified on the repository interface drawing 6285E07.

Justification: The referenced interface drawing identifies the worst-case CG radial offset condition that the repository may receive from the NNPP.

B.5 Special lifting and handling.

a. Deleted

b. Relocated as A.7.b.

B.6. Basket Shielding Design.

a. Requirement: For normal operations, the basket design shall ensure that fuel can not be positioned directly under the canister shield plug-to-shell gap or the canister shield plug notch for the WLCE or that the basket design shall provide sufficient shielding such that the fuel handling system requirements for radiation levels,

Justification: Preliminary shielding analyses with fuel directly beneath the gap indicate that the radiation levels in the shield plug recess However, this is dependent on the basket design and individual fuel type. Based on the reference basket designs, the outside basket ligaments are large enough to prevent the fuel from being positioned directly under the gap or there is sufficient cavity length to add shielding above the outside fuel modules to reduce the radiation levels if the modules could be positioned under the gap. Increasing the shield plug flange to reduce radiation levels would reduce the clearance for remote removal and installation operations of the shield plug.

b. Requirement: The basket design shall provide sufficient shielding such that the fuel handling system requirements for radiation levels,
, are met beneath the closed SBTC containing a loaded basket.

Justification: The fuel handling system FRD specification given by Reference (ax) assures a safe radiation work environment. Potential methods of reducing the subject radiation levels include increasing basket bottom plate thickness and minimizing hole size in the bottom plate.

B.7. Length and Diameter.

a. Requirement: The final basket assembly for fuel types not stored at INTEC shall fit inside (with zero clearance permitted) a perfect form cylinder of 61.52 inches maximum diameter.

Justification: Functional testing with an S5G basket has demonstrated that a basket built to this requirement can be installed into a canister. A diameter of 61.52 inches may be needed to maximize the packing efficiency and meet transportation, storage, and repository requirements.

b. Deleted

c. Requirement: Baskets for fuel types stored at INTEC or to be transported in the modified Large Cell Cask (LCC) shall fit inside (with zero clearance permitted) a perfect form cylinder of 61.00 inches maximum diameter.

Justification: The modified Large Cell Cask will have a bore diameter of 61.25 inches. A minimum 0.25 inch diametral clearance is needed for installation of SFC baskets.

d. Requirement: When loaded with prepared fuel modules, the overall height of the basket and modules and, as applicable, spacers and grapple assemblies shall be compatible with the cargo height capacity of the SBTC, the SFC and if transport in the LCC is applicable, the LCC.

Justification: All of these containers must accommodate the loaded baskets with allowance for maximum tolerance stackups and differential thermal expansion effects considered.

e. Requirement: The basket shall have a bottom support plate with a general diameter of no less than 60.50 inches and a general thickness no less than 2.0 inches.

Justification: These values have been used in existing shielding and pump down volume calculations used to support other system component designs. Using values outside of the specified ranges may require labor intensive redesign or recalculation to ensure that other critical design requirements are met.

f. Requirement: The thickness of the full diameter portion of any basket plate shall be no less than 1.25 inches.

Justification: This applies to the remaining thickness of the plates when chamfers are considered. A smaller thickness could enter the clearance gap reserved for design of the WLCE and risk damage to the equipment. This dimension will also provide the basis for load concentrations during basket loading operations. This requirement is consistent with the final design of the Canister Loading Station Universal Transition Equipment (UTE), submitted for NAVSEA approval via Reference (bs) and approved via Reference (bt).

g. Requirement: Deleted.

Justification: Requirement eliminated in accordance with comment c. of Reference (cp).

B.8. Water Draining.

a. Requirement: The baskets and spacers shall incorporate features which promote water filling and draining of baskets, spacers, and cargo voids.

Justification: The basket will be discharged into and withdrawn from water. On basket immersion, flooding void spaces assures water occupies voids which are assumed water-filled in thermal, shielding and water displacement analyses. Drainage from module cavities relieves preferential flooding concerns for criticality analyses. Drainage from basket cavities maximizes water movement to the SFC bottom where it is available for pump-down evacuation.

b. Requirement: The basket design shall minimize drainage over the basket plate peripheries.
Justification: Water drained from the basket contains radioactive materials that can contaminate surfaces that it drains onto. Most surfaces that the contaminated water might drain onto are susceptible to peripheral basket drainage; including the Shielded Basket Transfer Cask (SBTC) internal cylindrical surface, the horizontal circular cutouts integral with the SBTC door, and the Shield Door. Therefore, drainage over the basket plate peripheral edges should be minimized.

c. Requirement: The WLCE and WRE should be compatible with basket designs, canister designs and the canister loading processes for all fuel types.

Justification: It is preferred to have single system designs that could be used for all basket designs and canister loading operations.

B.9. Grapple Interface.

a. Requirement: The basket shall incorporate lifting features that will permit lifting the basket using the or universal grapple, the universal grapple being preferred over the grapple.

Justification: Use of existing grapples will save the costs of designing and procuring new grapples and promotes operational efficiency by minimizing grapple change out effort.

This item is a requirement because basket packing efficiency (cargo capacity) should, in general, dictate grapple design, for reasons of economy.

B.10. Geometry Interfaces.

a. Requirement: The required minimum envelope of each fuel port shall be verified at time of basket fabrication by use of a gauge.

Justification: The specified gauging will assure proper fit of the prepared fuel assemblies.

b. Requirement: The basket shall incorporate features which minimize the potential for basket hang-up during loading into and/or removal from the LCC and SFC. All interfaces with the production dry storage system (shield door, Canal Basket Bucket Assembly (CBBA), SBTC, etc.) are pertinent.

Justification: The openings in the LCC and SFC have ledges which could be caught by the peripheries of the basket plates. Chamfers, attached guide plates, or some other feature on the basket or basket plates could minimize or eliminate such hang-up potential.

c. Requirement: The basket assembly for fuel types stored at NRF shall be designed to be compatible with the basket bucket adapter plate assembly (KAPL Drawing 110E2954).

Justification: The basket bucket adapter plate assembly is installed in the basket bucket in the NRF water pits. The adapter plate design includes pins which are designed to engage mating holes in the basket bottom plate to provide rotational alignment with the SBTC. Since the basket is landed on the top of the adapter plate, holes must be located and sized properly on the basket bottom plate to accept the alignment pins.

B.11. Centering and Rotational Alignment.

a. Requirement: The basket shall incorporate centering and rotational alignment and grapple levelness features which are compatible with the corresponding mating features in the production dry storage system. Alignment marking on the top surface of the basket shall be applied as necessary to permit engagement of the basket alignment features.

Justification: Centering and rotational alignment of the basket and levelness of the basket grapple features is required to accomplish blind grappling of the basket for loading into the SBTC and to discharge the basket from the SBTC into the SFC.

B.12. Fuel Module Engagement.

a. Requirement: The basket design shall ensure that the prepared fuel modules remain supported (engaged) by all basket support plates (accounting for the worst case tolerance stack-up of all cargo within the canister and the canister itself) for all conditions associated with handling, storage, and transportation.

Justification: Keeping the fuel modules engaged in the support plates will avoid damage under worst case loading conditions.

B.13. Fuel Module Structural Support.

a. Requirement: The basket design should sufficiently support the fuel and poison assemblies such that the assemblies remain within their basket ports during all conditions specified for handling, storage, transport, and repository disposal. For baskets with sealed cans, this requirement applies to all fuel larger than 0.06 inches in diameter. Local deformation of the fuel is permitted.

Justification: Maintenance of the fuel within the port geometry will result in the minimum potential impacts on the results of any criticality, shielding, and thermal analyses. It will also eliminate the need for additional structural analyses of other loading conditions. This requirement prevents catastrophic failure of the fuel while allowing some permanent deformation.

The primary function for the corrosion-resistant cans is to prevent fuel from migrating and rearranging into a critical configuration. Nuclear analysis demonstrated that fines could escape and the corrosion resistant can and the package would remain subcritical. A 0.06 inch dimension ensures that larger test specimens will not escape from the can and invalidate the nuclear analysis.

b. Requirement: The basket shall be designed such that either (1) the basket will not deform enough to totally close the clearance between the fuel and poison assemblies and their ports in the basket or (2) if the clearance does close, the basket will satisfy the design criteria of Requirement B.4.a without relying on the fuel for structural support. This requirement applies for all conditions specified for handling, storage, transport, and repository disposal.

Justification: The baskets must be self-supporting without reliance on the spent fuel cargo since all baskets will not contain a full complement of cargo. This requirement also limits the axial and lateral loads applied to the fuel cargo.

B.14. Marking.

a. Requirement: Each basket port shall be conspicuously marked with an alphabetic character on the top surface of the basket.

Justification: Serialization of the basket ports permits tracking of each fuel module for fuel accountability.

b. Requirement: The top basket support plate, or similar feature viewable when looking down on the basket, shall have the alphabetic basket type designator and the basket serial number clearly visible. Characters shall be a minimum of 1 inch in height.
Justification: Serialization of the basket on the top features permits verification that the correct basket is being used during loading. A 1 inch minimum height is needed so that

the characters can be read underwater. A 2-inch height is preferred if adequate room exists.

C. Canister Criteria

Section C is excluded in Revision 6 of the FRD because the design is complete.

D. Welding and Cutting Equipment Criteria

Section D is excluded in Revision 6 of the FRD because the design is complete.

E. Canister Preparation and Canister Water Level Control and Water Removal Equipment Criteria

Section E is excluded in Revision 8 of the FRD because the design is complete and no further design changes are planned or required.

F. Storage Overpack Criteria

Section F is excluded in Revision 5 of the FRD because the storage overpack design is complete, the equipment has been used, and no further design changes are planned or required. Much of the material in section IV.F of Revision 4 of the FRD is dated. The SFC Storage SAR, Reference (aa), contains up-to-date documentation of compliance with 10 CFR 72.

G. Transportation Cask Criteria

Section G is excluded in Revision 8 of the FRD because the M-290 Shipping Container and railcar will be used to ship spent fuel canisters and the M-290 system has a separate functional requirements document.

H. Transportation Cask Rail Car Criteria

Section H is excluded in Revision 8 of the FRD because the M-290 Shipping Container and railcar will be used to ship spent fuel canisters and the M-290 system has a separate functional requirements document.

I. Control Rod/Poison Fixture Attachment Criteria

I.1 General Requirements for Structural Attachment of the Control Rod/Poison Fixture.

a. Deleted

b. Requirement: The poison attachment hardware must retain the control rod or poison within the fuel assembly during all conditions specified for handling, loading, storage, transport, and repository disposal. One exception for Large Cell Cask handling and shipping accidents: An objective is that the poison attachment devices not fail; however, failure of the poison attachment devices is permitted provided that the Cask, baskets, and spacers retain the poison in the fuel.

Justification: As documented in Enclosure (1) to Reference (l), failure of poison attachment devices in the LCC will not result in criticality because the LCC, baskets, and spacers would limit motion of the poison. Unlike the spent fuel canister transportation cask, the LCC will not be certified per 10CFR71 for public shipment. Therefore, per the LCC functional requirements, the LCC will not be evaluated for multiple sequential accidents and the conservatism of requiring the poison attachment devices to retain the poison in the fuel is not necessary.

c. Requirement: The allowable stresses shall be based on the material properties at the temperature(s) for the environment in which the fuel will be handled and shipped.

a) 70°F for lifting and handling in water pits.

b) Elevated fuel temperature for storage and shipment.

c) 600°F for potential handling at the Geologic Repository.

Justification: During shipping and storage of the fuel, the cluster is at elevated temperature(s) due to decay heat. During handling, the fuel is at a reduced temperature in the water pit. The 600°F value has been used to date for poison attachment hardware designs and is considered conservative. NRF water pit temperatures are approximately 50°F.

d. Requirement: The installed control rod/poison fixture and structural attachment device shall allow for installation of a fuel cluster lifting/handling device if that device is separate from the structural attachment device.

Justification: Fuel clusters must be lifted/handled at NRF and INTEC and must also be capable of being retrieved at the geologic repository.

e. Requirement: The control rod/poison fixture, structural attachment device, lifting/handling feature, and if applicable a separate lifting/handling device shall be capable of remote installation in water pits. Established remote operations should be employed.

Justification: The radiation level of the fuel clusters requires remote handling under shielded conditions (either water cover or concrete/steel shielding at NRF). Consistency with established operations is a productivity and cost minimization requirement.

f. Requirement: The installed control rod/poison fixture, structural attachment device, and lifting/handling feature shall allow for vertical stacking of fuel clusters. This is an interface rather than a length requirement.

Justification: As a contingency, it may be necessary to temporarily store fuel in the water pit. Therefore vertical stacking of fuel clusters to maximize use of water pit storage space should be considered.

g. Requirement: The control rod/poison fixture, structural attachment device, and lifting/handling feature should be compatible with appropriate water pit operations fixtures.

Justification: Since different fuel cluster types have different cross sections, different fixtures are required for each fuel type. The structural attachment device must be compatible with the appropriate fixtures to allow easy installation of the device on the module while the module is still in the fixture. This will reduce the need for additional fixtures.

h. Deleted

i. Requirement: Structurally attaching a control rod or poison shall not inhibit verification/certification of the fuel cluster identity and presence of a control rod.

Justification: Identity of a fuel cluster must be maintained throughout the cluster's life, for accountability and criticality control purposes. In addition, verification of the presence of a control rod or poison in the cluster is required to meet modeling assumptions for the NNPP Yucca Mountain Geologic Repository Probabilistic Safety Assessment.

j. Requirement: Each structural attachment device and poison fixture shall have unique permanent identification, including drawing and serial number.

Justification: Identification of the structural attachment device will provide for the control of hardware for record keeping purposes.

k. Requirement: Poison and retention devices should be visible after all processing is completed.

Justification: Requirement is needed to certify fuel is safely configured and to satisfy repository requirements.

l. Requirement: The control rod/poison fixture/structural attachment device design and fabrication shall consider the long term effect of elevated temperatures on the dimensional stability of the components.

Justification: Structural attachment devices that rely on design interferences for captivation should consider the long term temperature effects of dry storage or a repository on the stability of the parts, especially those that are not annealed after fabrication. This evaluation will ensure the integrity of the design throughout the anticipated life.

m. Deleted

n. Requirement: Minimize the number of cuts required to prepare the module for shipment. When practical, structural members at the bottom of the fuel should be retained to provide redundant means to assure that the control rod or poison remains within the module during postulated handling accidents.

Justification: Minimizing the number of cuts reduces the overall preparation time. In addition, not cutting the bottom of the cluster will minimize the possibility for creating greater than class C waste as well as potentially providing a physical obstruction for the control rod to pass out the bottom of the cluster.

o. Deleted

p. Requirement: Structural attachment devices and poison drawings shall invoke material control requirements of MCS-6, level A.

Justification: To maintain a high degree of confidence in the material used for the fixtures being the correct material, the requirements of MCS-6 are appropriate.

q. Requirement: A fuel cell with a poison fixture, a lifting / handling feature installed, and, if applicable, a separate handling tool installed, shall be capable of being freely (without interference) installed into the corresponding Spent Fuel Canister basket and NRF/INTEC storage racks.

Justification: The poison attachment hardware will engage the cluster in the NRF/INTEC storage racks. The module with the attached hardware will be placed in an SFC basket.

r. Requirement: The poison attachment hardware (along with associated grapples and support equipment) shall be designed to handle the operational loads (i.e. torque) expected during normal use.

Justification: Operational loads will be applied to the poison attachment hardware, grapples, and associated tooling. NRF and INTEC have stated, based on past experience, that a minimum torque capability of 10 ft-lbs is required (a minimum of 15 ft-lbs of capability is recommended as a design basis).

VI. REFERENCES

(a) WAPD-REO(GRD)-175 dated December 9, 1996
Technical Requirements Package for the Design and Lead Unit Fabrication of the Container System for the Management of Naval Spent Nuclear Fuel, For Approval

(b) G#97-03412 dated January 22, 1997
Dry Storage Container System for Naval Spent Nuclear Fuel - Technical Requirements Package for the Design and Lead Unit Fabrication of a Dual Purpose Canister System

(c) B-REO(GRD)-955 dated May 4, 2004
Revision 5 of the Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD)

(d) B-REO(GRD)-1066 dated September 16, 2005
Revision 6 of the Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD)

(e) B-REO(GRD)-984 dated December 23, 2004
Proposed Revision of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD) to Meet 10CRF63

(f) G#05-00525 dated April 13, 2005
Spent Fuel Disposal - Changes to Functional Requirements for Spent Fuel Canister System to Add Requirements from Repository Safety Analyses

(g) B-MER(YM)-71 dated August 19, 2005
Recommendation of Strategy for Representing Packaging Method A Spent Nuclear Fuel Types in Yucca Mountain Naval Nuclear Propulsion Program Probabilistic Safety Assessment and Strategy for Handling the Effect of an Intrusive Igneous Event on the Probability of Criticality for all Packaging Methods

(h) NUREG/CR-3854 dated March 1985
Fabrication Criteria for Shipping Containers

(i) NUREG-1536 dated February 1996
Standard Review Plan for Dry Cask Storage Systems

(j) ANSI N14.5-1987 dated January 1987
American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment

(k) KAPL letter RSO-84310-05-255 dated August 19, 2005
ECF Servicing: Strategy for Improving Fuel Processing Rate at ECF

(l) NR letter G#05-01399 dated April14, 2005
Spent Fuel Disposal - Functional Requirements and Development Plans for Spent Fuel Containers and Processing Equipment; Forwarding of Meeting Report and Spent Fuel Disposal - Funding For Check-Out of Basket Handling and Transfer Equipment and Testing of A1G Cell Rotating Devices

(m) B-REO(GRD)-976 dated October 15, 2004
Basket Drawing Changes to Resolve an Interference During Loading Into the Spent Fuel Canister and Change to the Functional Requirement for Basket Proof Test Load Requirements

(n) G#04-03810 dated October 28, 2004
Spent Fuel Disposal - Change to the Spent Fuel Canister Functional Requirements

(o) G#05-01399 dated April 14, 2005
Spent Fuel Disposal - Functional Requirements and Development Plans for Spent Fuel Containers and Processing Equipment; Forwarding of Meeting Report

(p) Deleted

(q) NUREG/CR-6007 dated January 1993
Stress Analysis of Closure Bolts for Shipping Casks

(r) M-1001
Association of American Railroads Specifications for Design, Fabrication and Construction of Freight Cars

(s) WAPD-REO(GRD)-211 dated April 7, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, For Approval

(t) G#97-03489 dated June 2, 1997
Dual Purpose Canister System for Naval Spent Fuel - Functional Requirements and Objectives

(u) WAPD-REO(GRD)-255 dated July 31, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, Revision 1; For Information

(v) B-CT(EA)-86 dated May 6, 2005
Recommendation of Objectives for the NNPP Probability of Criticality for Naval Spent Nuclear Fuel at the Geologic Repository

(w) WAPD-REO(GRD)-296 dated December 4, 1997
Functional Requirements and Objectives for the Naval Dual-Purpose Canister System, Revision 2; For Information

(x) B-REO(GRD)-1075 dated September 15, 2005
ECF Canister Loading Station Universal Transition Equipment Concept Design and Associated Functional Requirement and Objectives Documents (FROD)

(y) NR letter G#05-03859 dated October 12, 2005
Spent Fuel Disposal – Changes to the Functional Requirements and Safety Analyses to Avoid Processing S8G and D1G-2 Fuel and to Reduce the Probability of Criticality Due to Basket Failure in the Repository

(z) B-REO(GRD)-375 dated March 5, 1999
Naval Dual-Purpose Canister and Storage Overpack Designs and Technical Requirements Packages (TRPs), Welding Equipment Design and Build TRP, and Revised Functional Requirements and Objectives, for Technical and Funding Approval

(aa) B-REO(C)-2525
Naval Spent Fuel Canister System Storage Safety Analysis Report

(ab) NR letter G#05-04222 dated October 18, 2005
Spent Fuel Disposal – Changes to the Functional Requirement and Objectives Document for the Spent Fuel Canister Water Management System

(ac) NR letter Z#C05-03756 dated November 11, 2005
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(ad) Deleted

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(ag) Deleted

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Dual Purpose Canister System – Detailed Design of Dual Purpose Canister, Technical Requirements Packages for the Canister and canister Welding Equipment, and Revision to the Functional Requirements and Objectives Document
Dual Purpose Canister System – Detailed Design and Technical Requirements Packages for the Storage Overpack

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(aj) Integrated Interface Control Document Volume 1: U.S. Department of Energy Spent Nuclear Fuel and High Level Radioactive Waste to the Monitored Geologic, DOE/RW-0511, Revision 1, dated March 2002

(ak) B-REO(GRD)-379, Revision 4,
Functional Requirements and Objectives for the Naval Spent Fuel Canister System, transmitted as Enclosure 5 to
B-REO(CD)-2066, dated June 4, 1999
Spent Fuel Management – Naval Dual Purpose Canister Transportation Cask Conceptual Design for Information; Revision to Functional Requirements and Objectives and Change to Detail Design Submittal Date, for Technical Approval

(al) G#99-03556 dated July 9, 1999
Dual Purpose Canister System – Changes to Functional Requirements and Objectives

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(as) *Naval Nuclear Propulsion Program Technical Baseline Compliance Document*, Revision 1, October 2002, Enclosure (1) to B-QEA(EA)-35 dated October 29, 2002

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(au) KAPL document 521H1992, Rev -
PDS System Grappling Alignment Study

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(ax) B-REO(FED)-0001, Revision A, transmitted as Enclosure 11 to RSO-84310-02-008 dated June 28, 2002
Functional Requirements and Objectives Document for the Fuel Handling System to Load Naval Spent Fuel Canisters

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(bb) B-REO(CD)-2222 dated 6/16/2000
Spent Fuel Canister Transportation Cask - Detailed Design and Revisions to Functional Requirements and Objectives, for Technical Approval; Proposed Technical Requirements Package and Auxiliary Equipment Preliminary Designs, for Information

(bc) Deleted

(bd) ASME Boiler and Pressure Vessel Code Section III Division 3, Containment Systems and Transport Packagings for Spent Nuclear Fuel and High Level Radioactive Waste

(be) B-CT(EA)-9 dated May 16, 2003
BETTIS, KAPL, and BPMI Recommendation for the Design Basis and Implementing Approach for Criticality Control at the Proposed Geologic Repository for Naval Reactors Approval

(bf) G#03-01733 dated July 11, 2003
Spent Fuel Disposal - Changes to Design Requirements for Canister Baskets

(bg) G#00-10925 dated August 16, 2000
Naval Spent Fuel Canister System - Drawings and Operating Requirements for Transportation Cask, Changes to Functional Requirements and Objectives Document Based on Transportation Cask Design, Safety Analysis Report for Packaging for Transportation Cask

(bh) G#03-01077 dated April 15, 2003
Spent Fuel Disposal - Preparations for Continuing Dry Storage of Spent Fuel

(bi) G#02-0780 dated May 16, 2002
Expended Core Facility - Radiological Controls - Facility Features, and Quality Assurance for Dry Storage of Spent Fuel

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(bk) Deleted

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(bo) Deleted

(bp) Deleted

(bq) B-REO(GRD)-920 dated December 16, 2003

Proposed Revision 5 of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD)

(br) G#03-04245 dated February 18, 2004
Spent Fuel Disposal - Update to Functional Requirements for Spent Fuel Canister System

(bs) B-REO(GRD)-1132 dated April 4, 2006
Dry Storage Project – ECF Canister Loading Station Universal Transition Equipment Detailed Design, for NAVSEA Approval (U)

(bt) G#06-01879 dated May 22, 2006
Spent Fuel Disposal – New Drawings, Drawing Changes, Field Change, Functional Requirement Change, and Funding for Spent Fuel Canister Loading Station Water Level Control Equipment; Approval of With Comments

(bu) G#06 – 01106 dated April 10, 2006
Spent Fuel Disposal – Drawings, Procurement Specification, Technical Manual Changes, and Additional Funding for Baskets to Hold A1G Fuel Cells; Approval with Comments

(bv) G#05 – 03859 dated October 12, 2005
Spent Fuel Disposal – Changes to Functional Requirements and Disposal Safety Analyses to Avoid Processing S8G and D1G-2 Fuel and to Reduce the Probability of Criticality due to Basket Failure in the Repository; Approval with Comments

(bw) Table 6.5-10 of MDL-WIS-PA-000003, Rev 02D dated May 2005

(bx) B-MDP(E)GRD-0042
Proposed Revision of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD) to meet Repository Requirements, for Approval (U)

(by) B-REO(GRD)-1111 dated November 18, 2005
Revision 7 of the Naval Spent Fuel Canister (SFC) System Functional Requirements and Objectives Document (FROD), for Information (U).

(bz) G#C06-03307 dated September 26, 2006
Spent Fuel Disposal – Changes to Functional Requirements Document to Specify Criticality Analysis Conditions and Add New Disposal-Related Requirements; Approval with Comments and Request for Action. (U)

(ca) G#C06-02651 dated August 1, 2006
Spent Fuel Disposal – Change to Material in Miscellaneous Fuel Baskets; Approval with Comments. (U)

(cb) B-MDP(E)GRD-0064 dated December 15, 2006
Revision 8 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Information (U)

(cc) MDP-85310-07-0036 dated February 23, 2007
Recommendation of Specific Changes to the Functional Requirements Document (FRD) to Incorporate Spent Fuel Canister (SFC) Standard Basket Design Features and Plan to Maintain Current FRD Design Criteria for Basket Design, for Approval (U)

(cd) RSO-84310-07-039 dated March 8, 2007
ECF Projects: Naval Spent Nuclear Fuel Loading Strategy Modifications for Dry Storage – For Approval (U)

(ce) NR:RR:RGPratt G#07-01032 dated March 26, 2007
Spent Fuel Disposal – Changes to Functional Requirements for Spent Fuel Baskets; Approval with Comments (U)

(cf) NR:RR:RGPratt G#07-01392 dated April 20, 2007
Spent Fuel Disposal – Changes to Cargo Requirements for Spent Fuel Baskets; Disapproval of (U)

(cg) MDP-85310-07-0013 dated July 3, 2007
As-Received S8G Spent Fuel Canister Basket Design, For Approval (U)

(ch) B-MDP(E)GRD-0151 dated August 2, 2007
Technical Manual, Functional Requirements Document, Technical Requirements Package (TRP) Documents, and Revised Drawings for Process Changes in the Naval Spent Nuclear Fuel (SNF) Canister Evacuation Process; Request for Technical and Funding Approval (U)

(ci) B-MDP(E)GRD-0163 dated August 13, 2007
Request to change the Naval Spent Fuel Canister (SFC) Functional Requirements Document (FRD) in support of A1W-3 poison design, for Approval. (U)

(cj) B-MDP(E)DSO-0236 dated July 31, 2007
Dry Storage – Miscellaneous Naval Spent Nuclear Fuel, Packaging Method C, Corrosion Resistant Can Key Features, For Naval Reactors Action (U)

(ck) B-SEA(SH(SA)-1427 dated June 6, 2007
Submittal of Revision B of Background, Evaluation, and Analysis Report 5, "Preclosure Radiation Level Analysis for the Naval Spent Nuclear Fuel Canister" for Naval Reactors Approval (U)

(cl) NR:RR:SDJohnson G#07-03137 dated October 22, 2007
Spent Fuel Disposal – Material Selection for Container that Holds Fuel with Non-Intact Cladding in a Basket; Approval with Comment (U)

(cm) NR:RR:FVGalati G#07-03308 dated October 22, 2007
Spent Fuel Disposal – Deletion of Functional Requirement that Requires Securing A1W-3 Poison to the Fuel Cells; Withholding of Approval (U)

(cn) NR:RS:DJTalavera Z#C07-03246 dated September 6, 2007
S3G Revision to the Naval Spent Fuel Canister (SFC) System Storage Safety Analysis Report (SAR) for Bettis Cognizant Cargoes; Approval with Comment and Request for Bettis Action (U)

(co) NR:RR:FVGalati G#C07-00344 dated March 8, 2007
Spent Fuel Disposal – Release of Four S5G Fuel Cells for Disposal; Approval with Comments (U)

(cp) NR:RR:FVGalati G#C07-02774 dated October 9, 2007
Spent Fuel Disposal – S8G Spent Fuel Basket Drawings; Approval with Comments and Request for Action (U)

(cq) MDP-85310-07-0184 dated August 11, 2007
Processed D1G Spent Fuel Canister Basket Design, for Approval (U)

(cr) NR:RR:FVGalati G#C07-03291 dated September 14, 2007
Spent Fuel Disposal – Procurement Specification and Drawing Changes and Funding to Perform Alloy Identity Testing of Spent Fuel Canisters; Approval of

Spent Fuel Disposal – Changes to Technical Manual Requirements for Removing Water from Spent Fuel Canisters; Approval with Comments (U)

(cs) BPMI-REF-ENG-01089 dated September 28, 2006, Enclosure 5
Dry Storage Program, Loaded Canister Handling Equipment, Modification of Rod End Yield Strength., Submittal of Revision to Drawing 9034C09, Revised Drawing List, Revised Fit-up Study and Revised Structural Analysis for NAVSEA Information (U)

(ct) B-MDP(E)DSO-0074 dated August 9, 2006; Enclosure 1
Expended Core Facility (ECF) Production Dry Storage – Dynamic Alignment Study for Overpack Loading Operations, Revision of Vertical Gap Calculations, and Revision of Shielding Evaluation for Canister Loading Operations, for Information, Revision of TWR 4055 for Approval (U)

(cu) B-MDP(E)GRD-0213 dated December 4, 2007
Revision 9 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Approval (U)

(cv) NR:RR:DPMerlino G#07-04822 dated January 23, 2008
Spent Fuel Disposal – Changes to Functional Requirements Document for Spent Fuel Canister System; Approval with Comments (U)

(cw) MDP-85310-06-0187 dated October 31, 2006
Spent Fuel Canister (SFC) Basket Standard Design and Changes to Functional Requirements and Objectives Document (FROD) to Include Standard SFC Basket Design; for Approval (U)

(cx) NR:RR:RGPratt G#06-04591 dated November 29, 2006
Spent Fuel Disposal – Changes to Standard Basket Features in Function al Requirements Document; Withholding of Approval (U)

(cy) NR:RR:FVGalati G#C07-03894 dated December 4, 2007
Spent Fuel Disposal – Processed D1G Spent Fuel Basket Drawings; Approval with Comments (U)

(cz) NR:RA:GFHolden U#07-01495 dated May 24, 2007
Letter to Edward F. Sproat, III, Director, Office of Civilan Radioactive Waste Management, U.S.Department of Energy from J. M. McKenzie, Director, Regulatory Affairs, Naval Reactors providing gamma and neutron fluxes on the surface of the naval SNF canister.(U)

VII. Attachments

(A) Criticality Implementation Procedure (U)

VIII. Open Items List

1. Propose design loads for transportation. (Collopy) Status: **Open**
2. Modeling assumptions and acceptance criteria for miscellaneous fuel cells – specifically any poison needed to demonstrate an acceptably-low probability of criticality during and after an igneous event in the repository will be incorporated within 1 month of B-MDP(E)DSO-0154 being issued. (Weir / Tomko) Status: **Open**.
3. Perform a dimensional analysis to demonstrate that fuel cells cannot translate out of one basket if an adjacent basket fails for a generic basket design as part of the BEAR 8 revision. (Matyko / Meyers for BEAR 8 and Weir for dimensional analysis. Status: **Open**
4. ~~Evaluate revising FRD requirement A.8.a to better define the intent of the Hastelloy C-22 material option in future basket designs. (Weir and Der Gurahian)~~ Status: **Closed.**
5. Transportation cask RESERVED items. (Collopy, These items will be updated after the transportation cask redesign plan is developed) Status: **Open**.
6. Re-evaluate the repository seismic impact values to ensure conservative basket analyses are performed. (Weir and Der Gurahian) Status: **Open**
7. ~~Revise requirement B.14.b to include the alphabetic basket type designator in the serialization and that all characters be a minimum of 1.00 inches tall (2.00 inches preferred).~~ Status:**Closed**
8. Address additional packaging flexibility recommended in (cd) and disapproved in (cf) with comment to retain flexibility in LA Status: **Open**
9. ~~Provide additional basket alphabetic character designators for other basket and core types not yet identified,~~ Status: **Closed**
10. ~~Evaluate change to B.7.g for distance of fuel to shield plug following reduction of water level efforts and recommended changes at NRF.~~ Status: **Closed**
11. Evaluate whether combined seismic conditions must be added once response to BEAR 14 [B-REO(C)-3069] is issued. Status: **Open**
12 Evaluate addition of materials after recommendation from Comment e of Reference (cp) is completed (Scheduled for 1/11/08). Status: **Open**

FORM 76082e
4/1999

CONCURRENCE RECORD SHEET

- DOCUMENT NUMBER: B-MDP(E)DSS-5
- THIS DOCUMENT CONTAINS INFORMATION WHICH SHOULD BE CONSIDERED FOR PATENT DISCLOSURES ☐ YES ☒ NO
- THIS DOCUMENT CONTAINS INFORMATION WHICH MEETS BETTIS WORK CATEGORIES [A,B,C,D or (N/A)] A

CONCURRENCE SIGNATURES (Activity must be included) - RESOLVE COMMENTS BEFORE SIGNING

SIGNATURE/ACTIVITY	DATE	TYPE	DETAILS OF REVIEW REQUESTED (if necessary)

TYPE OF REVIEWS (to be determined by author) [See table at end of instructions for definitions.]

1-Peer:Summary 2-Peer:Intermediate 3-Peer:Detail 4-Independent 5-Informal Committee 6-Formal Committee 7-Specialist 8-Interface

NAME TYPED AND SIGNATURE OF NEXT HIGHER MANAGER NOT SIGNING ON LETTER		DATE
For D. A. Arcidiacono	P G Scarullo	February 07, 2008

- CONTRIBUTORS AND IMPACTED PARTIES NOT REQUESTED TO CONCUR AND WHY:

[ ] For Action from _____ by _____
[X] For Information Only

Document No. B-MDP(E)DSS-5

SUBJECT: Revision 9 of the Naval Spent Fuel Canister (SFC) System Functional Requirements Document (FRD), for Information and Use (U)

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