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National Institute of Standards and Technology
Gaithersburg, Maryland 20899-

U.S. Nuclear Regulatory Commission
Document Control Desk
Director Spent Fuel Project Office
Washington D.C. 20555

August 6, 2007

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Acceptable for approval

Subject: QA Program for ST Containers
Docket Number: 71-9246

Gentlemen,
Attached you will find the NIST Packaging and Shipping Quality Assurance Program for the 10CFR71-Transport of Radioactive Materials and the ST Container supporting documentation. If you have any further questions concerning this submittal please contact Mr. Carl Drewry at 301-975-2380 or carl.drewry@nist.gov.

Sincerely,
Wade J. Richards
Wade J. Richards, Ph.D
Chief Reactor Operations and Engineering

I certify under penalty of perjury that the following is true and correct.

Executed on: Aug 6, 2007 by: Wade Richards

cc.
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NMSS01

NIST

NRC LETTER ENCLOSURES FOR "ST" CONTAINER PACKAGE:

(1) NIST PACKAGING AND SHIPPING QUALITY ASSURANCE PROGRAM FOR 10 CFR 71 – TRANSPORT OF RADIOACTIVE MATERIALS

(2) TEST DATA & ASSOCIATED CRITICALITY CALCULATIONS FOR THE "ST" CONTAINER

(3) "ST" CONTAINER MODIFICATIONS & DESIGN CHANGES

(4) SAFETY EVALUATION REPORT FOR "ST" CONTAINER

(5) DRAWING D-04-048 (REVISION 4): SHIPPING CONTAINER MODEL "ST" SERIES

NIST PACKAGING AND SHIPPING QUALITY ASSURANCE PROGRAM FOR 10 CFR 71 – TRANSPORT OF RADIOACTIVE MATERIALS

Revision 3

July 2007

RECORD OF REVISIONS
NIST PACKAGING AND SHIPPING QA PROGRAM FOR 10 CFR 71

REVISION	DATE	DESCRIPTION	ORGINATOR	REVIEWER	APPROVER
0	6/25/80	Initial Issue	T. G. Hobbs	N/A	L. Pevey
1	10/13/81	Insert (after 1st paragraph)	T. G. Hobbs	N/A	L. Pevey
2	3/23/2007	All pages; clarify requirements per 10 CFR 71, Subpart H	C. Drewry	T. Mengers	W. Richards
3	7/30/07	Add Appendix A for ST Packages	C. Drewry	T. Mengers	W. Richards

NIST PACKAGING AND SHIPPING QUALITY ASSURANCE PROGRAM FOR 10 CFR 71 – TRANSPORT OF RADIOACTIVE MATERIALS

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Introduction

With this document, the National Institute of Standards and Technology (NIST) establishes a Shipping Quality Assurance (QA) Program in accordance with 10 CFR 71, Subpart H. It is designed to ensure the safety of the general public during packaging and transportation of radioactive material. Shipping containers regulated by 10 CFR 71 will be released for shipping from NIST only after they have satisfactorily met the requirements of the NIST Shipping QA Program. This QA Program applies to those activities affecting the packages and their components which are significant to safety. Quality assurance comprises those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. The degree of control over a radioactive materials shipment is governed by the activity and form of the radioactive materials involved. Typically, the control categories are: "Exempt," "Type A," "Type B," and "Large Quantity." This program concerns shipments other than "Exempt" and provides criteria for the QA factors that shall be addressed for packages of radioactive material used for transport to or from NIST and/or the National Bureau of Standards Reactor (NBSR). The criteria specified herein are consistent with the categories of 10 CFR 50, Appendix B and ASME NQA-1-2004 "Basic Requirements and Practices."

1. Scope and Responsibilities (10 CFR 71.101)

The description of the NIST Shipping QA Program, contained within, includes a discussion of which requirements of 10 CFR 71, Subpart H are applicable and how they will be satisfied. The NIST Shipping QA Program establishes requirements applicable to the procurement, use, maintenance, modification, and repair of packaging used to transport licensed radioactive material (reference to 10 CFR 71.4 and Appendix A of 10 CFR 71). The program includes the purchase, handling, shipping, storing, cleaning, inspection, operation, maintenance, and repair of Type A and Type B (reference 10 CFR 71.4 and

Appendix A of 10 CFR 71) shipping containers subject to a Certificate of Compliance (COC) as regulated by 10 CFR 71 (note: see Appendix A for "ST" Packages). The Chief, Reactor Operations and Engineering of the NIST NBSR retains the overall authority and responsibility for the NIST Shipping QA Program and its effectiveness. Independent oversight of the NIST Shipping QA Program shall be performed by the Chief, Health Physics, or his designee, on a regular basis to assure that the program is adequate and meets regulatory requirements. Quality Assurance and Quality Control (QC) functions are typically performed by designated Health Physics staff members. These individuals have the authority and responsibility to stop any unsatisfactory work and control over further processing, delivery, or installation of nonconforming materials. All NIST personnel involved with the shipment of licensed radioactive material requiring packaging covered by a COC (e.g., receipt or shipment of nuclear fuel) shall follow this QA Program. Additionally, NIST possesses and maintains non-Type A shipping materials and packages, including Type B containers and fissile material packages. This QA Program shall require vendor-supplied documentation of quality related activities applicable to the inspection, purchase, use, maintenance, modification, and repair of packages used and provided by the vendor (or organization) for transportation of licensed material in excess of a Type A quantity to or from NIST facilities. Establishment of this QA Program deems that all quality related activities applicable to the inspection, purchase, use, maintenance and repair of packages are implemented with written procedures approved by appropriate levels of management and are contained in NIST Shipping QA files.

2. <u>Quality Assurance Program Organization</u> (10 CFR 71.103)

The NIST facility organization chart for the NBSR is found in the NIST NBSR Technical Specifications as Figure 6.1. Responsibility for the NIST Shipping QA Program lies within the Chief, Reactor Operations and Engineering, or his designee, as QA Program Manager (QAPM). Any or all of the personnel on the NBSR of Health Physics staff may perform functions under this QA Program as designated by the QAPM. The Chief, Reactor Operations and Engineering shall ensure that measures are established to provide adequate control over any designated quality-related activities. Health Physics staff members performing QA functions shall have the responsibility and authority to stop unsatisfactory work and the delivery or installation of nonconforming materials. In addition, they shall have direct access to the Chief, Reactor Operations and Engineering, or higher-level management, who can ensure accomplishment of quality-related activities. The duties and qualifications required for the NIST QAPM and other principal personnel performing quality related functions shall be established and documented in the QA files. Typically, the QAPM should have some experience in a field that includes oversight of radioactive material shipments. Retraining of personnel performing quality related work will be on a continuing basis as changes are implemented in QA procedures. Indoctrination and training shall be included as part of an existing re-qualification program so that personnel performing quality-related activities important to safety are trained on a regular basis and qualified to perform these activities. Retraining shall be performed at least biennially.

A graded approach to quality assurance and procedures training shall be applied at such time as when specific containers are acquired or contracted for a specific radioactive material shipment activity. The extent of applied safety considerations will be based on their importance to safety as determined by the specific radioactive material involved. For

instance, more restrictive considerations would apply for spent fuel or high-level waste than for plutonium standard reference material, which, depending on quantity, may require more restrictions than non-irradiated "new" fuel or radiography-type sources.

3. Package Design Control (10 CFR 71.107)

The NIST facilities involved with radioactive material shipments requiring NRC-approved COC packages are only to be a user of radioactive material packaging, not a designer or fabricator of the packaging for the radioactive material. Therefore, the design, fabrication, assembly and testing activities for packages requiring an NRC-approved COC (other than "ST" packages) shall not be performed by any NIST facility and the criterion of 10 CFR 71.107 would not be applicable. For all packaging requiring a COC used to transport radioactive material, NIST shall assure that the design of the packaging was accomplished under the control of a Nuclear Regulatory Commission (NRC) approved QA Program as required. For supplier-provided packages, the supplier of the radioactive material packaging shall be required to submit documented proof (e.g. drawings, manuals, etc.) of package design under an NRC-approved QA plan as required. The documented proof, including the issued COC, or equivalent, for each package to be used will be kept on file at the appropriate NIST facility.

4. Procurement Document Control (10 CFR 71.109)

NIST, when procuring packaging requiring a COC, shall require the suppliers of radioactive material packaging to provide appropriate certifications verifying that the designated (model and serial number) packaging was manufactured under an NRC-approved QA Program as required. Other pertinent documentation (e.g., as-built drawings, photographs, sketches, use and maintenance manuals, identification of safety-related features or components, etc.) are to be furnished by the package supplier with the packaging to be used for transport of the radioactive material. The QAPM, or his designee, will determine all pertinent documentation required for the shipment. If any safety-related replacement parts are required to be procured for the packaging, the Chief, Reactor Operations and Engineering; or his designee, will designate QA personnel to ensure that appropriate technical and QA requirements are included in purchase orders and that the purchase orders are placed with suppliers that are or have been previously qualified to supply the parts or the package required. Procurement shall be made in consultation with the package owner. Procedures shall be established to delineate the sequence of actions for preparation, review, approval, and control of procurement documents, including review and concurrence on the adequacy of quality requirements by the QAPM in order to ensure the safety of the shipment.

5. Instructions, Procedures and Drawings (10 CFR 71.111)

In the preparation of packaging for use to transport radioactive materials, the QAPM, or his designee, shall ascertain that the package with its contents satisfies the applicable requirements of 10 CFR 71 and those contained in the COC. The Chief, Reactor Operations and Engineering, or his designee, has the authority to approve placing the package "in-use" for transporting radioactive material from any NIST facility. The Chief, Reactor Operations and Engineering, or his designee, shall prescribe activities affecting quality by documented instructions or procedures of a type appropriate to the particular circumstance(s) and shall require that these instructions or procedures be followed. Any plans for maintenance or repairs will be reviewed by designated QA personnel to verify that the maintenance or repair plans emphasize those characteristics that are most important to safety; safety is, therefore,

paramount. If a repair or maintenance is required to be performed on packaging, a written procedure will be followed and coordinated with the package owner/supplier and Quality Assurance personnel to ensure that appropriate inspection and test points are incorporated in the procedure and that effective repairs have been satisfactorily performed. The QAPM shall provide for QA review and concurrence regarding inspection plans; test calibration, and special process procedures; and drawings and specifications as necessary.

6. Document Control (10 CFR 71.113)

Each of the shipping and packaging documents under control of the Shipping QA Program shall be identified and maintained in the QA files associated with the NBSR Engineering Manual in accordance with NBSR facility configuration management (CM). The shipping and packaging documents shall be reviewed annually by appropriate Reactor Operations and Engineering or Health Physics personnel not directly associated with a specific radioactive material shipment. Control shall be exercised over the following documents, including the changes thereunto, used in the procurement, use, maintenance, modification and repair of NRC-licensed shipping packages (including Type A and B):

1. Operating procedures
2. Maintenance procedures
3. Inspection procedures
4. Loading and unloading procedures
5. Packaging and transport procedures
6. Modification and repair procedures
7. Audits
8. Drawings, sketches, manuals, and specifications
9. Training records

Revisions to these documents shall be reviewed by the appropriate Health Physics personnel having direct responsibility for shipment of radioactive material and approved by the QAPM, or his designee. Controlled copies of approved procedures will be made available to persons responsible for using those documents. In accordance with CM, the QAPM shall establish a master listing (or equivalent) that identifies the current revision level of instructions, procedures, specifications, drawings and procurement documents.

7. Control of Purchased Material, Equipment and Services (10 CFR 71.115)

Designated QA personnel shall take the necessary measures to assure that purchased material, equipment, and/or services, whether purchased directly or through contractors and subcontractors, conform to the procurement requirements. Documentary evidence that the package conforms to the particular procurement specification(s) shall be supplied with the package. This documentary evidence shall be retained and shall be sufficient to identify the specific requirements met by the purchased material or equipment.

The QAPM shall establish measures to ensure the proper disposition of items or services that do not meet procurement requirements. The measures established shall include evaluation(s) of nonconforming items categorized by the supplier, along with a justified recommended disposition (e.g., "use as-is").

Appropriate documentation, as identified in the purchase order, shall accompany the NRC-approved packaging during transport of the radioactive material.

8. Identification and Control of Materials, Parts and Components (10 CFR 71.117)
Designated QA personnel shall ensure that materials, parts, and components used for repair or modification of packaging in excess of Type A are adequately identified and controlled to prevent use of incorrect or defective items. Where replacement of limited-life items is specified, measures will be taken to preclude the use of items whose shelf- life or operation times have expired. Also, the physical identity of the item shall be maintained.

9. Control of Special Processes (10 CFR 71.119)
Special processes are not normally performed by the users of packaging. However, if packaging requires major repairs necessitating the use of these processes, designated QA personnel shall ensure that controls are followed for special processes subject to the following criteria:
1. Procedures, equipment, and personnel are qualified in accordance with applicable codes, standards and specifications.
2. The operations are performed by qualified personnel and accomplished in accordance with written procedures with recorded evidence of verification.
3. Qualification records of procedures, equipment, and personnel are established, filed, and kept current.

No special process will be undertaken without consultation with the package owner and those special processes shall be performed in accordance with an NRC-approved QA plan with appropriate procedures established by the package owner.

10. Internal Inspections (10 CFR 71.121)
Visual inspections by designated QA personnel shall be performed upon receipt of packaging to ensure compliance with procurement documentation and QA procedures. The criteria for acceptance of each of these inspections, and actions to be taken if noncompliance is encountered, shall be determined in accordance with approved procedures. These visual inspections shall, as applicable, include an inspection of the following:
1. Surface conditions.
2. Weld and structural integrity.
3. Condition of flange or sealing faces.
4. Gaskets and seals.
5. Gauges, rupture disks, valves, pressure relief devices.
6. Condition of tie-down members and impact limiters, if used.
7. Labeling, marking, and placarding.
8. Leak tightness of the packaging.

The inspection program shall ensure adequate maintenance of packaging. The manufacturer/owner/supplier of the packaging shall identify all safety-related items to be maintained, criteria for acceptability or replacement, and the frequencies of inspection assigned to each item during use of the package. Hold or witness points shall be identified in the use and inspection procedures. Additional tests and inspections may also be performed by designated QA personnel, including contractor personnel, as required in accordance with package-specific COC requirements. Prior to shipment, final inspections shall be performed with a checklist to verify that all the following items are complied with:
1. Packages are properly assembled.
2. Valves are set to specifications (where applicable).

3. Shipping papers are properly completed, including the Bill of Lading.
4. Packages are conspicuously and durably marked and labeled as required by DOT regulations.
5. Individual designated by the owner or user of the package has given authorization for shipment of the package.
6. Authorized individuals shall sign the shipping paperwork prior to release for shipment.

Inspection records shall be maintained as QA records to document performance of inspection activities.

11. Test Control (10 CFR 71.123)

Documentation of a test program shall be established or provided to ensure that all the required testing of packaging components are satisfactorily completed. These written procedures shall incorporate the acceptance limits contained in the package approval, provisions for assuring that all prerequisites for a given test were met, that adequate test instrumentation was used, and that the test was performed under suitable environmental conditions. For vendor-supplied packaging, the test results shall be made available as appropriate. For modifications, repair, and replacements of a package, testing shall be documented by designated QA personnel and evaluated by the Chief, Reactor Operations and Engineering, or his designee, to ensure that acceptance test requirements have been satisfied prior to delivering packages for transport to a carrier. For those cases, tests shall include the following considerations, where applicable:

1. Structural integrity.
2. Leak tightness.
3. Component performance (e.g. valves, gaskets, fluid transport devices, etc.).
4. Shielding integrity.
5. Thermal integrity.

During the loading process, periodic maintenance test programs shall be established to ensure that packages remain usable and free of excessive radiation and contamination.

12. Control of Measuring and Test Equipment (10 CFR 71.125)

Designated QA Personnel shall ensure that all instruments, gauges, and other measuring and testing devices used in activities affecting quality shall be properly controlled, calibrated (if necessary), and adjusted at specific times to maintain accuracy within necessary limits. This includes measuring and test equipment used for maintenance of safety-related items. Inspection and test equipment shall be tagged or labeled to indicate the date of the next planned calibration. All calibration test data shall be maintained with facility records or be readily traceable to nationally recognized standards. If no known recognized standard exists (for calibration), the basis for calibration shall be documented. When measuring and test equipment are found to be out-of-calibration, measures will be taken to validate previous inspection and test results up to the time of previous calibration.

13. Handling, Storage and Shipping Control (10 CFR 71.127)

The handling, storage, and shipping of Type B packaging shall be controlled to assure safety and minimize degradation, damage and/or loss. Measures will be taken to control the handling, storage, shipping, cleaning, and preservation of materials and equipment to

be used in packaging to prevent damage or deterioration. The following actions shall be performed when handling or storing packages of radioactive material for shipment:
1. If packaging requires special handling and lifting equipment (as identified in the COC), then such equipment will be used to move packaging from one station to another.
2. As required, special handling or storage provisions for packaging (e.g. impact limiters, tags or markings to adequately protect and identify critical components, etc.) shall be used.
3. As required, special protective environments (e.g. inert gas atmosphere, specific moisture content levels, and temperature levels, etc.) shall be specified and provided.
4. All conditions identified in a COC shall be adhered to when unloading packaging.

When preparing a package for shipment the following measures shall be taken, as appropriate:
1. Cavities within gas-cooled package containments have been adequately dried and cavities within liquid cooled packages have been drained to allow adequate void space.
2. Specified operations, inspections, and tests have been completed prior to delivery to a carrier.
3. NRC (10 CFR 71) and DOT (49 CFR 173) requirements have been satisfied prior to delivery to a carrier. When necessary, departure and arrival times shall be established and monitored to a degree consistent with safe transportation of the package.
4. Necessary shipping papers, including Bill of Ladings, have been prepared as required.

14. Inspection, Test and Operating Status (10 CFR 71.129)
Procedures will be established to control application and removal of inspection and welding stamps and status indicators. A tag, label, marking, log entry, or other documentation will indicate the inspection, test, or operating status of Type B shipping containers. The records shall indicate when periodic surveillance tests have been performed and if any nonconforming, inoperative, or malfunctioning structures, systems, or components have been identified. No deviation from the required inspection, test or other critical operations is authorized without the review and approval of the QAPM, or his designee.

15. Nonconforming Materials, Parts or Components (10 CFR 71.131)
Designated QA personnel shall ensure established measures are followed to control safety-related materials, parts, or components that do not conform to specified requirements in order to prevent their inadvertent use or installation. All safety-related materials, parts, or components for use by any NIST facility which are required to be quality controlled shall be inspected upon receipt or prior to use by designated QA personnel. This inspection shall include, as a minimum:
1. Proper identification of item and any nonconformance(s).
2. Segregation of nonconforming items.
3. Disposition.
4. Evaluation.

Procedures shall be developed for the identification, documentation, segregation, disposition, and notification to affected organizations of nonconforming materials, parts, or services. Nonconforming items will be placed in designated control hold areas until proper disposition is completed. Nonconforming items shall be dispositioned as follows: reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures. The acceptability of nonconforming items after designated repair or rework shall be verified by designated QA personnel by re-inspecting or retesting the item against the original

requirements. All information that is discovered concerning a nonconforming item will be recorded and kept with QA records such that it can be analyzed by designated QA personnel.

16. Corrective Action (10 CFR 71.133)

For activities important to safety concerning use, maintenance, modification, and repair of Type B packages, the Chief, Reactor Operations and Engineering, or his designee, shall ensure that conditions adverse to quality (e.g., those resulting from failures, malfunctions, deficiencies, deviations, and defective material and equipment, etc.) are promptly identified and reported to appropriate levels of management and, as necessary, the appropriate regulatory authorities. In the case of a significant condition adverse to quality, a 'root cause analysis' of the condition shall be performed and corrective actions taken to preclude recurrence. Lessons learned shall be utilized.

17. Quality Assurance Records (10 CFR 71.135)

Sufficient identifiable and retrievable written records shall be maintained in the NIST Shipping QA files to furnish evidence of activities affecting quality. The records shall include the following:

1. Instructions, procedures, drawings, and specifications required by 10 CFR 71.111.
2. Design records, as appropriate, including results of reviews.
3. Inspections (and Tests), as appropriate.
4. Audits.
5. Material Analyses.
6. Procurement Documents.
7. Maintenance and repair(s) of packages.
8. Calibration procedures and reports.
9. Nonconformance reports.
10. Training (and retraining) records and certifications.

All shipments of licensed radioactive material shall be reviewed and approved by designated Health Physics personnel. Shipping records for licensed radioactive material requiring COC packaging shall be kept on file by the NIST Health Physics Office. Records of licensed radioactive material shipments, including superseded records, utilizing a leased shipping container shall be kept for at least three years from the date of the last shipment. Records that are to be retained for the lifetime of the packaging shall include:

1. Appropriate design and production-related records, which are generated throughout manufacturing and furnished with the packaging.
2. Records demonstrating evidence of operational capability of the packaging.
3. Records verifying repair, rework, modification, and replacement that are used as a baseline for maintenance (as applicable).

18. Audits (10 CFR 71.137)

Audits of each safety related activity shall be completed at least annually to verify compliance with all aspects of the QA Program for radioactive packaging covered under this program and to determine the effectiveness of the program. The audit shall be performed by the Chief, Health Physics, or his designee, but not by staff having direct responsibility in the areas being audited. Audit results shall be documented and reviewed by the Chief, Reactor Operations and Engineering, or his designee. Follow-up or corrective action, including the re-audit of deficient areas, shall be taken as necessary.

APPENDIX A
NIST PACKAGING AND SHIPPING QA PROGRAM FOR "ST" PACKAGES

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Introduction

This document establishes the National Institute of Standards and Technology (NIST) Packaging and Shipping Quality Assurance (QA) Program specifically for the NIST Shipping Container Package "ST" in accordance with 10 CFR 71, Subpart H. It is utilized to ensure the safety of the general public during packaging and transportation of fissile material. Typically, shipping containers regulated by 10 CFR 71 can be released for shipping to or from NIST only after they have satisfactorily met the requirements of the NIST Packaging and Shipping QA Program for Transport of Radioactive Materials (Revision 3). The following "package specific" QA Program applies only to those activities affecting the "ST" package and its components, if any, which are significant to safety. The degree of control over a particular shipment of radioactive materials is governed by the activity and form of the specific radioactive material involved. Since the "ST" package was fabricated at NIST according to commercial engineered standards using off-the-shelf components, no credit is taken for design features related to safety (ref. NUREG/CR-6407, category A/B/C) and, as such, no controls would be required. For Type A shipments transported in the "ST" package(s), this program provides the criteria for the QA factors that are addressed for packages of radioactive material used for transport to or from NIST and/or the National Bureau of Standards Reactor (NBSR). The criteria specified herein are consistent with the categories of 10 CFR 50, App. B and ASME NQA-1-2004 "Basic Requirements and Practices."

1. Scope and Responsibilities (10 CFR 71.101)

The NIST Packaging and Shipping QA Program for Transport of Radioactive Materials (Revision 3) provides a discussion of which requirements of 10 CFR 71, Subpart H are applicable. The comprehensive program includes the purchase, handling, shipping, storing, cleaning, inspection, operation, maintenance, and repair of both Type A and Type B shipping containers (reference 10 CFR 71.4 and Appendix A of 10 CFR 71) subject to a Certificate of Compliance (COC) as regulated by 10 CFR 71, such as the one issued for approval by the

Nuclear Regulatory Commission (NRC) on September 27, 2006 for NIST package "ST" (i.e., COC No. 9246). This "package specific" NIST Packaging and Shipping QA Program for "ST" packages establishes the specific requirements applicable to component procurement, use, maintenance, modification, and repair of "ST" packaging used to transport licensed radioactive material. The design, fabrication, assembly and testing of the "ST" package was performed at NIST according to commercially accepted engineering standards (reference to 10 CFR 71.31 and 10 CFR 71.101) for a Type A package. The "ST" packaging itself performs no specific safety function during transport (other than Type A packaging) since both its contents and the quantity of packages per shipment is limited accordingly (per COC No. 9246). Hence, the requirements of 10 CFR 71.55 pertaining to package design, fabrication, assembly, and testing need not apply.

The Chief, Reactor Operations and Engineering of the NIST NBSR, retains the overall authority and responsibility for the NIST Packaging and Shipping QA Program for Transport of Radioactive Materials, including that for the "ST" package. An independent oversight of the NIST Shipping QA Program is performed by the Chief, Health Physics, or his designee, on a regular basis to assure that the program is adequate and meets regulatory requirements. The QA and Quality Control (QC) functions are typically performed by a designated Health Physics staff member. These individuals have the authority and responsibility to stop any unsatisfactory work and suspend any further processing, delivery, and prevent the installation or use of nonconforming materials for the "ST" package. All NIST and contractor personnel involved with the shipment of licensed radioactive material in "ST" packages (e.g., receipt or shipment of fresh nuclear fuel) follow provisions of this QA Program. Consistent with provisions of 10 CFR 71.37, this QA Program requires documentation of quality related activities applicable to inspection, purchase, use, maintenance, modification, and repair of "ST" packages used for transportation of licensed material to or from the NIST NBSR. Establishment of this 'package-specific' QA Program deems that all quality related activities applicable to the inspection, purchase, use, maintenance and repair of "ST" packages are implemented with written procedures approved by appropriate levels of management and are contained in NIST Shipping QA files.

2. <u>Quality Assurance Program Organization</u> (10 CFR 71.103)

The responsibility for the NIST Packaging and Shipping QA Program for "ST" Packages lies with the Chief, Reactor Operations and Engineering, or his designee, as QA Program Manager (QAPM). Any or all of the personnel on the NBSR or Health Physics staff may perform functions under this QA Program for "ST" packages as designated by the QAPM. Accordingly, the Chief, Reactor Operations and Engineering, ensures that measures have been established at NIST to provide adequate control over any designated quality-related activities regarding the transport of licensed material in "ST" packages.

A graded approach to quality assurance and procedures training shall be applied at such time as when specific containers are acquired, fabricated, or contracted for a specific radioactive material shipment activity (e.g., "ST" packages). The extent of applied safety considerations will be based on their importance to safety as determined by the specific radioactive material involved. For the specific quantities of fissile material being transported in "ST" packages (i.e., up to 360 grams of U-235 per package in COC No. 9246), <u>no</u> criticality potential exists and, as such, no specific safety function is performed by the "ST" package itself (other than that for Type A packages) during the transportation of the fissile material to and from NIST.

3. Package Design Control (10 CFR 71.107)

The current NRC-approved NIST Shipping QA Program for Transport of Radioactive Materials specifies that shipments requiring an NRC-approved COC package are to be made by NIST only as a user of the radioactive material packaging. Since COC No. 9246 limits and restricts the contents of each "ST" package as well as the quantity of "ST" packages in each shipment, the design, fabrication, assembly, and testing activities for the "ST" package need not be subjected to each specific criterion of 10 CFR 71.107. Hence, the "ST" package was designed and fabricated according to commercially accepted engineering standards for a Type A package, serving no safety function related to the items in 10 CFR 71.107 (e.g., criticality, radiation shielding, thermal stresses). Moreover, design control measures exist at the NIST NBSR facility to document any design changes to the "ST" package, as necessary. Documented proof of changes to the "ST" package, including the issued COC No. 9246 for the "ST" package, shall be kept on file at the NIST NBSR facility.

4. Procurement Document Control (10 CFR 71.109)

The QAPM, or his designee, shall verify that any part and material purchased for "ST" packages are in accordance with commercial engineered standards. Any replacement parts required to be procured for the "ST" package shall be provided with appropriate documentation. For instances when NIST requires suppliers of radioactive material packaging to provide the appropriate certifications verifying that the designated packaging (model and serial number) was manufactured under an NRC-approved QA Program, additional pertinent documentation such as 'as-built' drawings, photographs, sketches, use and maintenance manuals, and the identification of any significant features shall also be furnished by the package supplier with the specific packaging. NIST QA personnel shall ensure that appropriate technical and QA requirements are included in the purchase orders and that the purchase orders are placed with suppliers according to commercial engineered standards for the package or part in question. Procedures will be established to delineate the sequence of actions for preparation, review, approval, and control of procurement documents, including review and concurrence on the adequacy of quality requirements by the QAPM in order to ensure the safety of the ensuing shipment.

5. Instructions, Procedures and Drawings (10 CFR 71.111)

In the preparation of packaging for use to transport radioactive materials, the QAPM, or his designee, shall ascertain that the "ST" package with its contents satisfies the applicable requirements of 10 CFR 71 as well as those requirements contained in COC No. 9246. The Chief, Reactor Operations and Engineering, or his designee, has the authority to approve placing the "ST" package 'in-use' for transporting radioactive material to/from any NIST facility provided that COC No. 9246 is current and valid, the QAPM concurs, and Health Physics has not issued a stop-work order. Any plans for maintenance or repairs shall be reviewed by designated QA personnel to verify that the maintenance or repair shall be performed according to commercial engineered standards. The "ST" package itself does not take any "credit" for safety (i.e., criticality, shielding, thermal stress) since its contents (quantity of radioactive material) are restricted, resulting in no direct or specific safety implications from the packaging (other than that for Type A). If a repair or maintenance is required to be performed on the packaging, a written procedure shall be followed and coordinated with NIST as package owner to ensure that appropriate inspection and test points are incorporated in the procedure and that effective repairs and follow-up testing and inspection have been satisfactorily performed. The QAPM is responsible for providing for the QA review and concurrence regarding inspection plans, test calibration and special process procedures, and drawings and specifications. Revisions to "ST" package drawings are maintained within NBSR configuration management.

6. Document Control (10 CFR 71.113)

Each of the shipping and packaging documents under control of the NIST Packaging and Shipping QA Program, including those for the "ST" package, are identified and maintained in the QA files associated with the NBSR Engineering Manual in accordance with the Configuration Management (CM) program. The shipping and packaging documents for the NIST "ST" package are reviewed annually by appropriate Reactor Operations and Engineering or Health Physics personnel not directly associated with specific radioactive material shipments that utilize this package. Control shall be exercised over the following documents, including the changes thereunto, used in the procurement, use, maintenance, modification and repair of the "ST" package:

1. Operating procedures
2. Maintenance procedures
3. Inspection procedures
4. Loading and unloading procedures
5. Packaging and transport procedures
6. Modification and repair procedures
7. Audits
8. Drawings (revisions thereto), sketches, manuals, and specifications
9. Training records

Any revisions to these documents shall be reviewed by the appropriate Health Physics personnel having direct responsibility for shipment of radioactive material and approved by the QAPM, or his designee. Controlled copies of the approved procedures are made available to persons responsible for using those documents. In accordance with CM, the QAPM establishes a master listing (or equivalent) that identifies the current revision level of the "ST" package instructions, procedures, specifications, and drawings.

7. Control of Purchased Material, Equipment and Services (10 CFR 71.115)

Purchased material, equipment, and/or services, whether purchased directly or through contractors (and/or subcontractors), for the "ST" package conform to commercially accepted engineered standards, such as that for lid bolts (standard off-the-shelf item). Documentary evidence is retained and can be used to identify the specific requirements met by the purchased material or equipment.

The QAPM establishes measures to ensure the proper disposition of items or services that do not meet the procurement requirements. The measures established must include evaluation(s) of nonconforming items categorized by the supplier, along with a justified recommended disposition (e.g., "use as-is" or "replacement required").

Spare parts (e.g., spare lid-bolts, spacers, etc.) as well as its associated documentation accompany the "ST" package during shipments of licensed radioactive material.

8. Identification and Control of Materials, Parts and Components (10 CFR 71.117)

Designated QA personnel ensure that any materials, parts, and components used for repair or modification of the "ST" package are adequately identified and controlled to prevent use of incorrect or defective items. Replacement of limited-life items should not be needed for the "ST" package as there are none that are known. The physical identity of any replacement item(s) utilized in "ST" packages is routinely maintained via the CM program.

9. Control of Special Processes (10 CFR 71.119)

Special processes are not normally performed by the users of "ST" packaging. However, if the "ST" package requires major repairs necessitating the use of these processes, designated QA personnel shall ensure that controls are followed for special processes subject to the following criteria:

1. Procedures, equipment, and personnel are qualified in accordance with applicable codes, standards and specifications.
2. The operations are performed by qualified personnel and accomplished in accordance with written procedures with recorded evidence of verification.
3. Qualification records of procedures, equipment, and personnel are established and filed.

No special process will be undertaken without consultation with NIST as owner and those special processes will be performed in accordance with commercial engineering standards and with appropriate procedures established by NIST.

10. Internal Inspections (10 CFR 71.121)

Visual inspections by designated QA personnel shall be performed upon receipt of "ST" packages to ensure compliance with pertinent documentation and NIST QA procedures. The criteria for acceptance of each of these inspections, and actions to be taken if noncompliance is encountered, is determined in accordance with approved procedures. These visual inspections shall, as applicable, include an inspection of the following to allow re-use:

1. Surface conditions.
2. Weld and structural integrity.
3. Condition of flange and associated sealing faces.
4. Bolts and gaskets.
5. Wood end spacers.
6. Condition of any tie-down members, if used.
7. Labeling, marking, and placarding.
8. Leak tightness of the packaging (e.g., no obvious breach of containment).

The NIST receipt inspection program ensures adequate maintenance of the "ST" package. The manufacturer/owner/supplier (i.e., NIST for the "ST" package) of the packaging is responsible for identifying any safety-related items to be maintained, criteria for acceptability or replacement, and the frequencies of inspection assigned to each item during use of the package. As the "ST" package performs no specific safety function other than that of Type A packaging, there are no 'safety-related' items that need to be regularly maintained. Also, additional tests and inspections may be performed by designated QA personnel, including contractor personnel, as required in accordance with any 'package-specific' COC requirements. Prior to shipment, final inspections are performed with a Shipper's Checklist to verify that all of the following items are complied with:

1. The "ST" package is properly assembled.
2. Shipping papers are properly completed for the "ST" package, including Bill of Lading.
3. The "ST" package is conspicuously and durably marked and labeled as required by DOT regulations (per 49 CFR 173).
4. Shipper designated by NIST has given authorization for shipment of the package.
5. Authorized individuals shall sign the shipping paperwork prior to release for shipment.

11. Test Control (10 CFR 71.123)

Documentation of a test program ensures that any testing of "ST" packaging components is satisfactorily completed to commercial engineered standards for a Type A package. Written procedures incorporate the acceptance limits contained in the "ST" package approval and provisions for assuring that all prerequisites for a given test were met. For modifications and repair of the "ST" package, testing is documented by designated QA personnel and evaluated by the Chief, Reactor Operations and Engineering, or his designee, to ensure that acceptance test requirements have been satisfied prior to delivering the package for transport to a carrier. For those cases, tests include the following considerations, when applicable, for the "ST" package:

1. Structural integrity.
2. Leak tightness (for breach occurrence and subsequent repair).
3. Component performance (e.g., gaskets, bolts, etc.).

During the loading process, periodic contamination checks (e.g., smears) shall be performed to ensure that the "ST" package remains usable and free of contamination.

12. Control of Measuring and Test Equipment (10 CFR 71.125)

Designated QA personnel shall ensure that any instruments, gauges, and other measuring and testing devices used in activities affecting "ST' package quality are properly controlled, calibrated (if necessary), and adjusted at specific times to maintain accuracy within acceptable limits. Since the "ST" package does not perform any criticality, radiation shielding, thermal stress, or hydraulic stress safety function, the control of measuring and test equipment may conform to commercial engineering standards.

13. Handling, Storage and Shipping Control (10 CFR 71.127)

Measures to control the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in the "ST" package are implemented to prevent damage or deterioration, including indoor storage of the "ST" packages. The following actions are performed when handling or storing the "ST" packages for radioactive material shipment:

1. Special handling and lifting equipment, when or if needed, will be used to move the "ST" packages from one station to another (as identified in the COC).
2. As required, special handling or storage provisions for packaging (e.g. tags or markings to adequately protect and identify critical components, etc.) are to be used.
3. All conditions identified in COC No. 9246 must be adhered to during "ST" package unloading.

When preparing an "ST" package for shipment the following measures shall be taken, as appropriate:

1. Specified operations, inspections, and tests (if any) must have been completed prior to delivery to a carrier.
2. NRC (10 CFR 71) and DOT (49 CFR 173) requirements must have been satisfied prior to delivery to a carrier. When necessary, departure and arrival times shall be established and monitored to a degree consistent with safe transportation of the package.
3. Necessary shipping papers, including Bill of Lading(s), shall be prepared as required.

14. Inspection, Test and Operating Status (10 CFR 71.129)

A tag, label, marking, log entry, or other documentation will indicate the inspection, test, or operating status of the "ST" package and indicate when, or if, periodic surveillance tests have been performed and if any nonconforming, inoperative, or malfunctioning structures, systems, or components have been identified. No deviation from the required inspection, test or other critical operation(s) for the "ST" package is authorized without the review and approval of the QAPM, or his designee.

15. Nonconforming Materials, Parts or Components (10 CFR 71.131)

The "ST" package contains no specific 'safety-related' parts or components. Hence, specific measures to control the use of any 'safety-related' materials, parts, or components that do not conform to specified requirements are not required. However, procured parts that are utilized as replacements or spares are evaluated for nonconformance by NIST QA personnel. Inspections typically include the following:

1. Proper identification of item and any nonconformance(s).
2. Segregation of nonconforming items.
3. Disposition.
4. Evaluation.

In the same vein, procedures for the identification, documentation, segregation, disposition, and notification to affected organizations of nonconforming materials or parts exist for the "ST" package (e.g., dispositioning stripped lid bolts). Nonconforming items are placed in designated control hold areas until the proper disposition is completed. Typically, the acceptability of nonconforming items after designated repair or rework is verified by appropriate QA personnel and replacement of the item is performed in accordance with commercial engineered standards. All information that is discovered concerning a nonconforming item is recorded and kept with the QA records for the "ST" package.

16. Corrective Action (10 CFR 71.133)

For activities important to safety concerning the use, maintenance, modification, and/or repair of the "ST" packages, the Chief, Reactor Operations and Engineering, or his designee, ensures that conditions adverse to quality (e.g., those resulting from failures, malfunctions, deficiencies, deviations, and defective material and equipment, etc.) are promptly identified and reported to appropriate levels of management and, as necessary, the appropriate regulatory authorities. In the case of a significant condition adverse to quality for the "ST" package, a 'root cause analysis' of the condition shall be performed and corrective actions will be taken to preclude recurrence. Lessons learned shall be utilized, as necessary.

17. Quality Assurance Records (10 CFR 71.135)

Sufficient identifiable and retrievable written records for the "ST" package are maintained in the NIST Shipping QA files to furnish evidence of activities affecting quality. The records could include the following:

1. Instructions, procedures, drawings, and specifications required by 10 CFR 71.111.
2. Design records (e.g. change notices), if any, including results of applicable reviews.
3. Inspections (and Tests), as appropriate.
4. Audits.
5. Material Analyses, as necessary.

6. Procurement Documents (e.g., packing list for lid hold-down bolts).
7. Maintenance and repair(s) of the "ST" package.
8. Training (and retraining) records and certifications.

All shipments of "ST" packages are reviewed and approved by designated Health Physics personnel. Shipping records for shipments of "ST" packages are kept on file by the NIST Health Physics Office in Building 235. Records retained for the lifetime of the "ST" package include:

1. Any "production-related" records generated from modifications and furnished with the packaging, as appropriate.
2. Records demonstrating evidence of operational capability of the "ST" packaging.
3. Records verifying repair, rework, modification, and replacement of parts that are used as a baseline for maintenance (as applicable), including spare parts that accompany the shipment.

18. Audits (10 CFR 71.137)

Audits and/or checklists for shipments utilizing the "ST" package to transport fissile material are completed at least annually to verify compliance with all aspects of the NIST QA Program for radioactive material packaging covered under this specific program and to determine the effectiveness of the program. The audit is performed by the Chief, Health Physics, or his designee, but not by staff having direct responsibility in the areas being audited. Audit results are documented and reviewed by the Chief, Reactor Operations and Engineering, or his designee. Follow-up or corrective action, including any re-audit of deficient areas, is taken as necessary.

NIST | UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
(Gaithersburg, Maryland 20899)

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February 14, 1992

Mr. Charles E. MacDonald
Chief, Transportation Branch
Division of Safeguards and Transportation
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Docket Number 71-9246

Dear Mr. MacDonald:

Enclosed please find the additional requested information pertaining to criticality (10CFR71.61), and package integrity 10CFR71.55. Revised drawings of the container (Revision 2) are attached. This reflects the removal of the lifting and tie-down eyelets from the package design. There are no tie-down or lifting devices which are a structural part of the package in this final design.

Sincerely,

J. Michael Rowe
Chief, Reactor Radiation Division

Enclosure

NIST "ST" SERIES SHIPPING CONTAINER
TESTING FOR NORMAL CONDITIONS OF TRANSPORT

The "ST" series Fissile Material Package is designed to transport a single NBSR fuel element in compliance with 49CFR173 and 10CFR71. This package was tested to demonstrate its integrity for normal conditions of transport.

The tested package is identical to those that will be used for transport. Prior to the sequence of tests, the package was loaded with a dummy element. The dummy element is identical to a fueled element except for the absence of the fueled portion of the internal plates. All tests required by 10CFR71.71 were performed in sequence as outlined below. Photographs were taken to document the physical conditions of the test.

Water Test: The sprinklers were arranged so that all sides of the package are wetted. The simulated rainfall via sprinklers was measured and exceeded 2" per hour. A post test time delay to allow "soak in" was not required since this is a metal container. Following the test, the package was examined for any deterioration or evidence of water entering the container. No water entered the container.

Free Drop Test: The package was dropped from a height of 4 feet onto a poured concrete pad. Because of the geometry of this package this test was repeated such that

(1) the first drop was on the closed, welded end,
(2) the second drop was on the end with the removable plate, and
(3) the third drop was with the package horizontal.

Prior to the 4' free drop test the package was dropped from a height of one foot on each corner of each end (four drops per end). The package was examined for any damage that could affect its integrity. No damage was found.

Penetration Test: A 6kg, 3.2cm diameter bar was dropped so as to impact the center of the package from a height of 1 meter. The package was resting on an unyielding surface, positioned horizontally as it would be during a shipment. Because the bar must impact a curved surface of the package, care was taken that the impact was not glancing.

The test bar was examined for any deformity at the impact point; none was found. The package was examined for any damage that could affect its integrity. No damage was observed.

Compression Test: This test was applied in the geometry in which the package normally is positioned during shipment, that is with the longitudinal axis of the package horizontal and each end resting on an unyielding surface (concrete). The projected area of the package (5-1/2" diameter pipe, 70" long) is 2500cm^2. This requires the greater of (1) 1300 kg/m^2 x 0.25 m^2 = 325 kg (715 lbs.), or (2) 5 x 55lbs. = 275 lbs. Hence 325kg was placed along the length of the package by placing three layers of lead bricks, each layer consisting of eight bricks (11.9 kg/brick), plus four additional bricks for a total of 28 bricks (333kg) on top of the package. This provided the uniform compression loading on two sides as required by 10CFR71.71. The load remained in place for 24 hours.

Upon completion of this test, the package was examined for any damage that could affect its integrity. No damage was observed.

Upon completion of the test sequence, the package was opened. The dummy element was examined for any damage that would indicate a possible failure of the package containment effectiveness. The interior of the package was examined for any damage that could affect its integrity. Other than chipped paint on the exterior of the package no effects of the testing were observed on the package. The dummy fuel element also showed no effects from the testing. It was not distorted or marred in any way. The package clearly met all the performance requirements of 10CFR71.57(d).

NIST "ST" SERIES SHIPPING CONTAINER
SUBCRITICAL ANALYSIS (10CFR71.61)

Criteria: Twice this number of packages would be subcritical.

The attached report of a criticality analysis by the fabricator of the NBSR fuel, Babcock and Wilcox, demonstrates that up to seven undamaged NBSR fuel elements, arranged in any undamaged configuration, would be subcritical for any moderation and reflection geometry. No credit is taken for the poison effect of the steel in the package, nor for the spacing between packages.

Criteria: This number of packages would be subcritical if stacked together in any arrangement with optimal reflection and moderation.

Two (2) packages contain no more than 720 grams. Criticality cannot be achieved under any condition since this is less than the smallest mass of ^{235}U required to achieve criticality.

N 3-1

Babcock & Wilcox
a McDermott company

Naval Nuclear Fuel Division

To	A. J. Koudelka - NNFD-15A	
From	M. N. Baldwin - NNFD-15A	File No. or Ref. MNB91-04
Subj.	FOUR NBSR ELEMENTS IN INFINITE SEA OF WATER	Date 1/31/91

REFERENCE 1: MEMO FROM J. W. HARWELL TO B. O. KIDD TITLED "NUCLEAR CRITICALITY SAFETY EVALUATION OF RIFLE RACKS IN THE RTRFE AREA TO INCLUDE ADDITIONAL ELEMENT TYPES," MARCH 28, 1989.

As you requested in response to a request from the National Institute of Standards and Technology, I have determined the upper limit of K-eff for four fully flooded NBSR fuel elements arranged 2x2 on a uniform square pitch in an infinite sea of water. The evaluation shows that the maximum K-eff value does not exceed 0.734.

For this evaluation, the basic NBSR element employed in Reference 1, and modeled in KENO Va was used. Each standard NBSR element was modeled explicitly to contain 17 fuel plates in the top and bottom fueled region, making a total of 34 fuel plates. The 2.436-Inch by 11.37-Inch by 0.020- Inch fueled portion of each plate is uniformly loaded with a matrix of 93% enriched UO2 and aluminum to give a total plate loading of 10.294 Grams U-235. Clad thickness is 0.01525 Inches and water gap spacing is 0.116 Inches. A 6.00 Inch long water-filled center section separates the top and bottom fueled regions of the element. Total U-235 loading for the element is 350 grams.

The computer code KENO Va and the 16-group Master Library from Scale-3 processed thru BONAMI were used for the calculations. This was accomplished through the use of the Scale-3 control module CSAS25. Scale-3 is a modular code system for performing standardized computer analyses for licensing evaluations. It was prepared for the U. S. Nuclear Regulatory Commission by Oak Ridge National Laboratory. The CSAS25 control module has been benchmarked against numerous known-critical systems by Babcock & Wilcox Company (B&W) in addition to many other organizations. Since B&W benchmark and validation work shows that this control module (with various option restrictions which B&W imposes on criticality safety calculations) never underestimates the actual K-eff value of a system by more than 2%, and since a statistical uncertainty is always associated with a KENO Va calculation, a bias value of 0.02 plus two-sigma is always added to the calculated value when criticality safety is the consideration.

Five calculations, representing variations in the element spacing were made. The results presented in Table 1 include the two-sigma uncertainty and the 0.02 bias. K-eff is at a maximum when the element separation is about 0.5 Cm.

Although this evaluation uses the same calculational techniques, codes, bias value and cross-section library as would an internal criticality safety evaluation, and although the writer is confident that the K-eff quoted is conservative for safety considerations, and although it has been independently reviewed by another criticality safety engineer who has included his QA statement; this memo does not address many items that would be required by our evaluation procedures (such as review of required procedures, double contingency evaluation, posting requirements, etc.). This memo is not intended to constitute a criticality safety evaluation as defined by our procedures, and must not be subject to audit as a criticality safety evaluation. It is rather, what our customer requested: a determination of the upper limit of K-eff for four fully flooded NBSR fuel elements arranged 2x2 on a uniform square pitch in an infinite sea of water.

M. N. Baldwin

M. N. Baldwin

QA Statement:

I have reviewed these calculations and concur with the model, the codes used, the calculational techniques, the cross-section library, the results and conclusions. I further concur that this evaluation is not and is not intended to be a criticality safety evaluation as defined by NNFD procedures.

J. W. Harwell

J. W. Harwell

cc: FM Alcorn, NNFD-15A
JJ Bazley, NNFD-15A
AB Croft, NNFD-15A
RL Dunham, NNFD-15A
JW Harwell, NNFD-15A
BO Kidd, NNFD-15A
TD Lee, NNFD-35
RB Park, NNFD-15A
LL Wetzel, NNFD-15A

TABLE 1 - RESULTS OF CSAS25 RUNS - FOUR NBS ELEMENTS ON SQUARE PITCH IN AN INFINITE SEA OF WATER

RUN ID	ELEMENT SEPARATION	UPPER LIMIT* OF K-EFF
NBSG	0.0 CM.	0.708
NBSH	0.5 CM.	0.734
NBSI	1.0 CM.	0.726
NBSJ	3.0 CM.	0.590
NBSK	30.0 CM.	0.412

* calc. K-eff + two-sigma + 0.02

N.3-1

Babcock & Wilcox
a McDermott company

Naval Nuclear Fuel Division

To	A. J. Koudelka, NNFD-46	
From	M. N. Baldwin, NNFD-46	File No. or Ref. MNB91-08
Subj.	SEVEN NBSR ELEMENTS IN INFINITE SEA OF WATER	Date APRIL 26, 1991

Reference 1: MEMO FROM M N BALDWIN TO A J KOUDELKA TITLED "FOUR NBSR ELEMENTS IN INFINITE SEA OF WATER", JANUARY 31, 1991.

Reference 2: MEMO FROM J W HARWELL TO B O KIDD TITLED "NUCLEAR CRITICALITY SAFETY EVALUATION OF RIFLE RACKS IN THE RTRFE AREA TO INCLUDE ADDITIONAL ELEMENT TYPES", MARCH 28, 1989.

In response to a request to you from the National Institute of Standards and Technology, I determined and reported in Reference 1, the upper limit of K-eff for four fully flooded NBSR fuel elements arranged in their most reactive configuration in an infinite sea of water. The evaluation showed that the maximum K-eff value for four elements does not exceed 0.734.

Recently, a second request was received from the National Institute of Standards and Technology for the upper limit on K-eff for seven fully flooded and reflected elements. This second evaluation shows that the maximum K-eff value for seven elements does not exceed 0.881.

The methods used are basically the same as previously reported, but descriptions are repeated herein for the convience of the reader.

For this evaluation, the basic NBSR element employed in Reference 2, and modeled in KENO Va was used. Each standard NBSR element was modeled explicitly to contain 17 fuel plates in the top and bottom fueled region, making a total of 34 fuel plates. The 2.436-inch by 11.37-inch by 0.020-inch fueled portion of each plate is uniformly loaded with a matrix of 93% enriched UO2 and aluminum to give a total plate loading of 10.294 Gm U-235. Clad thickness is 0.01525 inches and water gap spacing is 0.116 inches. A 6.00 inch long water-filled center section separates the top and bottom fueled regions of the element. Total U-235 loading for the element is 350 grams.

UNCLASSIFIED

Arne J. Olsen 5/7/91
Classifier Date

The computer code KENO Va and the 16-group Master Library from Scale-3 processed through BONAMI were used for the calculations. This was accomplished through the use of the Scale-3 control module CSAS25. Scale-3 is a modular code system for performing standardized computer analyses for licensing evaluations. It was prepared for the U. S. Nuclear Regulatory Commission by Oak Ridge National Laboratory. The CSAS25 control module has been benchmarked against numerous known-critical systems by Babcock & Wilcox Company (B&W) in addition to many other organizations. Since B&W benchmark and validation work shows that this control module (with various option restrictions which B&W imposes on criticality safety calculations) never underestimates the actual K-eff value of a system by more than 2%, and since a statistical uncertainty is always associated with a KENO Va calculation, a bias value of 0.02 plus two-sigma is always added to the calculated value when criticality safety is the consideration.

Five calculations, representing variations in the element spacing were made. The results presented in Table 1 include the two-sigma uncertainty and the 0.02 bias.

Although this evaluation uses the same calculational techniques, codes, bias value and cross-section library as would an internal criticality safety evaluation, and although the writer is confident that the K-eff quoted is conservative for safety considerations, and although it has been independently reviewed by another criticality safety engineer who has included his QA statement; this memo does not address many items that would be required by our evaluation procedures (such as review of required procedures, double contingency evaluation, posting requirements, etc.). This memo is not intended to constitute a criticality safety evaluation as defined by our procedures, and must not be subject to audit as a criticality safety evaluation. It is rather, what our customer requested: a determination of the upper limit of k-eff for seven fully flooded NBSR fuel elements in an infinite sea of water.

M. N. BALDWIN

QA statement:

I have reviewed these calculations and concur with the model, the codes used, the calculational techniques, the cross-section library, the results and conclusions. I further concur that this evaluation is not and is not intended to be a criticality safety evaluation as defined by NNFD procedures.

J. W. Harwell

TABLE 1 - RESULTS OF CSAS25 RUNS -
SEVEN NBS ELEMENTS IN AN INFINITE SEA OF WATER

RUN ID	ELEMENT SEPARATION	UPPER LIMIT OF K-EFF *
NBSB	0.0 CM.	0.849
NBSC	0.5 CM.	0.876
NBSD	1.0 CM.	0.881
NBSEE	1.5 CM	0.874
NBSFF	2.0 CM	0.859

* calc. K-eff + two-sigma + 0.02

Figure Withheld Under 10 CFR 2.390

NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY
GAITHERSBURG, MARYLAND 20899

SHIPPING CONTAINER MODEL ST SERIES

FOR NBSR FUEL ELEMENT

DRAWN BY JACK STURROCK DATE 8-24-90	TRACED BY JACK STURROCK DATE 8-24-90
DESIGNED BY MAHESH SUTHAR DATE 2-7-92	APPROVED BY JOHN NICKLAS DATE 2-7-92
ALL DIMENSIONS IN FEET AND INCHES	SCALE: DO NOT SCALE
DWG. SIZE B/A	DRAWING NO. D-04-048

SHEET 1 OF 2

Figure Withheld Under 10 CFR 2.390

NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY GAITHERSBURG, MARYLAND 20899	
SHIPPING CONTAINER MODEL ST SERIES	
FOR NBSR FUEL ELEMENT	
JACK STURROCK 8-24-90	JACK STURROCK 8-24-90
MAHESH SUTHAR 2-7-92	JOHN NICKLAS 2-7-92
ALL DIMENSIONS IN FEET AND INCHES	SCALE: DO NOT SCALE
834	D-04-048
	SHEET 2 OF 2

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
[formerly National Bureau of Standards]
Gaithersburg, Maryland 20899

October 9, 1990

MEMORANDUM FOR Record

From: Les Slaback LS for LAS

Subject: **Certificate of Compliance**

Package: "ST" Series Container for NBSR Fuel Element

Specification: USDoT Type 7A

Date Tested: October 4-9, 1990

We herewith warrant and certify that the referenced containers have been manufactured and tested in accordance with:

10 CFR 71
49 CFR 173.411
49 CFR 173.412
49 CFR 173.415
49 CFR 173.417
49 CFR 173.461
49 CFR 173.465

Copies of relevant documentation are attached.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
(formerly National Bureau of Standards)
Gaithersburg, Maryland 20899

October 9, 1990

MEMORANDUM FOR Record

From: Les Slaback JS for LAS

Subject: DoT Type 7A Test of NIST "ST" Series Package

The "ST" series DoT Type 7A Radioactive Material Package is described in Enclosure 1. This package is designed to transport a single NBSR fuel element in compliance with 49CFR173 and 10CFR71.

The tested package is identical to those that will be used for transport, and in fact is itself expected to be used for transport. Prior to the sequence of tests, the package will be loaded with a dummy element as per the loading procedure (Enclosure 2). All tests required by 49CFR 173.465 are shown in Enclosure 3. These will be performed in sequence and the results recorded on Enclosure 3. Photographs will be taken of each test to document the physical conditions of the test.

Water Test: The sprinklers will be arranged so that all sides of the package are wetted. The simulated rainfall via sprinklers shall be measured and will exceed 2" per hour. A post test time delay to allow "soak in" is not required since this is a metal container. Following the test, the package will be examined for any deterioration or evidence of water entering the container.

Free Drop Test: The package will be dropped from a height of 4 foot onto a poured concrete pad. Because of the geometry of this package this test will be repeated such that

(1) the first drop is on the closed, welded end,
(2) the second drop is on the end with the removable plate, and
(3) the third drop is with the package horizontal.

Prior to the 4' free drop test the package will be dropped from a height of one foot on each corner of each end (four drops per end), as per 49CFR 173.365(c)(3). The package will be examined for any damage that could affect its integrity.

Penetration Test: A 6kg, 3.2cm diamater bar will be dropped so as to impact the center of the package from a height of 1 meter. The package shall be resting on an unyielding surface, positioned horizontally as it would be during a shipment. Because the bar must impact a curved surface of the package, care must be taken that the impact is not glancing. If the bar does not substantially recoil (bounce) vertically the test will be repeated.

The test bar will be examined for any deformity at the impact point (none permitted). The package will be examined for any damage that could affect its integrity.

Compression Test: This test will be applied in the geometry in which the package normally is positioned during shipment, that is with the longitudinal axis of the package horizontal and each end resting on an unyielding surface (concrete). The projected area of the package (5-1/2" diameter pipe, 70" long) is 2500cm^2. This requires the greater of (1) 1300 kg/m^2 x 0.25 m^2 = 325 kg (715 lbs.), or (2) 5 x 55lbs. = 275 lbs. Hence 325kg will be placed along the length of the package by placing three layers of lead bricks, each layer consisting of eight bricks (11.9 kg/brick), plus four additional bricks for a total of 28 bricks (333kg) on top of the package. This will provide the uniform compresion loading on two sides as required by 49CFR 173.365(d). The load shall remain in place for 24 hours.

Upon completion of this test, the package will be examined for any damage that could affect its integrity.

Upon completion of the test sequence, the package will be opened. The dummy element will be examined for any damage that would indicate a possible failure of the package containment effectiveness. The interior of the package will be examined for any damage that could affect its integrity. Any observed damage will be documented on the testing results form.

DESCRIPTION OF N.I.S.T. SHIPPING CASK

(DOT TYPE 7A PACKAGE "ST" SERIES)

The N.I.S.T. Shipping Cask consists of a carbon steel welded tube, 5 1/2" outside diameter x 1/8" wall x 70" long, welded closed on one end with a 3/8" thick carbon steel plate and a 1/2" thick carbon steel flange welded to the other. This flange is tapped with eight 1/4-20 holes to receive a cover plate and 1/8" thick neoprene gasket with the same hole pattern. The attaching screws protrude through the flange and have a 1/16" diameter hole for attaching a seal. The fuel element has wooden attachments at each end that are assembled to it outside the cask. The wooden attachments are almost the same diameter as the inside diameter of the tube to restrict movement. A 3/16" sponge tape is also applied on the flange end as a cushion backup. The fuel element assembly is inserted and the cover and gasket applied and bolted then properly torqued and sealed. The loaded cask weighs approximately 55 pounds. At approximately 1/2" from each end is a 6 1/2" x 1/4" thick square plate with four 3/4" diameter holes for attachment of carrying handles. These holes are also to be used for securing the cask during shipment.

The design of this shipping cask complies with the requirements of 49CFR173.411 and 173.412. Specifically 49CFR173.412(b) is met by the holes for a seal, 173.412(f) is met by the bolted closure and the non-volatile nature of the contents, 173.412(i) is met by the designed limited area opening (22 in^2) and eight securing bolts, 173.412(l) is met by the design detail that the tie down flange is not an integral part of the containment portion of the package.

NIST "ST" SERIES DOT TYPE 7A PACKAGE

Loading, Unloading, and Quality Assurance Procedure

Loading:

1. Survey the interior and exterior of empty package and perform contamination checks.
2. Inspect package for any damage that could affect its integrity, e.g. cracks, weld failures, major deformations.
3. Inspect bolts and thread for condition.
4. Assemble wood attachments to element.
5. Insert element, assuring that it is in contact with the rear of the package.
6. Insert package and plate, with gasket, assuring that it is snug against the wood insert on the element.
7. Tighten all end plate bolts snugly, i.e., to 10 ft.lbs., but not more than 14 ft.lbs.
8. Attach the security seal.
9. Apply required shipping labels.

Unloading:

1. Survey the package. Perform a contamination test around the end plate gasket.
2. Inspect the package for any damage that might indicate damage to the element.
3. Verify the security seal is in place and is the same as indicated on the shipping papers.
4. Remove the end plate.
5. Perform a contamination check on the accessible interior surface.
6. Remove the fuel element.
7. Perform a contaminate check on the interior of the package.
8. Perform an initial inspection of the elements for any observable damage.
9. Remove the wood end pieces. Check each one for contamination.
10. Inspect the package for any damage or deterioration.

SINGLE FUEL ELEMENT CONTAINER
SHIPPER'S CHECKLIST

1. Assure, primarily through visual inspection, that the container is intact and serviceable. All required QA procedures must be completed prior to shipment. _____

2. Package has been surveyed for external radiation levels and swiped for contamination (660 dpm alpha/300 sq. cm. and 6600 dpm beta/300 sq.cm.) _____

3. Type A packaging security seal has been applied. _____

4. Package has been labelled with both Yellow III and Fissile III labels. _____

5. Transport vehicle has been placarded with RADIOACTIVE placards on four sides. _____

6. Verify criticality safety by insuring that package is segregated from other fissile material at all times (i.e., package must <u>not</u> be loaded on vehicle with any other fissile material). Shipping papers <u>must</u> indicate this segregation requirement. _____

7. Check that shipment meets the additional requirements for Fissile Class III shipments:

   (1) Exclusive use vehicle (for NIST alone)
   (2) Escorted (driver has companion)
   (3) No other RAM packages aboard _____

8. Shipping papers include the description required by 172.203(d) for Fissile Class III shipments. _____

9. All required shipping documentation has been completed and provided to the driver. _____

10. Written instructions required for exclusive use shipments have been provided to the driver. _____

Enclosure 3

PACKAGE TYPE 7A TEST PROTOCOL

Package Tested: Shipping Container for Single NBSR Fuel Element

Date of Test: 10/4/90

Package ID: PROTOTYPE

	PASS	FAIL
1. Pretest inspection (complies with drawings, no construction defects, no corrosion, no distortions)	✓	
2. Water spray test (Start time: 13:40) (The water spray test shall simulate exposure to rainfall of approximately 5 cm (2 inches) per hour for one hour. **Time elapsed** 1:05 hrs. **Depth of water collected** > 3" inches.)	✓	
Observation: NO Evidence of Deterioration		
3. Free drop test (Time: 15:05) (Free fall drop of 1.2 meters (4 feet) onto a flat, horizontal, unyielding surface.)	✓	
Observation: Chipped paint but no Damage to structural integrity		
4. Penetration test (Time: 15:15) (One meter (3.3 feet) vertical drop of penetration test bar onto the center of the weakest part of the packaging specimen.)	✓	
Observation: Chipped paint and small (less than 1mm) scratch in surface		
5. Compression test (Start time: 09:00) 10/5/90 Stopped 9:40 AM 10/9/90 (Compression test shall last for at least 24 hours and consist of 325 kg. of lead bricks placed along the length of the container, with the container in a horizontal position.)	✓	
Observation: The test was started at 16:15 10/4/90 but the bricks fell during the night analogue, Registered using 30 bricks totalling 357 kg		

Remarks: Note that it was raining moderately during the water spray test.

This package has/~~has not~~ passed all DoT Type 7A tests (49CFR 173.365).

Tests Conducted By: Timothy F. Mengers
Print Name

Timothy F. Mengers
Signature

Tests Observed By: JOHN SHUBIAK
Print Name

John Shubiak
Signature

January 10, 2000

MEMORANDUM FORFile

FROM Jim Tracy
QAPM

SUBJECT Maintenance/repair of cask USA/9246/AF s/n #3 and #4

This is a memo to document maintenance performed on the above referenced casks. The maintenance was performed on both casks.

The two casks were painted. This was needed because the name of the shipper (which was permanently marked on the cask) was changed. The cask was painted to reflect this change. In addition the weight of the cask was removed from the marking. Since the cask weight is less than 110 pounds this is acceptable. Both casks were painted and then marked with the following:

Radioactive Material, fissile, NOS UN2918
USA/9246/AF Type A
NIST Model ST s/n 3 (4 for the other cask)

In case of emergency
Notify 804-522-5003
BWX Technologies NNFD
P.O. Box 785
Lynchburg, VA 24505

NIST
I270 and Quince Orchard Road
Gaithersburg, MD 20899

November 26, 1999

MEMORANDUM FOR File

FROM Jim Tracy
QAPM

SUBJECT Maintenance/repair of cask USA/9246/AF

This is a memo to document maintenance performed on the above referenced casks. The maintenance was performed on both casks.

The two casks were painted. This was needed because the name of the shipper (which was permanently marked on the cask) was changed. The cask was painted to reflect this change. In addition the weight of the cask was removed from the marking. Since the cask weight is less than 110 pounds this is acceptable. Both casks were painted and then marked with the following:

Radioactive Material, fissile, NOS UN2918
USA/9246/AF Type A
NIST Model ST s/n 1 (2 for the other cask)

In case of emergency
Notify 804-522-5003
BWX Technologies NNFD
P.O. Box 785
Lynchburg, VA 24505

NIST
I270 and Quince Orchard Road
Gaithersburg, MD 20899

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

June 11, 1996

MEMORANDUM FOR File

FROM Jim Tracy
QAPM

SUBJECT Maintenance/repair of cask USA/9246/AF

This is a memo to document maintenance performed on the above referenced casks. The maintenance was performed on both casks.

On March 11 and 12 Forrest Clark and Mark Cassells replaced the 1/4-20 bolts currently on the cask with identical stainless steel certified 1/4-20 bolts. They also refurbished the threads by reaming them with a thread tracer.

NIST

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

May 22, 1996

MEMORANDUM FOR Jim Tracy
Program Manager for Radioactive Material packages
245/C101

FROM Mahesh Suthar/Paul Liposky
Reactor Engineering
235/A151 x6266

SUBJECT Proposed design changes to the Shipping Container for NBSR fuel elements.

In order to improve handling, assembly and disassembly of the above subject shipping container, the following minor modifications to the wooden supports within the container are proposed (Refer to drawing no. D-04-048, rev. 3):

(i) Decrease diametrical dimensions by 1/8" of item no. 3, 4, and 5 (Top, Bottom, and Nozzle Supports).

(ii) Replace 2" long wood screws on item no. 3 (Top Support) with 1/4"-20 bolts and tee nuts.

(iii) Drill a 1/4" diameter thru hole in the center of item no. 3 (Top Support) and install a 1/4" diameter tee nut at the bottom of the lower piece as shown. This will facilitate to remove the Top Support from the fuel element by inserting a 1/4" diameter threaded rod, threading it into the tee nut and pulling the whole assembly out.

These modifications will provide for easier insertion and removal of the fuel element from the container and will eliminate past difficulties experienced in some removals. At the same time, it will provide a positive and reliable hold on the element within the container. Accordingly, it is our conclusion that the proposed modifications do not change any of the safety considerations of the shipping container.

Please review the proposed modifications. We will proceed upon receipt of your approval.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION REPORT
Model No. ST Package
Certificate of Compliance No. 9246
Revision No. 0

By application dated February 7, 1992, as supplemented February 14, 1992, the National Institute of Standards and Technology (NIST) requested approval of the Model No. ST package as a Type AF package. Based upon the statements and representations contained in the application, as supplemented, and the conditions listed below, we have concluded that the Model No. ST package meets the requirements of 10 CFR Part 71.

REFERENCES

National Institute of Standards and Technology application dated February 7, 1992.

Supplement dated February 14, 1992.

DESCRIPTION

A closed steel pipe for the transport of an unirradiated research reactor fuel element. The pipe is a 5-1/2-inch OD carbon steel pipe, approximately 71 inches in length, with a closed bottom end and flanged top end. The top end is closed by a cover plate, which is 1/4-inch thick and 6-1/2 inches in diameter, and a gasket. The cover plate is secured to the pipe flange by 8 cap screws. A wooden nozzle support and top support position the fuel assembly within the pipe. The package weighs approximately 75 lbs., including the fuel element.

DRAWINGS

The packaging is constructed and assembled in accordance with National Institute of Standards and Technology Drawing No. D-04-048, Sheet 1, Rev. 2, and Sheet 2, Rev. 2.

CONTENTS

(1) Type and form of material

Unirradiated NBSR fuel element composed of enriched uranium and aluminum.

(2) Maximum quantity of material per package

One fuel element containing 360 grams U-235.

(3) Fissile Class III

Maximum number of packages per shipment 2

STRUCTURAL EVALUATION

The package is limited to a Type A quantity of radioactive material. In addition, the quantity of fissile material per Fissile Class III shipment (two packages with one fuel element each) is limited to less than the critical mass of U-235. Therefore, the package was not evaluated for accident conditions, since the criticality safety of the fissile material does not depend on the packaging to maintain geometry.

The package was evaluated as a Type A package, and was subjected to the normal conditions tests, including water spray, free drop, penetration and compression tests. The package was dropped 4 feet onto a concrete pad in three different orientations. Prior to the 4-foot drops, the package was dropped from 1 foot onto each of the quarters of the top and bottom rims. The fuel assembly was maintained within the packaging, and there was no damage to the fuel assembly under normal conditions tests.

There are no lifting or tie-down devices which are a structural part of the package.

CRITICALITY EVALUATION

The applicant evaluated the shipment as a Fissile Class III shipment with a maximum of two packages per shipment, with one fuel element per package. For normal conditions, the applicant reported a series of criticality analyses using the KENO Va computer code with the 16-group master library cross section set. The applicant reported that four fuel elements, without the packaging, were subcritical under optimum conditions of light water moderation, reflection and fuel spacing. The maximum value of k-eff, including bias and statistical uncertainty, was 0.734.

For accident conditions, the quantity of fissile material in two fuel elements is less than the minimum critical mass under optimum conditions of geometry, moderation and reflection from light water.

The NRC staff performed an independent criticality analysis for normal conditions, using the KENO Va program in the SCALE computer code system and the 27GROUPNDF4 cross section set. The NRC calculations were performed assuming that an array of four packages was fully flooded and reflected. The maximum k-eff was 0.4853 ± 0.0038.

THERMAL EVALUATION

The contents are limited to unirradiated enriched uranium, which has negligible decay heat.

CONTAINMENT EVALUATION

The contents are limited to a Type A quantity of radioactive material. The package prevents the loss or dispersal of radioactive material under normal conditions of transport as demonstrated by physical testing.

SHIELDING EVALUATION

The contents are limited to unirradiated enriched uranium, therefore external radiation levels are low. The operating procedures require that radiation surveys be made prior to each shipment.

OPERATING PROCEDURES, ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

The application includes loading, unloading, and maintenance procedures for the package, and a shipper's checklist. Procedures include steps for visual inspection of the packaging, radiation surveys, and application of a security seal.

CONDITIONS

In addition to the requirements of Subpart G of 10 CFR Part 71, the package shall be prepared for shipment, operated, and maintained in accordance with the loading, unloading, and quality assurance procedures in the application. Prior to each shipment, the shipper shall make the determinations specified in the NIST "ST" Series Shipping Container Shipper's Checklist in the application.

CONCLUSIONS

Based on the review of the statements and representations contained in the application and the conditions listed above, we have concluded that the Model No. ST package meets the requirements of 10 CFR Part 71.

Charles E. MacDonald, Chief
Transportation Branch
Division of Safeguards and
Transportation, NMSS

Date FEB 2 6 1992

Figure Withheld Under 10 CFR 2.390

NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY GAITHERSBURG, MARYLAND 20899	
SHIPPING CONTAINER MODEL ST SERIES FOR NBSR FUEL ELEMENT	
DESIGNED BY: JACK STURROCK DATE: 8-24-90	DRAWN BY: JACK STURROCK DATE: 8-24-90
CHECKED BY: MAHESH SUTHAR DATE: 2-7-92	APPROVED BY: JOHN NICKLAS DATE: 2-7-92
ALL DIMENSIONS AND TOLERANCES ARE IN INCHES	SCALE: FULL
DIV. 856 REVISION NO. 4	DRAWING NO. D-04-048

Figure Withheld Under 10 CFR 2.390

NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY GAITHERSBURG, MARYLAND 20899	
SHIPPING CONTAINER MODEL ST SERIES	
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DIV: 856 REVISION NO: 4	DRAWING NO. D-04-048