IAEA-TECDOC

GUIDELINES DOCUMENT ON PREPARATORY WORK PRIOR TO RETURN OF SPENT FUEL OF US-ORIGIN FROM FOREIGN RESEARCH REACTORS

DRAFT

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D R A F T

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1. INTRODUCTION

PURPOSE

101. This 'Guidelines' document is designed to help research reactor operators in developing countries that possess spent fuel containing enriched uranium of United States origin to prepare their fuel for shipment to the United States should they decide to participate in the US Department of Energy (DOE) program under the United States Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (the "Policy")[1].

SCOPE

102. This guidance document is intended to have general applicability to the shipment of irradiate fuel from any research reactor. However, the particular characteristics of the research reactor facilities requires some flexibility in the fulfillment and application of the guidance given in this document. Therefore, it is necessary that users of this document make a conscious and justifiable selection of the information offered. In addition, the extent of detail in the application of the guidelines will depend on the characteristics of the facility and the irradiated fuel, especially its radioactivity level.

103. The scope of this document is to provide guidance for all the steps necessary to prepare for shipment and to ship to the U.S. MTR and TRIGA fuel containing enriched uranium of U.S. origin

104. The recent DOE Record of Decision regarding the above Policy will require operating organizations to make several decisions concerning the operation of their facilities and the shipment of irradiated fuel. This guideline document is not intended to play a major role in these decisions.

OBJECTIVE

105. By presenting a step-by-step process with samples of required technical and administrative documentation, this guide is intended to assist research reactor personnel to prepare their spent fuel for shipment off-site.

BACKGROUND

106. On May 13, 1996, the U.S. Department of Energy (DOE) announced the Record of Decision for the Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel. Based on this policy, subject to certain conditions, the U.S. will accept and manage in the U.S. foreign research reactor MTR and TRIGA spent nuclear fuel that was originally enriched in the U.S. The policy will allow for the acceptance of spent fuel generated up to ten years following the implementation of the policy, with an additional three year allowance for final shipment to account for cooling time, logistics, and delays.

107. Under the terms of the policy, aluminum based spent fuel will be accepted at the Savannah River Site of DOE, and TRIGA fuel will be accepted at the Idaho National Engineering Laboratory. All shipments will be in accordance with agreed upon schedules.

108. The preparation of spent fuel for shipment off-site has until recently been part of the operation of intermediate and high power research reactors primarily. Based on the announced policy, many facilities will be shipping spent fuel for the first time. In many cases, these facilities are of low power level and the preparation and shipment of spent fuel will involve more radioactivity than ever previously handled at the facility.

109. The shipment of irradiated fuel is a highly regulated activity requiring extensive coordination between the reactor facility operating organization and the shipping cask vendor, the transportation company, international, national and local governmental agencies, port authorities and the receiving facility. Generally, the operating organization has the responsibility for the entire process including coordination. First time arrangements for the shipment of irradiated fuel , especially internationally, is a long lead time endeavor and ample time should be allowed to perform the many required tasks.

110. The characteristics of research reactors include a large variety of designs, a wide range of power levels, different modes of operation, particulars of siting and differences among operating organizations, in particular concerning their resources. These characteristics require flexibility in the setting and fulfillment of basic requirements for the shipment of spent fuel off-site. These circumstances have been taken into account in the preparation of this guidance.

111. A list of publications related to the safety of shipping spent fuel from research reactors is given at the end of this guidance.

STRUCTURE

112. This guidance document consists of a main text, appendices and annexes.

113. The main text describes the implementation of the program as it will be administered by DOE (Section 2); the technical operations required of the operating organization for the preparation of the fuel elements for shipment (Section 3); the selection of a transportation package (shipping cask) (Section 4); setting up a Quality Assurance program (Section 5); preparation of written procedures, (Section 6); training of personnel (Section 7); USDOE contract considerations (Section 8); local arrangements (Section 9); arrangements with other countries (Section 10); safeguards and physical protection during transport (Section 11); preparations preliminary to a shipment (Section 12); records and reports (Section 13); and a summary of arrangements needed (Section 14). Following these is a list of references and a bibliography, as well as appendices showing examples of the various forms, documents, calculations, etc.

2. PROGRAM IMPLEMENTATION

To be written once DOE has issued its implementation program.

3. CLASSIFICATION OF IRRADIATED FUEL

GENERAL

301. The first requirement for the reactor operator is to identify and categorize the spent fuel desired to be shipped from the reactor facility. Enrichment, materials of construction, cooling time, and integrity of the fuel cladding are parameters the reactor operator should take into consideration in identifying specific fuel assemblies proposed for shipment. Generally, fuel that is of higher enrichment and longest cooling time since irradiation should be shipped first. Fuel with non-intact cladding requires special packaging which might delay shipment of intact fuel. The reactor operator should identify more assemblies than is planned for shipment so that substitutions can be made later in the process, if necessary.

302. DOE's receipt process requires that the fuel proposed for shipment be fully categorized. It must be classified based on the materials of construction, physical dimensions, decay heat load, dose rate, fissile content, selected isotope content and the physical condition of the fuel. These parameters are determined from the fabrication drawings and specifications, the fabrication quality control records, and the operating history of the fuel assembly. Figures 3.1 and 3.2 present a typical compilation of this information in the format normally required by the receiving facilities at Savannah River and Idaho. Normally each fuel assembly will be identified with an embossed number and this number will be utilized when compiling data. If an identifying number is not present or will be removed during cropping of the fuel assembly, a new number must be applied to identify the assembly uniquely either by embossing or by tag.

303. While the examples in Figures 3.1 and 3.2 do not contain descriptions of base materials (clad & side plates, internal poisons, end fittings, etc.), this information is required by the receiver.

PHYSICAL DIMENSIONS

304. It must be determined that the physical dimensions of the fuel assembly as shipped will allow it to fit into the shipping container basket (restraining device) without damage to the assembly. In some cases, it may be necessary to trim away those portions of the fuel assembly which do not contain fuel (e.g., grid plate fittings, end boxes) in order for the assembly to fit into the shipping container basket. The usual source of information for these determinations is the fabrication drawings and specifications.

305. The method for trimming of the fuel assembly will depend on the radioactivity of the assembly. It may consist of manual trimming with minor shielding, use of an underwater powered saw or trimming in a hot cell. In all cases, radiological protection of personnel and the environment is essential. Methods must be in place to insure chip collection and to insure that the integrity of the fueled portion of the assembly is maintained.

306. In most cases the final assembly is placed into a basket or other restraining device whose dimensional tolerances do not allow for large clearances between it and the fuel assembly and between the basket and container. A determination shall be made that the physical dimensions are well known and are compatible with the basket which will be used.

307. Fabrication drawings for the fuel elements and for any grouping of elements (subassemblies and assemblies) representing the proposed shipment configuration need to be identified. DOE will require four copies of these drawings as part of the descriptive Appendix A to

your contract (see example in Appendix I). The drawings should document the design dimensions, and physical configuration of the fuel. They should clearly identify the location and dimensions of the fuel section and should show the location of the assembly identification embossing if applicable.

308. In most cases, the nominal dimensions of the fuel assembly will not change with irradiation or during spent fuel storage. If this is not the case, post irradiation or storage dimensions will be necessary.

MATERIAL DESCRIPTION

309. The basic materials of the fuel assembly, as shipped to the receiving facility, shall be described including the weight of each material. The sum of all weights should equal the known weight of the assembly.

310. Subassembly and full assembly descriptions will be necessary for fuel rods or plates that are grouped into a larger structural unit. This will apply to virtually all of the MTR fuel shipped from foreign research reactors. The descriptions should correspond the shipment configuration and to the fuel design represented on the drawings to be supplied.

SUMMARY OF IRRADIATION HISTORY

311. From operating records, a general statement of the irradiation history for the fuel will be generated. If fuel of several different irradiation histories is proposed for shipment, the descriptions of each history should be developed. This is a summary description of the nominal fuel performance and post-irradiation decay, not a description for each element.

FISSILE CONTENT

312. The pre-irradiation amounts of uranium-235 and total uranium in the fuel assembly is required by the receiving facility. In addition, the post-irradiation amounts of uranium and uranium-235 are required by the receiver and for the selection of a shipping container to insure that the amount of fissile material permitted in the container is not exceeded.

OTHER RESIDUAL ACTIVITIES

313. In addition to the amount of fissile material contained in the fuel assembly, the receiving facility will require a calculation of the activity of several specific isotopes of uranium and plutonium and the total plutonium, thorium, and neptunium present in the irradiated fuel. These amounts will need to be calculated based on the operating history and the variation in characteristics throughout the reactor core. Average values, maximum values, and uncertainties should be estimated for the assemblies proposed for shipment. Appendix A to the contract requires both a summary tabulation and a tabulation for each assembly whose identification number is listed as a candidate for possible shipment. An example calculation and parameters required are given in Appendix II.

DECAY HEAT

314. The decay heat load is required by the receiver and for the selection of the shipping container to insure that the permissible heat load of the container is not exceeded.. The decay heat load of a fuel assembly is determined by its operating history; i.e., from the documented burn-up and decay of each assembly. The reactor operating log is the prime source of this history.

315. Calculation of decay heat load for low power reactors or reactors which operate with a low duty cycle is complicated by the fact that the fuel assemblies are old with the burn-up spread over a long period of time. Fortunately, simple calculations with conservative assumptions will demonstrate that the decay heat load in these cases is low and well below the limitations imposed by the shipping container or the reprocessing plant.

316. Unless computer programs for detailed decay heat calculations are already in use at the facility for other reasons, it is recommended that a simplified, conservative technique be utilized. Appendix II presents one of many techniques for performing this calculation.

ACTIVITY AND DOSE RATE

317. The mixed fission product activity (and in some cases, the activity associated with the clad and structural materials) is required by the receiver and for the selection of the shipping container. Conversion of this activity into a dose rate on the outside of the shipping container is required before finalizing the selection of the shipping container. For some fuel assemblies involving low fission product activity, it may be possible to measure the dose rate from a fuel assembly directly and use this data as the basis for calculations.

ADDITIONAL INFORMATION

318. The dates on which each fuel assembly was placed in the core must be determined. The last date of irradiation in the core for each fuel assembly must be determined. The irradiation history for each fuel assembly should be examined to determine its burn-up in MWD. The minimum number of cooling days between removal from service and shipment for each fuel assembly shall be determined.

4. SELECTION OF A TRANSPORTATION CASK

GENERAL

401. Transportation packages utilized in the international transport of spent nuclear fuel are designed, constructed, maintained, loaded and sealed in accordance with performance standards recommended by the IAEA and as adopted and enforced by national competent authorities. After review by a national competent authority, a certificate of approval (sometimes called a certificate of compliance) is issued. The certificate details the permissible content for the cask and the main conditions for use. Often, use of the package in a country other than the country of design and fabrication will require approval of the new-use country. Additional conditions of use may be contained in the quality assurance plan for the package.

402. Selection of a transportation cask is the process of comparing its specifications as contained in the Certificate and detailed drawings with the data resulting from Section 3 and the considerations of this section.

AVAILABLE CASKS

403. While many casks have been approved internationally for use in the shipment of spent fuel, only a few are suitable for the shipment of spent fuel from research reactors. Amongst these are the five listed below in Table 4-1. Additional casks are being approved and may be available by the end of 1997. A summary of the specifications for each cask is given in Appendix III.

TABLE 4.1 AVAILABLE CASKS

CASK IDENTIFICATION	WEIGHT (MT)	NUMBER OF CASKS	CONTACT
NAC-LWT	23.2	5	NAC INTL
NLI _		5	NAC INTL
TN7-2	24.5	2	NCS
GNS 11	13.6	2	GNS
IU -04	18.9	5	TRANSNUCLEAIRE

CASK WEIGHT, DIMENSIONS AND LOADING OPTIONS

404. The cask selected for use must be capable of being accommodated and loaded safely within the reactor facility. Compatibility assessment will include crane capacity, maximum crane hook height, allowable floor loading and spent fuel pool depth. Also to be considered are the physical size of doorways, the area and clearances for handling the cask in the building, spent fuel storage pool, and hot cell. Sometimes, it is necessary to obtain assistance in these assessments from the reactor building architect, crane manufacturer, cask supplier and professional riggers. It may be required that the crane be up-graded or that shoring be placed under floors so that they will carry the heavy loads.

405. If the cask is to be loaded underwater using the reactor pool, it is important to verify that the reactor pool floor will withstand the cask load without breaching the integrity of the pool. If, for example, the cask is unintentionally placed on foreign material on the bottom of the pool (i.e., a bolt), the weight of the cask may push the bolt through the liner breaching the integrity of the pool. Unless recently performed, the crane should undergo a safety inspection, which may include load testing, before use with the shipping cask.

406. The cask may be transported to the reactor facility on a flat bed trailer or a rail car. It will be necessary to verify that the cask transport system is compatible with the equipment at the reactor facility.

407. In some cases, the shipping cask may be so large and heavy that it is impossible or undesirable to load the spent fuel inside the facility. A transfer flask (a lighter fuel transfer cask) may then be used to transfer one or more fuel assemblies from the facility to the large cask outside the facility. For this technique, a complete system will be provided by the cask vendor.

CASK AND FUEL ASSEMBLY COMPATIBILITY

Dimensions of the Fuel Assembly

408. Each shipping cask has approved basket designs which accommodate fuel assemblies of specific physical dimensions. It must be determined that the fuel assemblies will fit into the basket and into the shipping cask without damage to the fuel assembly or interference with the sealing of the shipping cask. It may be necessary to remove those portions of the fuel assembly which do not contain fissile material (e.g., grid plate fittings, end boxes) in order for the assembly to fit into the basket.

409. If acceptable baskets are not included in the Certificate, new baskets will have to be designed, fabricated and licensed. In this case, assistance from the cask owner and DOE should be obtained.

Irradiation Data

410. The Certificate for the shipping cask will contain limitations on the content of fissile and fissionable material in a fresh fuel assembly, the geometry, the burn-up, the total decay heat, and the cooling time before shipment. If the limitations are beyond the specifications for the fuel assemblies, an amendment to the Certificate must be obtained with the cooperation of the cask owner. In this case, DOE assistance should also be obtained.

Cask Handling Capabilities

411. It is the responsibility of the operating organization to insure that truck or rail transportation of the cask to and from the site is possible and that handling equipment and cranes of adequate capacity are available. For international transport, the shipping cask may be in a closed ISO type container.

Compatibility with the DOE Receiving Facility

412. The operating organization must have verification that the shipping cask selected for use is compatible with the facilities at the DOE receiving site and is acceptable to them. Appendix B to the contract between the operating organization and DOE will specify the cask and the approval and documentation requirements which must be met. An example is provided in Appendix IV.

ARRANGEMENTS FOR USE OF SHIPPING CASK

413. Following the selection of a shipping cask, a contract with a cask supplier or agent is necessary. The cask supplier will proved the safety documentation for the cask, the Certificate and generic operating procedures which may be used to develop specific operating procedures for the reactor facility. The cask supplier or agent will be responsible for the validation of the Certificate and the registration for use in the countries of transport.

5. QUALITY ASSURANCE PLAN

GENERAL

501. Many countries require that all aspects of a program to return spent fuel to its country of origin be conducted according to an approved QA plan. If such a requirement does not exist, a QA Plan should nevertheless be prepared by the operating organization and subjected to an appropriate review and approval. While the QA plan should cover all aspects of the spent fuel shipment process, it should be graded in that the QA requirements for each aspect of the process should be commensurate with the importance of the aspect to safety and safeguards.

502. In addition, the use of a container whose Certificate of Compliance permits use under the general license provisions of the USNRC, requires that the user have a QA plan. This plan must include provision for pre-loading inspection and testing, loading and post-loading testing of the container and should be developed to a level consistent with the requirements of the certificate and the radioactivity of the fuel to be shipped.

503. ln some instances, the operating organization may have a QA plan already in existence for routine operation of the research reactor. This plan may be modified to include shipment of the spent fuel.

PREPARATION GUIDELINES AND CONTENT

504. Guidelines for the preparation of a QA plan may be found in many places. Among such places are:

a) IAEA Safety Standard Safety Series 35-S2
b) lAEA Safety Practice SS113
c) USA Subpart H 10CFR71
d) USA ANSI/ANS NQA-1
e) USA ANSI/ANS 15-18 (adaptation required)

505. In addition, many countries may provide specific guidance for the preparation of a QA plan and this should be utilized.

506. The QA plan should describe the organization, methods of document control, inspections during receipt, loading and shipping of the container, procedures for non-conforming parts and materials, and corrective actions and records. The plan should require that all operations during the shipment process, including the preparation of the fuel for shipment, be performed according to written and approved procedures. The plan should provide for its periodic review and audit at those facilities where regular or repetitive shipments will be made. At those facilities where the plan will be used infrequently, it should be reviewed before beginning preparations for a shipment

507. Appendix V presents a representative QA plan. This plan has been used for shipments of fuel from a 20 MW reactor facility using the BMI-1 container.

REGULATORY APPROVAL

508. The regulatory body may require that the QA plan be submitted to it for review and approval before the initial use of the certified container. In addition, the regulatory body may require that it approve the container vendor's and the contract carrier's QA requirements before the initial use of the certified container. Sufficient lead time should be allowed for these approvals.

QA REQUIREMENTS OF CONTAINER VENDOR

509. The operating organization must obtain the current Certificate of Compliance, including the current QA requirements, from the container vendor. These must be reviewed to insure that all aspects of the container use are permitted and that all requirements for use of the container can be met by the operating organization.

QA REQUIREMENTS OF CONTRACT CARRIERS

510. If contract carriers (land, air, sea) are utilized, the operating organization must obtain the current QA requirements of the carrier. These must be reviewed to insure that all requirements of the operating organization are met by the carrier and that all requirements of the carrier are met by the operating organization.

USE OF THE QA PLAN DURING THE SHIPPING PROCESS (FORMS)

511. The QA plan should be developed so that it becomes a useful, working document during the spent fuel shipment process. It should contain forms which will be completed during the process insuring that all required steps are performed.

The sample QA plan presented ln Appendix V includes representative forms which have been utilized for shipments of spent fuel.

6. PREPARATION OF PROCEDURES

GENERAL

601. The preparation and shipment of spent fuel is an infrequent process at most research reactors. For this reason and because of the complexity of the task, it is important that detailed procedures be prepared, approved and utilized to ensure that all steps in the process are performed safely and properly. The procedures should include a list of facility systems which must be operating during each step of the process (e.g., area monitors, ventilation, air monitors),establishment of a log book, personnel requirements, and provisions for the verification of crucial operations by two individuals. This includes preparation of the facility and the fuel assemblies for shipment, receipt and testing of the shipping container, movement of the container in the facility, loading of fuel into the container, closure, sealing and testing container, preparation for shipment and shipment. The procedures should also include special security requirements. Example procedures are given in Appendix VI.

602. Guidance for the preparation of procedures including the form and content may be found in the following documents.

a) IAEA Safety Standards Safety Series 35-S2
b) IAEA Safety Practice Safety Series 35-P5
c) ANSI/ANS 15-1 1990.

603. Details of handling instructions, tests and inspections, and special equipment needed for use of the cask may be found in the cask operating manual supplied by the cask vendor.

PREPARATION OF THE FUEL ASSEMBLY

604. Procedures shall be prepared for the preparation of the fuel assemblies.

605. The preparation of fuel for shipment must be performed well in advance of the receipt of the shipping cask. The process is work intensive and should not be done simultaneous with the loading of the cask.

606. The preparation of the fuel assembly will be determined by the type of assembly (e.g., standard, control, removable plate) and the size of the assembly which the selected cask will accommodate. While many casks have baskets that will accommodate full length fuel assemblies, some casks will have a larger capacity if the fuel free portions of the assemblies are trimmed away.

607. If the assemblies are not trimmed, little, if any, preparation will be required for assemblies with no clad failure. Assemblies with cladding failures require special treatment. Cladding failures may be detected by chemical and radioactive spectrometric analysis of the storage cask water or air. If in spite of these analyses, doubt still exists concerning cladding integrity, other additional techniques should be employed such as inspections by periscopes or underwater TV. Instructions for the canning and shipment of an assembly with cladding failure should be obtained directly from the DOE receiving facility.

608. Fuel assemblies have been trimmed using several techniques. Low dose rate assemblies have been trimmed by hand using temporary shielding and manual and power hack saws. High dose rate assemblies have been trimmed using a hot cell with remotely operated

cutting tools or underwater in a pool using an underwater cut off saw. Two typical operating procedures for trimming of boxes from each end of an MTR assembly may be found in Appendix VI. The first procedure is for simultaneously trimming end boxes using an underwater duel blade cut off saw. The second procedure is for trimming end boxes in a hot cell. In both cases, provisions must be made to collect the radioactive chips which result from the operation.

609. Extreme caution should be observed so as not to cut into the fueled section of the assembly which will release fission products. This can be accomplished by the use of assembly restraining devices during trimming and by two individual verification of positioning and effectiveness of restraining device.

610. Note that in all cases, provisions must be made to pick up the trimmed assembly if the lifting bale is removed during the trimming. This is sometimes done by fabricating special tools such as a remotely operating grip device or a T shaped tool which is passed through a coolant channel and turned 90 degrees lifting the assembly from the bottom. Provisions must also be made for safe storage of the trimmed assembly if the existing storage racks use the (now removed) end fittings for assembly stability in the racks.

RECEPTION AND MOVEMENT OF THE SHIPPING CASK

611. Procedures are required for the reception of the cask at the facility and the movement of the cask within the facility. The procedures should specify the equipment (e.g., air samplers, survey meters, step ladders) that is necessary for cask reception and movement and the cask should not be brought on site until this equipment is available and functioning.

612. All casks should be considered contaminated and the reception procedures should address this possibility. In addition, the cask may contain liquids from its last use. These liquids are sometimes contaminated or radioactive and must be collected and disposed of safely. The baskets in the cask should be assumed to be contaminated and should be handled accordingly. The sample QA plan presented in Appendix VI contains representative reception procedures.

613. Movement of the shipping cask must be pre-planned accounting for the load bearing capabilities of floors and the crane. In cases where experience in handling heavy objects is lacking, it may be necessary to employ consulting riggers to provide advice during the movement. Appendix VI presents sample procedures for movement of the cask from the receiving area into the fuel loading area.

614. The spent fuel shipping cask may be loaded in a spent fuel pool, a hot cell or the reactor pool. In all cases a mishandled cask will lead to serious problems. For example, dropping the cask while lowering it into the reactor pool may damage stored fuel, the reactor structure or the integrity of the pool. The cask may wedge itself into to pool making it difficult to retrieve.

PRE-USE INSPECTION AND TESTING OF THE CASK

615. Before off-loading the cask from its transport vehicle, a visual inspection should be performed to insure that there has been no damage to the cask or its lifting devices during transit.

616. Before inserting fuel into the cask an internal inspection of the cask and its baskets should be performed to ensure all equipment and surfaces are damage free and in accordance with requirements.

617. In some instances, verification must be made that the baskets contain neutron absorbing materials. If the cask QA plan does not specify a method, the operating organization must develop a technique. One such technique involves the use of a neutron source and a neutron detector such as a neutron survey meter with the basket wall containing the poison material placed between them.. The system may be checked for response using a known, sample absorbing material (e.g., boral.)

LOADING THE SHIPPING CASK

618. Procedures are required for the loading of the shipping cask. The recommendations of the cask vendor should be incorporated into the procedures.

619. If it is impossible to bring the shipping cask into the reactor building for loading, it will be necessary to leave the cask outside and use a transfer flask to bring the irradiated assemblies to the shipping cask. This transfer flask provides the shielding and the containment for the fuel. The transfer flask mates with the shipping cask such that it is not possible to spill its contents. The transfer flask mates in such a way as to provide shielding during the transfer from the flask to the shipping cask. These devices operate as a system as described in the Certificate. This type of loading is usually performed by the personnel of the cask vendor with members of the operating organization performing the fuel movements in the facility.

620. When loading a cask in a pool or hot cell, most procedures require that the empty basket be placed into the cask before placing the assemblies into the basket.

621. The loading scheme into the baskets must be recorded and made available to the receiver.

622. The loaded cask is then closed using the directions of the vendor and returned to the receiving area to prepare for shipment.

623. Appendix presents sample procedures which have been used to load a cask.

PRESHIPMENT TESTING OF THE LOADED CASK

624. Procedures are required for the pre-shipment testing of the cask.

625. The Certificate for the cask will specify the tests required before the cask may be shipped. These test usually require a time period for parameters to approach equilibrium. The testing may include leak testing of seals and valves, air sample of the interior of the cask for radioactive materials, surface and 1 meter dose rates, surface temperature of the cask, checking for exterior surface contamination and hot particles and testing of gauges.

SHIPPING THE CASK

626. The loading of the cask onto the transport vehicle at the site (e.g., a flat bed trailer, a rail car, perhaps a ship) is performed in conjunction with the operators of the transport vehicle and the cask vendors. The QA program for the cask will detail the requirements including the tie down techniques.

627. Special attention must be paid to the bill of lading, the sealing of the cask and the labeling of the cask and the transport vehicle. The shipper must be aware of the predicted weather and other conditions along the route and use this information to determine if the shipment will take place as scheduled.

628. Written instructions to the drivers will include procedures for response to emergencies, security , notifications, and any other requirements of the regulatory body or other government agencies having jurisdiction.

629. If a contract shipper is employed, many of these procedures will be performed by contract personnel. However, the operating organization must be aware of all arrangements and agree to them.

RADIATION PROTECTION

630. Procedures are required for all radiation protection activities during the entire process. For the most part, these activities are similar to those radiation protection activities normally conducted at the facility. The radiation protection activities which will be part of the shipping process should be examined for new activities and procedures should be developed for them.

631. All aspects of the shipping process should be discussed with the health physics staff. The health physics staff should participate in training for those tasks which they have not performed previously.

632. Normally, all handling of irradiated fuel with high dose rates is performed with considerable shielding to protect operating personnel.. If, however, high dose rate assemblies are moved using distance to protect personnel instead of adequate shielding (e.g., by using a crane with a long control pendant, a long handling tool), procedures should be available for actions to be taken in the event of a failure (e.g., in the crane motor.)

633. If the end boxes of fuel assemblies are cut off, potential contamination is a serious concern. Adequate procedures should be in place to minimize it.

SPECIAL SECURITY CONSIDERATIONS

634. The security plan or some other document for the research reactor may specify approved storage locations for fuel assemblies. The provisions may not be broad enough to allow for temporary storage in the shipping cask. In such a case it may be required to obtain a license amendment or permission of the regulatory body.

7. TRAINING OF PERSONNEL

GENERAL

701. All personnel who will perform tasks associated with the shipment of irradiated fuel elements shall receive training on the tasks they will perform. The extent of this training shall be commensurate with the safety related importance of the task

GUIDANCE

702. The IAEA is in the process of preparing a safety guide which discusses the training of personnel for research reactor. This document, or a draft of this document, may be available to assist the operating organization in the training of its staff for shipment of irradiated fuel.

703. ANSI/ANS 15-4 - 1988 contains guidance on the training of research reactor personnel.

TRAINING ON PROCEDURES

704. Shipment of spent fuel and handling of heavy object is usually an infrequent activity at research reactors. For this reason and because of the possible consequences of mistakes, the operating staff and the health physics staff must be instructed in all phases of the procedures. The topics and content for training may be learned from the sections of Chapter 6.

705. If cropping or canning of elements is required, training should be provided using unfueled devices. While dummy fuel elements may be too expensive for actual cutting training, it may be possible to fabricate an inexpensive device which will resemble a fuel element and presents the came cutting profile.

706. This training also serves the purpose of validating the procedures.

8. DOE CONTRACT CONSIDERATIONS

CONTRACT NEGOTIATIONS

801. A contract for the receipt of spent fuel must be negotiated and signed with the U.S. Department of Energy (DOE) before the receiver will approve the fuel for shipment. This contract will provide the terms and conditions applicable to the delivery to and receipt by DOE of the spent fuel as well as the location of the site (INEL or SRS) which will act as the receiver of the fuel.

Terms and Conditions

802. The contract terms and conditions will cover such items as:

a) Identify roles and responsibilities
b) Pre-shipment inspections
c) Documentation submittal requirements
d) Operational aspects of the shipments
e) Reports.

SPENT FUEL ACCEPTANCE CRITERIA

803. A Spent Fuel Acceptance criteria document, referred to as Appendix A to the shipping contract, has to be prepared and submitted to the receiver for each type of fuel (based on differing materials, geometry and fissile content), to be shipped under the contract. The information required for this document is described in Section 3. Classification of Irradiated Fuel and illustrated in Appendix I.

TRANSPORT PACKAGE (CASK) ACCEPTANCE CRITERIA

804. Appendix B to the shipping contract with Savannah River describes the design features and limitations of the transport package required to assure compatibility with the Savannah River Sites' Receiving basins for offsite fuels and its handling equipment. It also contains information or requirements for cask cooling mediums, special handling tools, radioactive contamination, and criticality safety requirements. An example of this appendix is given in Apendix VII.

NOTIFICATION REQUIREMENTS

805. The fuel shipment contract contains several advance notification requirements. These include, but are not limited to,

a) Method of shipment
b) Arrival date
c) Number of casks
d) Physical parameters for the cask
e) Cask documentation

806. The required notifications with dates and times by which they must be submitted are contained in the contract or its appendices.

9. LOCAL ARRANGEMENTS

REGULATORY REQUIREMENTS

901. The operating organization shall ensure that all applicable regulatory requirements are met. More than one governmental agency may be involved. Typically, the organizations involved are the nuclear regulatory body including its export offices and the transportation agency. The transport agency not only validates the shipping package certificate but may also prescribe some requirements of the shipping process such as labeling and placarding.

902. For the purpose of export authorization and shipping package acceptance, the regulatory body may require the following information from the operating organization:

a) The number and type of fuel elements which are to be shipped
b) The mass of U-235 and total uranium in these fuel elements
c) The mass of the residual U-235 in the fuel elements
d) The activity of other isotopes
e) The activity of each loaded cask and the dose rates on the outside of the cask at the time the cask leaves the facility.

903. It should be noted that this and other information is the topic of Chapter 3 of this document.

904. The regulatory body may require copies of the contracts between the operating organization and the DOE and between the operating organization and the carrier. It may also require a copy of the cask Certificate.

ROUTING

905. The operating organization or its contract carrier on its behalf shall arrange for a routing plan for the cask between the facility and the port. These arrangements may require approval by a regulatory agency, the local police or others as required by law or regulation. For security reasons the routing plan as well as the time period when the routing will be utilized, should be considered safeguarded information and with-held from unauthorized disclosure.

906. Interim storage along the entire transportation route should be avoided. Where this is not possible, safe havens should be selected for temporary storage. These safe havens should be areas of high security.

907. The routing plan should show distances and driving times between major cities, town, and provincial borders, fuel and food stops, safe havens, communications capability along the route, phone numbers of police and other emergency organizations along the route, locations of high population areas, and armed escort requirements. While the carrier will probably be familiar with routing along major highways, it may be necessary for the operating organization to suggest a suitable route from the facility to the nearest major highway.

908. The routing plan should consider requirements which may be imposed by cities, towns and provincial jurisdictions along the route.

AUTHORIZATIONS

909. The operating organization is responsible for obtaining all authorizations required for the shipment including an export license. At the request of the operating organization, the regulatory body will issue an export license for the shipment. The carrier, in cooperation with the operating organization, will submit this export license to the customs agents at the time of export.

EMERGENCY PLANNING

910. The operating organization should insure that emergency plans exist along the transport route to cover transportation accidents, radiation accidents and other events. If the jurisdictions along the route do not have appropriate plans, it may be necessary for the operating organization to work with the jurisdictional authorities to develop such plans. The plan should be implemented with procedures which will be used by the carrier personnel and authorities in responding to an accident.

MULTICONTAINER ARRANGEMENTS

911. In some cases, the irradiated fuel may be shipped on the same vessel as fuel from another facility or country. The carrier, in cooperation with the operating organization, shall make arrangements to allow for the transit (port, rail, truck) of the foreign fuel. If different shipping packages are used for the local and foreign fuel, it may be necessary to obtain local approval for the new design.

NOTIFICATION REQUIREMENTS

912. It is the responsibility of the operating organization to make all notifications which may be required along the route. The carrier will be of great assistance in notifications outside the country of origin. The contract with DOE may relieve the operating organization from notification requirements in the U.S.

NUCLEAR LIABILITY INSURANCE COVERAGE

913. The operating organization shall insure that adequate liability insurance is in force during the entire shipment. The carrier may assist the operating organization in this determination for intermediate countries and ocean carriers. The DOE contract should state when the provisions of the Price-Anderson Act (a U.S. law providing liability insurance for certain nuclear activities) apply to the shipment.

10. ARRANGEMENTS WITH OTHER COUNTRIES

REGULATORY REQUIREMENTS

1001. The regulatory body in collaboration with the operating organization must comply with the requirement imposed by International Organizations such as IAEA, EURATOM (for EC countries) etc.

ROUTING

1002. The transport company in collaboration with the operating organizations and US DOE arranges the routing from the country's border to the US entry port. The operating organization informs officially the regulatory body about the selected route.

PERMITS AND LICENCES

1003. The regulatory body in collaboration with relevant authorities of countries involved in the transportation through routing, provides the shipping agent with the necessary licences and permits care of the operating organization.

EMERGENCY PLANNING

1004. For an emergency situation the transport company must comply with the IAEA relevant regulations.

AUTHORIZATIONS

1005. The operating organization authorizes the transport company to present to the US authorities all the necessary documents.

MULTICONTAINER ARRANGEMENTS

1006. The transport company provides the regulatory authorities of other countries in case of multicontainer arrangements with information relevant to the kind and quantity of shipped fuel as well as the validity of licence of used casks.

NOTIFICATION REQUIREMENTS

1007. The operating organization makes an advance notification to the safeguard authorities of the International Agencies (IAEA, EURATOM etc) using the relevant forms. In these forms the shipping time is estimated, as well as, nuclear data of under shipment spent fuel assemblies are given.

1008. A final notification is proved at least .... days before shipment.

LIABILITY COVERAGE

1009. The operating organization must cope with all international requirements of issuance of liability coverage (e.g. the Paris convention of 1960 concerning the third party liability in the field of nuclear Energy.

11. TRANSPORTATION SAFEGUARDS AND PHYSICAL PROTECTION

SAFEGUARDS NOTIFICATION

1101. For fuel under international safeguards notification to the safeguarding organization (IAEA, Euratom, etc.) is usually required well in advance of the proposed shipping date. The safeguarding agency will then arrange for appropriate verification and sealing of the shipment for transit.

PREPARE PHYSICAL PROTECTION PLAN FOR SHIPMENT

1102. The Convention on the Physical Protection of Nuclear Material provides an international basis for the safe and secure transport of nuclear materials. This Convention obligates parties to "make specific arrangement and meet defined standards of physical protection for international shipments of radioactive material" and sets an objective for States to "establish conditions which would minimise the possibilities for unauthorized removal of nuclear material or for sabotage.

1103. The transport arrangement must comply with the requirements laid down in the Convention and acts on security requirements issued by competent authorities of the countries involved with the shipment.

On-Site considerations

1104. The physical protection plan for research reactor facilities will specify approved storage locations for fuel assemblies. The provisions of the plan may not be broad enough to allow for temporary storage in the shipping cask. In such a case, it may be necessary to obtain a license amendment or approved revision to the reactor's physical protection plan.

1105. In addition, a physical protection plan covering the fuel loading operations and preparations for shipment will be required. Details of the requirements will come from the local Regulatory Body.

On-Route considerations

1106. In addition, a physical protection plan covering the transport of the fuel will be required. Details of the requirements will come from the local Regulatory Body, the IAEA (Ref x) and USDOE.

1107. In many countrles the physical protectlon requirements for transportation of spent fuel elements are higher than the IAEA recommendations. In many cases guarded transportation and additional communication systems are requlred.

1108. In addition, the requirements of the originating country or in-transit countries may specify the type of ship to be used (INF-1, 2 or 3).

12. PRELIMINARY TO SHIPMENT

REVIEW CONTRACTUAL COMMITMENTS

1201. In Section 15 contracts are listed which have to be in force before activities for shipment start at the facility (arrival of the cask) and must be in force till the offloading of the fuel at the selected US-naval harbor. Operators should carefully look at the conditions of these contracts to be sure that all of these are all fulfilled.

REVIEW PERMITS AND APPROVALS REQUIRED

1202. Permits and approvals required are being listed in Section 15. It is within the responsibility of the operator to look at all necessary permits and to check the validity of the permits. The operator is also responsible to have the approval in time prior to shipment.

SEND UPDATED SHIPMENT DATA TO DOE OPERATIONS OFFICE

1203. In cases where shipments are being delayed significantly after being lead the approval for e.g. Appendix A or ICPP documents it may be necessary to send updated data to DOE operations Office. Of course the actual shipment is only allowed to go after DOE agrees to the new schedule.

ADVANCE NOTIFICATIONS TO ALL JURISDICTIONS

1204. The notifications listed in Section 15 have to be made in advance dependent from existing regulations: e.g. IAEA safeguard has to be notified at least.... days in advance. In some countries licensing authorities and organizations responsible for physical protection (like state or federal police departments) need a 48h or 72h notice in advance. The lead time has to be checked individually for each facility.

ARRANGE FOR ANY NECESSARY CRANES AND RIGGERS

1205. If additional cranes or riggers are necessary contracts must be on hand in advance and e.g. the handling procedure has to be discussed with the riggers in detail in advance.

FACILITY CRANE INSPECTION AND LOADING TESTS

1206. Make sure that all necessary inspection of the facility crane and all lifting equipments have been done to allow safe handling of the casks. As discussed in Section 7 preloading tests may be necessary and required.

13. RECORDS

DOCUMENTATION

1301. During the process, many records will be generated. One of the purposes of these records will be to demonstrate compliance with various requirements.

Content

1302. Among these records, will be data sheets and checkout forms covering the following operations:

(1)Incoming contamination and radiation survey.
(2)Inspection of cask before use.
(3)Cask loading data sheets.
(4)Cask sealing data.
(5)Preshipment inspection report
(6)Outgoing contamination and radiation survey
(7)Shipping documentation
(8)Bills of lading and packing lists
(9)Facility specific radioactive material transfer forms

1303. In addition there may be records specific to the shipping package (cask) used.

Examples

1304. Appendix VII presents examples of typical forms which have been utilized to meet the above objectives.

14. OUTLINE OF ARRANGEMENTS NEEDED

CONTRACTS

1401. Contracts, as outlined below, are needed with the various entities involved in the spent fuel shipment in order to delineate scope of work, responsibilities, costs, liabilities, etc.

USDOE

1402. A Contract is needed between the US DOE and each reactor operator. The contract will cover the shipment of spent reactor fuel identified in the appendix attached to the contract, from the specific reactor facility and the designated US DOE receiving facility.

Transportation

1403. Contract(s) with transport organization (s) must be in place covering all aspects of transport from shipping facilities to receiving facilities (see section 9 for further details).

Cask

1404. Contract must be in place with the selected cask supplier covering cask, baskets, operating equipment and services for the expected duration of the shipment.

Liabilities and insurance

1405. A detailed analysis should be conducted for each type of transport including operations on site, and the necessary insurance coverages, both conventional and nuclear, should be made before the starting of the operations. Relevant information should be reported in the corresponding contracts. In particular, an indemnification will be needed for each contractor performing work in the reactor facility in preparation for transport and for the transportation contractors. An insurance certificate naming the contractors as covered members will be required.

PERMITS

1406. Various permits are needed to complete the shipment. The contract with DOE will define the responsibilities of the two parties withregard to acquisition of these permits.

Cask Certification/Endorsement

1407. Cask certification documents appropriately validated and endorsed is required prior to the shipment. These documents include an approved Competent Authority Certification and a validation or endorsement of certification issued by each country where the cask is to be transported. Examples are shown in appendix .....

1408. The facility must have copies of these documents to be included as part of the shipping documentation.

Export permit

1409. Depending on the facility's country an Export Permit for the shipment may be necessary.

US Import permit

1410. An Import License issued by USNRC Office of International Affairs is required (see sample..).

Customs papers

1411. Appropriate Forms must be filled at the time of the shipment according to local regulations

Paris Convention

1412. Under Article 4(c) of the Paris Convention the Operating Organization must provide the carrier with a certificate of financial security. The certificate shall state the name and address of the Operating Organization and the amount, type and duration of the security provided. The certificate shall also indicate the nuclear substances and the carriage in respect of which the security applies and shall include a statement by the competent authority that the Operating Organization is an operator within the meaning of the Convention.

Other permits

1413. For some countries a permit from other agencies like EURATOM Supply Agency is necessary before the material may be transferred.

WRITTEN APPROVALS

1414. In addition to various permits there are many approvals required from the various entities having control over the conditions of the shipment or over the route it will take.

Receiver's Approval

1415. The Receiver requires appropriate data regarding the fuel to be shipped before approval for the shipment will be given. Most of the required data is contained in the appendix documents filed under the USDOE contract. The Receiver uses this data to assess the receiver's capability to safely store and handle the fuel.

1416. This data must be updated as necessary to reflect changes in the shipment content before formal approval from the US DOE will be granted. Once a final listing of fuel data for assemblies to be included in the shipment is approved the shipment may take place.c

Shipping Date

1417. A tentative date for the shipment must be agreed to between the Shipper and Receiver before the planning for the shipment progresses too far. US DOE approval of the actual shipping date is required prior to the shipment

Transportation plan

1418. A transportation plan must be prepared in advance. It should include the following items:

(1)Quality Assurance Plan
(2)Physical protection arangements
(3)Emergency Response planning
(4)Proposed routing.

1419. This plan must be approved by US DOE and other Authorities according to Regulations in force.

NOTIFICATIONS

1420. Several Agencies or Authorities have to be notified prior the each shipment

(1)IAEA/Euratom Safeguards (in particular to attend loading operations)
(2)Regulatory Authorities
(3)Receiver
(4)Other Government and Local Jurisdictions

15. REFERENCES

1. Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, USDOE, DOE/EIS-0218F, February 1996.

16. BIBLIOGRAPHY

American National Standard for Shipment and Receipt of Special Nuclear Material (SNM) by Research Reactor Facilities., ANSI/ANS-15.19-1991.

MNR Spent Fuel Shipment Procedure. SFS, McMaster Nuclear Reactor, October 1988.

A Guide to the Shipment of Spent Fuel from University Research Reactors to Reprocessing. (A.F. DiMeglio)undated.

Draft Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, Volume 2 - Appendix B; Foreign Research Reactor Spent Nuclear Fuel Characteristics and Transportation Casks. USDOE, DOE/EIS-0218D, March 1995.

APENDIX A AGREEMENT NO. 10-2 Under Contract No. DE-AC09-76SR01033 with Atomic Energy of Canada Limited, Dated December 1977 - prepared September 1988, (Typical Appendix A data).

Owner's manual for use of the BMI-1 cask.

APPENDIX I

APPENDIX A AGREEMENT

SPENT NUCLEAR FUEL ACCEPTANCE CRITERIA

APPENDIX A AGREEMENT
SPENT NUCLEAR FUEL ACCEPTANCE CRITERIA

No. ___ UNDER CONTRACT NO. _____
WITH _____

THIS AGREEMENT, entered into this _____ day of _____, 19____, constitutes an agreement by the U.S. Department of Energy (hereinafter called DOE) to receive under the terms and conditions of Contract No. __, the specification material described herein. This agreement provides a detailed description of the material to be delivered to DOE in accordance with this contract and also enumerates the specifications and requirements which the Customer must meet. Failure of the material delivered hereunder to comply with the specifications and requirements given in this agreement will result in the material being non-specification material. A separate Appendix A Agreement will be required for each element, subassembly, or assembly which is different in Description. All dimensions must be given in meters or centimeters and all weights in grams or kilograms.

A. Definitions

The following definitions are applied to the Specification Material described in this Agreement:

The Fuel Element -The smallest integral unit of clad fuel (or blanket) containing source or special nuclear material (e.g., plate, tube, rod, disc, etc.).

Subassembly - If used, is a group of elements, combined in a structural unit, which is grouped with other subassemblies to form the larger unit called the assembly.

Assembly - A group of elements or subassemblies combined in a structural unit. The assembly is usually that fuel structure which is removed from the reactor as an individual unit.

B. Form and Composition of Specification Material

1. Drawing Identification

The following drawing(s), four (4) copies of which are attached and which are incorporated herein by reference thereto, constitute(s) a comprehensive illustration of the fuel elements, subassemblies, and assemblies to be delivered under this Contract as charged to the reactor, in sufficient detail and accuracy under this Contract.

Drawing No. / English Title	Drawing No. / English Title

2. Material Description

The following summarizes the description of fuel elements, subassemblies, assemblies and

assemblies modified after discharge. Where dimensions are required, the nominal dimensions, as charged to the reactor, must be used and the best estimate of the maximum change in these dimensions because of irradiation must be given. Weights must be dry, unirradiated weights with the expected range of weights also to be included. Where isotopic weights of SNM are required, tolerances shall be specified.

(a) Fuel 'Element' Description

Fuel element type (plate, disc, rod, tube, etc.)	
Nominal dimensions (include clad and bond, cm)	
Active length of fuel element (cm)	
Nominal total weight of fuel element (g)	
Nominal weight of SNM before irradiation (g)	
Total U (g ± g uncertainty)	
U-235 (g ± g uncertainty)	
Total Pu (g ± g uncertainty)	
Pu-239 (g ± g uncertainty)	
Thorium (g ± g uncertainty)	
Chemical form of SNM (e.g., UO_2, UAl_x-alloy, UC, etc.)	
Weight of SNM (g)	
Fabricated form of SNM (pellets, slugs, ribbons)	
Alloy or dispersing material (Al, SS, etc.)	
Alloy or dispersing material weight (g)	
Cladding material (Al, SS, etc.) & method of sealing	
Clad thickness (cm), weight (g)	
Bonding material, if any (Na, Al-Si, etc.)	
Bond thickness (cm), weight (g)	
Spacers, inactive material (MgO, SS, etc.)	
Spacer dimensions (cm), weight (g)	
Other materials contained in the fuel element: (include dimensions and weights)	

(b) 'Subassembly' Description

Number of elements	
Over-all subassembly dimensions (cm)	
Total subassembly weight (g)	
Casing Material (Zr, Al, etc.)	
Casing dimensions (cm), weight (g)	
Side plate material	
Side plate dimensions (cm), weight (g)	
Spacer material	
Spacer dimensions (cm), weight (g)	
End box material	
End box dimensions (cm), weight (g)	
Braze or weld material	
Braze or weld dimensions (cm), weight (g)	
Other structural material contained in subassembly (include dimensions and weight)	

(c) Full 'Assembly' Description

Number of subassemblies/elements	
Over-all dimensions (cm)	
Over-all weight (g)	
Casing Material (Zr, Al, etc.)	
Casing dimensions (cm), weight (g)	
Side plate material	
Side plate dimensions (cm), weight (g)*	
Spacer material	
Spacer dimensions (cm), weight (g)	
End box material	
End box dimensions (cm), weight (g)	
Braze or weld material	
Braze or weld dimensions (cm), weight (g)	
Other structural material in assembly (include dimensions and weight)	

* Side plate weight shall account for any slot volume(s).

Do the fuel elements contain Sodium (Na)? Yes q No q

C. Fuel Identification

Each separately removable unit in a shipment batch must be identified by a durable tag or by embossing. Identification of the Units to be delivered under this Appendix A Agreement are as follows (**NOTE: Customer shall list actual assembly identification numbers):**

_____

_____

_____

_____

_____

D. Fuel Irradiation Specifications

1. Fuel Irradiation History - General Summary

_____

_____

_____

_____

_____

2. Post-Irradiation Specifications

The average and maximum SNM content post-irradiation is to be specified in grams per assembly. The best available value should be given and the uncertainty stated. The irradiation history for each assembly is to be provided according to Section F.

SNM Material	Average (g)	Maximum (g)	Uncertainty (± g or ± %)
Total U			
Total Pu			
Total Np			
Total Th			
U232			
U-233			
U-235			

U-236			
Pu-239			
Pu-241			

3. Specifications for Failed/Warped Fuel Units

1. Fuel elements or assemblies distorted beyond specified dimensional limits must be considered on an individual basis. The Customer should provide DOE with complete dimensional information for each failed/warped unit at least 60 days before delivery.

2. If material normally removed from the element or subassembly by the Customer cannot be removed due to fuel failure, warpage, or other reasons, the Customer must notify DOE at least 60 days before delivery giving complete dimensional, material, and weight information. Detailed structural drawings are also required by DOE.

E Correspondence

1. Customer Contact

Laboratory/ Research Center/University	
Reactor Name	
City, State, Country	
Customer Name	
Customer Signature	
Title	
Phone Number	
Fax Number	
Date	

2. Department of Energy Contact

All correspondence or inquiries regarding this document and the information contained herein shall be directed to:

U.S. Department of Energy
Savannah River Operations Office
Reactors & Spent Fuel Division
P.O. Box A
Aiken, SC 29801

Phone and facsimile inquiries may be made to:

Phone: (803)-557-3759
Fax: (803)-557-3763

F. Fuel Irradiation History - Assembly Specific Data

The irradiation history for each assembly is to be provided according to the format specified below. Additional tables may attached (if necessary).

Assembly	Pre-Irradiation		Post-Irradiation											
Unique ID No.	U grams	U-235 grams	U grams	U-235 grams	U-236 grams	Np-237 grams	Pu grams	Pu-239 grams	Pu-241 grams	Time In Reactor (days)	Cooling Time (days)	Power Level mwd/mtu	Exposure mwd/mtu or Burnup %	Decay Heat (Watts) as of: ___

UNITED STATES OF AMERICA
BY: UNITED STATES DEPARTMENT OF ENERGY

BY: _____ BY: _____

TITLE: _____ TITLE: _____

DATE: _____ DATE: _____

APPENDIX II

DECAY HEAT AND RESIDUAL ACTIVITY CALCULATIONS

TO BE ADDED

APPENDIX III

CASK SPECIFICATIONS

TO BE ADDED

APPENDIX IV

APPENDIX B AGREEMENT

TRANSPORT PACKAGE (CASK) ACCEPTANCE CRITERIA

APPENDIX B AGREEMENT
TRANSPORT PACKAGE (CASK) ACCEPTANCE CRITERIA

No. __ UNDER CONTRACT NO. _____
WITH _____

A. Shipments

1. Shipments to the Savannah River Site can be routinely made by rail or by motor freight.
2. Agreement between the customer and the U. S. Department of Energy - Savannah River Operations Office is required on all shipping schedules. Further, the Savannah River Operations Office must be notified in advance of each shipment, giving such information as:
   (a) Method of shipment
   (b) Arrival date
   (c) Number of transport packages (casks)
   (d) Transport package contents (Approved Appendix A)
   (e) Activity of primary coolant in curies*

   Note: Clean water shall be added to the cask prior to shipment and the clean water sampled. The cask shall then be allowed to sit for a minimum of four hours and the water resampled. The sample will be analyzed for radioactivity levels. If the level of activity is greater than or equal to _____ mCi/ml (_ _____ Bq/l) of Cs^{137}/Ba^{137m}, the fuel will be determined to be failed, i.e., non-specification, and will not be shipped. If the level of activity is less than

   _____ mCi/ml (_____ Bq/l) of Cs^{137}/Ba^{137m}, the fuel will be determined to be specification material and may be shipped. Handling procedures for fuel assemblies or elements not subject to the above treatment or which use a bonding material which can react violently with water will be established on an individual basis prior to shipment and may require special handling.

   (f) Transport package outside radiation and contamination levels *
   (g) Gross weight of the loaded transport package (cask) and container *
   (h) Safety Analysis Report Packaging (SARP) documentation showing criticality safety analysis and letter indicating applicable SARP and Certificate of Competent Authority governing shippment
   (i) Diagram showing configuration of fuel within the cask baskets
   (j) Other information as required

   * - Information should be transmitted immediately after determination.
3. F.O.B. Points
   (a) Rail - Dunbarton, South Carolina
   (b) Truck - Dunbarton, South Carolina
4. Fuel will not be shipped to the Savannah River Site until after DOE-SR review and approval of the relevant Appendix A Agreement for the shipment.

B. Coolant Medium

The Savannah River Site is equipped to handle transport packages (casks) containing water as the primary coolant or to handle dry cask shipments. The use of any liquid coolant other than water as the primary cooling medium, or the use of additives, such as antifreeze, will be considered on an individual basis prior to shipment and may require special handling.

C. Radioactive Contamination

1. External Contamination

Any transportation package received at the Savannah River Site having external contamination in excess of 22,000 d/m per 100 sq. cm. of beta-gamma or 2,200 d/m per 100 sq. cm. of alpha will require non-routine decontamination in accordance with Article VII.

2. Internal Contamination

The activity of the transport package will be determined at the Savannah River Site by sampling prior to opening the transport package. If the total beta-gamma activity of the coolant is significantly greater than that determined at the shipping point, the cask will be flushed in an attempt to reduce the activity; and, by various techniques, including laboratory analyses, an attempt will be made to determine the cause of the activity and the appropriate handling requirements for the material, which shall be considered non-routine under Article VII.

D. Microbiological Contamination

The Department of Energy is committed to maintaining the biological activity in the storage basins of the Savannah River Site at the lowest levels possible. In an effort to ensure the biological activity levels do not increase at the Savannah River Site, a sample of water from the shipping facility's spent nuclear fuel storage pool may be requested. If requested, the sample shall be taken at the time of fuel loading and shipped to the Savannah River Site using a transportation method approved by Savannah River Site.

D. Surface Temperatures

Cask designs that permit attainment of cask surface temperatures which present a handling hazard must also incorporate designs that permit safe handling techniques. Cost of provision of special handling tools must be borne by the customer.

E. Criticality Safety Document Requirements

Fuel contained in a cask shipped to the Savannah River Site must be critically safe when submerged in water with the cask lid removed. The fuel assemblies must be packaged in the cask so that they can be removed in water without resulting in a criticality hazard. In addition, consideration must be given to the possibility of the cask coming into close proximity to other casks in transit and in the receiver's yard. The customer must submit for review and approval, the appropriate Certificate of Competent Authority and SARP detailing the model basis for determination that the cask is critically safe under accident conditions. Data from any critical experiments that have been performed shall also be included.

F. The Savannah River Site's Receiving Basins for Off-Site Fuels (RBOF)

1. General

Casks are handled in one cask unloading basin serviced by a 90.7 metric ton crane. The crane is of twin hook design, with an adapter to convert it to a single hook crane, with 7.52 meters maximum clearance to the palm of the hooks in the Basin area. Clearance to the palm of the hooks at the car unloading spot is 9.35 meters.

2. Cask Dimensional Limitations

The water-filled cask unloading basin is rectangularly shaped, 3.96 meters wide and 8.23 meters long. The floor level in the basin is at a water depth of 8.53 meters and in addition, the basin contains a pit 2.9 meters in diameter and a water depth of 13.41 meters. Cask assemblies are lowered into the basin and placed on the floor at the proper depth. The cask lid is removed and stored in the basin or in an external pit. The hoists on the 90.7 metric ton, twin hook crane operate independently or as a single unit. The

span between the inside faces of the hooks can be varied from a minimum of 2.44 meters to a maximum usable span of 6.4 meters.

(a) Cask Limitations

	Horizontal Cask [4,5]	Vertical Cask [4,5]
Maximum loaded cask weight	90.7 metric ton	90.7 metric ton
Crane hook spacing, minimum	2.44 m	2.44 m
Maximum	6.4 m	6.4 m
Maximum height cask body [1]	4.27 m	-----
Maximum length, including trunnions[2]	7.42 m	10.06 m minus X
Maximum width cask	2.74 m	-----
Maximum diameter[6]	-----	2.69 m
Minimum clearance under trunnions [3]	See crane hook dimensions "D" below	

Notes:

(1) Include any projections, such as dowel pins. Also presumes element removal in horizontal position.

(2) X = Maximum fuel assembly length in meters.

(3) For engagement of crane hooks.

(4) Any variation from these limits will be handled on an individual basis.

(5) The terms horizontal and vertical refer to the disposition of the long axis during under water unloading.

(6) Includes any projections such as lifting trunnions

All casks are assumed to be top opening for unloading.

(b) Crane hook dimensions (45.35 metric ton)

A. Width	15.88 cm
B. Depth through palm	52.07 cm
C. I.D. of throat	17.78 cm
D. Distance from tip to bottom of hook	31.75 cm

(c) Crane hook dimensions (90.7 metric ton)

A. Width	25.4 cm
B. Depth through palm	88.9 cm
C. I.D. of throat	23.5 cm
D. Distance from tip to bottom of hook	71.12 cm

3. Fuel Assembly Packaging

Fuel assembly packages within the cask vary with the nature of the assemblies and the cask design. The weight of any fuel package to be removed from the cask as a unit and transported under water must not exceed three tons. The size of the fuel assembly package is limited to:

- Size of fuel assembly must fit within a 12.38 cm diameter bundling tube
- Vertical length of any unit, 298.45 cm.
- Handling of fuel assemblies not meeting this criteria must have prior DOE approval

G. Transport Package (Cask) Design

1. The transport package (cask) must be compatible with the Savannah River Site's Receiving Basins for Offsite Fuels and its handling equipment as described in Section F hereof. In addition, the cask design must include the following features:

(a) The cask must be equipped with tapered dowel pins or other positioning devices to guide the lid into position if the lid is to be replaced under water following unloading. These guides are required to prevent damage to the hold-down bolts or other parts of the cask.

(b) Provision for free drainage from all external surfaces and attachments.

(c) A means of sampling and flushing the cask primary coolant with the cask closed, while the cask is on the transport vehicle. This design feature must include valves that isolate cask coolant from the cask connection. If a secondary coolant is used, a sampler tap and isolation valves must be provided. When pipe connections or valves on the cask which will be used at the Savannah River Site are not equipped with American Standard Taper Threads, coupling adapters to American Standard Taper Threads must be provided.

(d) Means shall be provided for measurement of the maximum primary coolant temperature or cask cavity wall temperature at any time, by use of a portable readout instrument if desired.

(e) A siphon drain line or drain line to remove water from the cask for return shipment.

(f) Casks must be top opening.

(g) If cask trunnion design is not compatible with the limits and dimensions given in Section F, a yoke must be furnished to handle the cask with the appropriate hook (45.35 or 90.7 ton). Such yokes are required to be rigid and must be designed so that the specific static stress does not exceed 1/5 of the ultimate strength of a member. (Refer to Specification No. 61 of the Electrical Overhead Crane Institute, Inc., No. 1 Thomas Circle, N.W., Washington, D.C. 20005) Also, yokes must be designated for vertical storage as they will be engaged and disengaged underwater. The customer must provide or ensure that three copies of the complete stress analysis of the yokes have been furnished to the Savannah River Operations Office for review.

(h) All inner cask surfaces which are likely to be contacted by the coolant must be of stainless steel or other acceptable non-corrosive metal. All external surfaces must be accessible for decontamination. These external surfaces, including weldments, must be smooth, free of weld spatter, and crevices or pockets.

(i) Cask design must be such as to permit cask handling operations prior to unloading, such as cask transfers and bolt removal, to be accomplished with a maximum total exposure of 24 mrem (.24 mSv) to operating personnel at the RBOF facility.

(j) Cask lifting devices must be a part of the cask proper and not the cask lid. Cask lids must contain a lid lifting eye and the lids will be handled by a single crane hoist or with an adapter yoke.

(k) All casks must be provided with some means to prevent over-pressurizing and some means of containment for liquid release.

(l) The outer edge of the bottom of the cask must be given at least a 1.27 cm radius to prevent gouging the stainless steel floor lining in the RBOF basins.

2. In order to assure that the cask meets the criteria of this Section G, the Customer must obtain the

approval of the Director, Reactors and Spent Fuel Division, Savannah River Operations Office, prior to utilizing a cask for shipment to the Savannah River Site. The customer must provide three copies of the most recent versions of the following documents to the Director, Reactors and Spent Fuel Division at least 60 days prior to commencement of the shipment or 120 days for any cask not previously received at SRS: (1) the transport package SARP, (2) the COCA (from the U.S. Department of Transportation or the U.S. Nuclear Regulatory Commission), (3) a complete set of as-built drawings including all components of the transport packaging, (4) the transport packaging operations manual/procedures, and (5) details of the method of attachment of the transport package to the shipping vehicle. In the case of casks not yet constructed, it is recommended that design drawings be submitted to the Director, Reactors and Spent Fuel Division, for review and comment prior to actual construction. Any approvals given by the Reactors and Spent Fuel Division Director, pursuant to this section relate solely to the receipt and handling of such cask at the Savannah River Site and shall not be construed as indicating approval of any State, Federal or other regulatory agency, including the Nuclear Regulatory Commission.

H. Receipt of Solid Radioactive Waste

No contaminated waste materials which are not an integral part of the fuel assembly will be received by the Savannah River Site for disposal unless specifically arranged for and agreed to prior to shipment.

I. Provision of Special Tools

Unless otherwise agreed to by the parties, any and all tools required to inspect, lift, sample, unload, decontaminate or prepare the transport package for return that are above and beyond what would be reasonably expected to be available at a spent nuclear fuel receiving facility must be provided with the transport package.

J. Transport Package and Containers

Transport packages (casks) that are transported inside ISO containers shall only be received by the Savannah River Site when configured with one transport package per ISO container. The Savannah River Site does not have the capability to receive multiple transport packages in a single ISO container. If the cask is loaded horizontally, the ISO container must be marked to indicate the location of the top of the cask.

K. Correspondence

1. Customer Contact

Laboratory/Research Center/University	
Reactor Name	
City, State, Country	
Customer Name	
Title	
Customer Signature	
Phone Number	
Fax Number	
Date	

2. Department of Energy Contact

All correspondence or inquiries regarding this document and the information contained herein shall be directed to:

U.S. Department of Energy

Savannah River Operations Office

Reactors & Spent Fuel Division

P.O. Box A

Aiken, SC 29801

Phone and facsimile inquiries may be made to:

Phone: (803)-557-3759 Fax: (803)-557-3763

APPENDIX V

REPRESENTATIVE QUALITY ASSURANCE PLAN

TO BE ADDED

APPENDIX VI

EXAMPLE PROCEDURES

TO BE ADDED

APPENDIX VII

REPRESENTATIVE RECORDS AND REPORTS

TO BE ADDED

APPENDIX VIII

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