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APPROVED FOR PUBLIC RELEASE <i>8/31/94 D. Solis</i>		
7. Abstract The CNS 1-13G cask, a U.S. Nuclear Regulatory Commission (NRC) certified cask manufactured by the ChemNuclear company, will be utilized for the transportation of irradiated fuel elements from the K Basins to the 327 Laboratories in the 300 Area for characterization. The cask will utilize an inner container to compensate for the possibility of failed fuel cladding and to reduce the chances of contaminating the cask or the offloading facility. The Packaging Design Criteria (PDC) for these shipments establishes the acceptance criteria for the cask and for the design of an inner container that will be used in the Safety Evaluation for Packaging (SEP).		
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PACKAGING DESIGN CRITERIA FOR THE N REACTOR/SINGLE PASS REACTOR FUEL CHARACTERIZATION SHIPMENTS

1.0 INTRODUCTION

1.1 BACKGROUND

The majority of the spent fuel from the N Reactor and the single pass reactors (SPR) is presently being stored at the basins in the 100 K Area. Characterization of these fuels is essential to formulate a safe and efficient processing/disposal method for the spent fuel. Consequently, it is necessary to transport a cross section of spent fuel from the K Basins to the hot cells at the 327 Building in the 300 Area for analysis.

To accomplish this, ChemNuclear's CNS 1-13G cask has been chosen to transport the fuel from the 100 K Area to the 300 Area. This cask was chosen because it has a Certificate of Compliance (CoC) issued by the U.S. Nuclear Regulatory Commission (NRC) authorizing it to be used in the transport of irradiated oxide and metallic fuel. The configuration of the irradiated N Reactor/SPR fuel deviates from the CoC in that the fuel cladding may be breached. To compensate for the possibility of failed cladding, inner containers will be designed and constructed to hold the irradiated fuel. This plus the highly controlled transportation environment that can be provided at Hanford will provide a degree of safety commensurate with that of the cask used as per the CoC.

1.2 PURPOSE

The purpose of this Packaging Design Criteria (PDC) document is to provide criteria for the safety analysis and lease of the CNS 1-13G cask packaging system. It provides criteria for the safety analysis and design of the inner containers. The CNS 1-13G cask will be used to transfer Type B highway route controlled quantities (HRCQ) of fissile radioactive material in the form of irradiated N Reactor and SPR fuel assemblies.

The PDC will provide a basis for the Safety Evaluation for Packaging (SEP). The approved PDC provides a formal set of standards early in the design and analysis process, and prevents later costly delays due to multiple and iterative interpretations of the requirements. The CNS 1-13G SEP will be approved by Westinghouse Hanford Company (WHC), including Quality Assurance (QA) and Safety, as well as U.S. Department of Energy, Richland Operations Office (RL) to authorize onsite interarea transfer of the fuel assemblies.

1.3 JUSTIFICATION

Since the N reactor fuel shipping campaign will involve the onsite transfer of radioactive materials, an appropriately designed and analyzed packaging system is required. Packages that are currently available on the Hanford Site either do not provide an adequate margin of safety or are incompatible with the equipment that will be used during the transfer of the fuel. The CNS 1-13G cask has been selected as a suitable packaging system for this operation.

The CNS 1-13G was selected for this campaign because it is authorized by the NRC to ship irradiated nuclear fuel in commerce (ChemNuclear 1992). The CoC allows for irradiated fuel pins with up to 500 ^{235}U equivalent grams of fissile material. The irradiated fuel may either be metallic or oxide fuel. Additionally, the CNS 1-13G is capable of being loaded underwater and transported with a water filled inner cavity. It is also compatible with the loading and handling equipment presently available at the Hanford Site.

The only aspect of the N Reactor and SPR fuel that does not conform to the CoC is that some of the fuel that is to be shipped has breached cladding. Inner containers shall be utilized to protect operating personnel and the cask from unnecessary contamination.

The SEP will establish the safety of the CNS 1-13G cask during the shipping campaign. This safety will be based on equivalency to offsite material transport regulations, as implemented by the *Hazardous Material Packaging and Shipping* manual, WHC-CM-2-14. An equivalent safety approach shall be used to show that the use of an inner container in the CNS 1-13G cask for the N Reactor/SPR fuel will provide a degree of safety equivalent to that provided for in the CoC.

2.0 PACKAGE CONTENTS

2.1 PAYLOAD CHARACTERISTICS

2.1.1 Physical Form

The CNS 1-13G cask will be utilized to transport irradiated N Reactor and SPR fuel. The vast majority of the irradiated fuel in the K Basins is from the N Reactor. Since SPR fuel is significantly small and has decayed for a much longer period of time than the N Reactor fuel, N Reactor fuel is considered to represent the worst case source term. N Reactor fuel consists of zircalloy clad outer and inner elements which have a maximum length of 26.1 in. and have outer diameters of 2.42 in. and 1.28 in., respectively. The inner element has a maximum weight of 16.5 lb (7,484 g) and the outer element has a maximum weight of 35.2 lb (15,967 g). The elements have been stored in

the East and West K Basins for periods of at least seven years. Some elements that are scheduled to be shipped suffered cladding failure while in the reactor. Other elements have undergone significant corrosion/damage during their storage in the basins. Some elements may be broken or similarly degraded.

To help maintain an environment similar to that found in the K Basins, the inner container shall be shipped with basin water. Additionally, residual basin water will be present in the inner vessel of the CNS 1-13G cask.

2.1.2 Radioactive Materials

The worst case fuel for the shipping campaign is assumed to be 16% ^{240}Pu irradiated N Reactor fuel that has been allowed to decay for five years. This is a conservative estimate as few fuel elements were allowed to reach 16% ^{240}Pu , and the minimum amount of decay that has been experienced by an N Reactor/SPR fuel element is seven (7) years.

The fuel portion of the rods that will be shipped in the CNS 1-13G is primarily $^{235}\text{U}/^{238}\text{U}$, but it also contains significant amounts of transuranic materials such as ^{240}Pu and ^{239}Pu as well as fission products such as $^{137}\text{Cs}/^{137\text{m}}\text{Ba}$. The cladding will be contaminated with activated material such as ^{60}Co . Table 2-1 provides a list of the worst expected activity levels for an inner and outer fuel element. Table 2-1 also provides the expected activity level for the CNS 1-13G packaging when it contains 500 ^{235}U equivalent grams of fissile material, which is the maximum amount allowed by the SARP (ChemNuclear 1992). As determined in Appendix 6.2, the CNS 1-13G payload is considered to be Type B, HRCQ of fissile material for transportation.

2.1.3 Chemical Constituent Source Term

The primary chemical constituent concern for the irradiated fuel is its capability to create hydrogen through radiolysis. To prevent an explosive reaction of hydrogen with oxygen, a maximum concentration of 5% H_2 with a factor of safety of two (2.5% H_2) is permitted for transportation (NRC 1984). Build up of H_2 within the gas space of the inner container could seriously decrease the maximum safe shipping time and create handling problems in the 327 Facility. Therefore, the inner containers shall be allowed to vent H_2 to the gas space of the inner cavity of the CNS 1-13G cask. The hydrogen concentration within the cask shall be maintained at or below 2.5% through the use of chemical scavenger or recombination packs within the inner container(s) and/or by placing limits on the amount of contiguous time that the cask can remain sealed without venting.

The possibility exists that hydrogen created via radiolysis or chemical reactions have combined with corroded fuel to form uranium hydride (UH_3).

This material has pyrophoric properties similar to that of metallic uranium. The hazard of an O_2 - UH_3 reaction is minimized by having the inner container filled with water during handling and shipment.

Table 2-1. Activity of Worst Case Inner and Outer N Reactor Fuel Element.

Specie	Inner Fuel Content (Ci)	Outer Fuel Content (Ci)	Maximum Payload (Ci)	Specie	Inner Fuel Content (Ci)	Outer Fuel Content (Ci)	Maximum Payload (Ci)
$^{90}Sr/^{90}Y$	65.7	104.2	358.9	^{152}Eu	0.01	0.02	0.06
^{99}Tc	0.01	0.03	0.07	^{110m}Ag	0.01	0.02	0.05
$^{106}Ru/^{106}Rh$	19.01	40.6	130.9	^{238}Pu	0.90	1.93	4.94
^{113m}Cd	0.036	0.08	0.20	^{239}Pu	1.06	2.26	5.80
^{125m}Te	1.186	2.53	6.50	^{240}Pu	0.75	1.61	4.11
^{134}Cs	10.62	22.7	58.1	^{241}Pu	85.24	181.9	465.7
$^{137}Cs/^{137m}Ba$	87.86	187.5	480.0	^{241}Am	0.82	1.75	4.48
$^{144}Ce/^{144}Pr$	21.4	45.7	116.9	^{244}Cm	0.27	0.57	1.45
^{147}Pm	65.6	139.9	358.2	^{55}Fe	0.31	0.67	1.71
^{151}Sm	0.78	1.66	4.26	^{60}Co	0.10	0.22	0.57
^{154}Eu	2.24	4.78	12.3	^{125}Sb	0.17	0.36	0.93
^{155}Eu	0.72	1.54	3.95	^{125m}Te	0.04	0.09	0.23
^{85}Kr	7.03	15.0	38.4	^{119m}Sn	0.02	0.04	0.09
^{125}Sb	4.86	10.4	26.6	^{63}Ni	0.02	0.04	0.09
3H	0.40	0.85	2.17	^{235}U	1.18×10^{-4}	2.52×10^{-4}	6.46×10^{-4}
^{144m}Pr	0.26	0.55	1.40				

3.0 FACILITY OPERATIONS

3.1 ORIGINATING SITE - 100 K AREA BASINS

The loading of the inner containers and the placement of the inner containers within the CNS 1-13G cask shall take place in the handling basins of the K East and K West Basins. Extraction of the fuel elements from their present storage containers, transferral to one or more inner containers. The inner containers will then be placed in the CNS 1-13G cask. The cask will be extracted from the basin(s), drained of water, and internally and externally

decontaminated. The inner containers will remain filled with water. The cask will be mounted onto a flat bed trailer provided by the cask vendor along with the cask's protective overpack.

3.2 DESTINATION SITE - 327 LABORATORIES

The off-loading of the cask and inner containers shall take place in the 327 Laboratories located in the 300 Area. The laboratories are equipped with basins that are of sufficient size to accommodate the CNS 1-13G. Given the size of the cask, overpack and trailer, the cask off-loading operation may not be performed entirely within the 327 Facility. Therefore, the off-loading operation may consist of the removal of the cask overpack outside of the facility prior to the movement of the trailer into the 327 Facility. For movement of the trailer into the facility, tiedowns will be provided for the inner cask without its overpack.

The cask will be placed into the basins where it shall be opened and off-loaded. The inner containers will be moved into hot cells where the fuel elements shall be removed from the containers by remote handling.

4.0 PACKAGING/TRANSPORT SYSTEM DESIGN

4.1 GENERAL

The CNS 1-13G will be approved for use onsite as an interarea packaging authorized to transfer Type B HRCQ quantities of fissile radioactive material in the form of irradiated fuel assemblies in accordance with WHC-CM-2-14. The SEP shall demonstrate the safety of the transfer through a combination of cask performance as documented by the CoC (ChemNuclear 1992) and the design of the inner container.

An evaluation will be performed to address the ability of the CNS 1-13G cask and special inner container to provide containment, shielding and subcriticality for breached irradiated fuel during normal and accident conditions.

4.2 PACKAGING DESIGN CRITERIA

4.2.1 Packaging Specification and Materials

The CNS is a stainless steel encased, lead shielded cask (Figure 1). It consists of a $\frac{1}{2}$ in. thick outer stainless steel shell, a 5 in. lead shell and a $\frac{1}{2}$ in. thick inner stainless steel shell. The outer base of the cask is comprised of a $\frac{1}{8}$ in. stainless steel shim plate and backing ring and a $\frac{1}{2}$ in.

Figure 4-1. CNS 1-13G.

stainless steel plate welded to form a $\frac{1}{2}$ in. thick base which is integrally welded to the outer stainless steel shell of the side wall. The cask lid is a lead-filled flanged plug. The cask closure is sealed by a silicone rubber gasket. Positive closure is accomplished by six 1 in. diameter studs.

The inner container must be constructed of stainless steel or some other corrosion resistant material. It must be capable of being sealed by a silicone rubber gasket, graphite seal or equivalent.

To minimize movement of the inner container(s), a rack shall be constructed of stainless steel or similar corrosion resistant material.

4.2.2 Packaging Dimensions

The nominal dimensions of the CNS 1-13G are:

Overall Height, Without Overpack	68.0 in.
Outside Diameter, Without Overpack	38.5 in.
Inner Cavity Height	54.0 in.
Inner Cavity Diameter	26.5 in.
Overall Height, With Overpack	85.4 in.
Outside Diameter, With Overpack	68.0 in.

The minimum dimensions of the inner cavity of the inner packaging required to contain the irradiated fuel elements are as follows:

Minimum Inner Cavity Height	27.0 in.
Minimum Inner Cavity Diameter	4.0 in.

To allow for handling within the K Basin handling pool and the 327 Laboratory hot pool, the maximum outer dimensions of the inner container are as follows:

Maximum Height	34.0 in.
Maximum Diameter	6.0 in.

The inner container rack shall be constructed so that it fits within the inner cavity of the CNS 1-13G (54.0 in. x 26.5 in. ID) and accommodates and minimizes transport movement of at least three (3) inner containers.

4.2.3 Maximum Gross Weight

The unloaded weight of the CNS 1-13G and overpack is 25,500 lb. The cranes facilities in the 327 Laboratory and K Basins can accommodate a maximum weight of 30,000 lb. Therefore the weight of three inner containers, fuel elements, and shoring assembly and cask water (17.2 ft³, weighing 1,075 lb) shall not exceed 4,500 lb.

Given the limitations of handling equipment for the inner containers, the weight of an individual container, its payload, and water shall not exceed 75 lb.

4.2.4 Lifting and Tiedown Attachments

The CNS 1-13G is equipped with two lifting flanges. The overpack is equipped with two tiedown flanges. An additional two tiedown points are provided by a tiedown yoke that is attached to the top of the overpack.

To allow for handling of the inner container in the handling pools and hot cells, the container will be equipped with one or more lifting handles located at the top of the canister. Additionally, the bottom of the inner container shall have a 7/16 in. wide by 5/16 in. deep notch to prevent container rotation during closure and valve operations.

4.2.5 Venting

The CNS 1-13G shall not be vented. The hydrogen concentration within the CNS 1-13G shall be limited to 2.5% or less (NRC 1992) through the use of chemical scavenger or recombination packs within the inner container(s) and/or the application of administrative controls on the amount of the time the cask may be sealed.

To allow for the dissipation of hydrogen to the inner cavity of the CNS 1-13G, the inner container shall be equipped with a capillary system. The inner diameter of the venting capillary tube shall be sufficient to ensure continuous ventilation of generated hydrogen from the inner container to the inner cavity of the CNS 1-13G. The venting capillary system may be outfitted with a filter to minimize the possibility of contamination for the CNS 1-13G inner cavity.

4.2.6 Closure

Closure of the CNS 1-13G is obtained by a lead-filled flange plug with a silicone rubber gasket. Positive closure is accomplished by six 1 in. diameter studs.

The inner container closure mechanism and valving shall be similar in construction to that used on the Mark II Encapsulation Canister (H-1-46215).

4.2.7 Maintenance

For the inner container, components requiring frequent maintenance or testing shall be minimized. Features requiring maintenance shall be designed in accordance with As Low As Reasonably Achievable (ALARA) principles using the guidance found in Section 3 of WHC-CM-4-9, *Radiological Design*.

4.2.8 Reuse

The CNS 1-13G shall be reused in accordance with the requirements set forth in its Safety Analysis Report for Packaging (SARP) (ChemNuclear 1992).

The SEP shall provide the necessary requirements (such as inspections and part replacements) to allow for the effective and safe reuse of the inner containers.

4.3 TRANSPORT SYSTEM

4.3.1 Transport Vehicle

ChemNuclear, the CNS 1-13G vendor, shall supply a flat bed trailer that is specially equipped to allow for the secure tiedown of the CNS 1-13G cask and overpack.

4.3.2 Tiedown

The CNS 1-13G cask and vehicle shall be tiedown to the specially equipped flatbed trailer as per the CNS 1-13G SARP (ChemNuclear 1992).

5.0 GENERAL REQUIREMENTS

5.1 TRANSPORTATION SAFETY

5.1.1 Chemical and Galvanic Reactions

The CNS 1-13G inner container must be made of materials and construction that assure that there will be no significant chemical, galvanic or other reaction among the components or between the components and the contents that will jeopardize the integrity of the packaging system.

5.1.2 Surface Contamination

During transfer conditions, removable contamination on the exterior surfaces of the CNS 1-13G cask shall not exceed the following limits (WHC Radiological Control Manual, WHC-CM-1-6):

Nuclide (note 1)	Removable, (dpm/100 cm ²) (note 2)	Total (Fixed + Removable), (dpm/100 cm ²) (note 3)
U-natural, ²³⁵ U, ²³⁸ U, and associated decay products.	220 alpha	5,000 alpha
Transuranics, ²²⁶ Ra, ²²⁸ Ra, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	20	500
Th-nat, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁴ Ra, ²³² U, ¹²⁶ I, ¹³¹ I, ¹³³ I	200	1,000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above. Includes mixed fission products containing ⁹⁰ Sr.	1,000 beta/gamma	5,000 beta/gamma
<p>Table notes:</p> <ol style="list-style-type: none"> 1. The values in this table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item. Where contamination by both alpha and beta/gamma-emitting nuclides exists, the limits established for the alpha and beta/gamma-emitting nuclides apply independently. 2. The amount of removable radioactive material per 100 cm² of surface area should be determined by swiping the area with dry filter or soft absorbent paper, while applying moderate pressure, and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm², the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranic elements, ²²⁸Ra, ²²⁷Ac, ²²⁸Th, ²³⁰Th, ²³¹Pa, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination. 3. The levels may be averaged over 1 m² provided the maximum activity in any area of 100 cm² is less than three times the values in the table. 		

5.1.3 Thermal

The CNS 1-13G has been authorized to transport payloads with heat generation of up to 600 W. The payload shall be limited so that the heat generation shall be less than 600 W.

5.1.4 Normal Transfer Conditions

The CNS 1-13G packaging system with the inner containers shall be capable of retaining the contents, limiting direct radiation, and maintaining subcriticality during normal conditions of transport (10 CFR 71).

a. Containment

The CNS 1-13G cask shall prevent the loss or dispersal of the radioactive contents during normal conditions of transport. The CNS 1-13G has been shown to maintain containment under normal transfer conditions in its SARP (ChemNuclear 1992). The design of the inner containers and shoring shall be such that it will not compromise the cask's capability to maintain containment during normal conditions of transport. Specifically, the cask with overpack must maintain adequate containment subsequent to a 2 ft drop as specified by 10 CFR 71.71. The acceptance criteria for containment are contained in the SARP for the CNS 1-13G (ChemNuclear 1992).

b. Shielding

Contents of the CNS 1-13G cask shall be limited such that the contact dose rate on the external surface of the overpack is less than 200 mrem/h. The dose rate at 2 m from the surface of the overpack shall be limited to less than 10 mrem/h. The dose rate at any normally occupied space in the transfer vehicle shall be limited to less than 2 mrem/h.

c. Criticality

The contents of the CNS 1-13G shall be limited as per the SARP (ChemNuclear 1992). Less than 500 g ²³⁵U equivalent grams of fissile material will be permitted to be transferred in the cask for an individual shipment.

5.1.5 Accident Events

a. Containment

The CNS 1-13G cask has been certified as a Type B container. The design of the inner containers and rack shall be such that it does not compromise the capability of the cask to meet the Type B criteria with the exception of its performance under fire conditions. An evaluation of a fire event shall be performed to demonstrate that the package meets the following criteria:

- **Incredible Events** - Any unplanned event that has a probability less than 10^{-6} per year is incredible. Such events shall not result in an offsite dose consequence of greater than 25 rem effective dose equivalent (EDE). Onsite dose consequences do not require evaluation.
- **Credible Events** - Any unplanned event that has a probability between 10^{-6} and 10^{-3} per year shall not lead to a radiation exposure of greater than 5000 mrem EDE to an individual onsite or 500 mrem EDE offsite. These unplanned events are considered credible.

- **Probable Events** - Any unplanned event that has a probability of greater than 10^{-3} per year shall not lead to a radiation exposure of greater than 200 mrem EDE to an individual onsite, or 10 mrem EDE offsite. Any unplanned event that has an indeterminate frequency shall be considered probable.

b. Shielding

The contents of the packaging shall be limited so that the external dose rate shall not exceed 1 R/h at 1 m (3.3 ft) from the surface of the cask/overpack assembly.

c. Criticality

Following an accident, the contents of the CNS 1-13G shall be limited as per the SARP (ChemNuclear 1992) so that less than 500 ^{235}U equivalent grams of fissile material will be permitted to be transferred in the cask for an individual shipment.

5.2 FACILITIES

During the offloading of the cask and, to a lesser degree, during the loading of the cask, there is the possibility of a gas release that will have a significant hydrogen concentration (up to 2.5% by volume). The loading and offloading facilities, the K Basins and 327 Laboratories, respectively, shall have adequate equipment and procedures in place to allow for the safe dissipation of the hydrogen that may be vented from the cask during loading and offloading operations.

5.3 ALARA

The design features of the CNS 1-13G, inner containers and rack shall be consistent with the requirements of WHC-CM-4-11. Exposure of personnel to radiological and other hazardous materials associated with the loading, closure, tiedown, transfer, and off-loading of the package shall be minimized. Cost benefit analyses should be performed as needed, to determine the best balance between exposure and economical design.

5.4 QUALITY ASSURANCE

The QA program requirements for activities such as design, procurement, fabrication, inspection, testing, component handling, and documentation of the CNS 1-13G cask are specified in the *Quality Assurance Program Plan for the Hazardous Material Transportation and Packaging Program*, WHC-IP-0705 (WHC 1990).

To establish a quality assurance plan for the CNS 1-13G packaging system, a graded approach was used to define the Safety Class of both the system and individual components of the CNS 1-13G packaging system. The application of the Safety Class system is fully documented in *Management Requirements and Procedures* (MRP) 5.46, WHC-CM-1-3. QA instructions or plans shall be developed for the procurement, fabrication and inspection of the package based on the assigned safety class of the package. The *QA Program Plan for the Hazardous Materials Transportation and Packaging Program*, WHC-IP-0705 (WHC 1990), and *Standard Engineering Practices* (EP) 1.4, WHC-CM-6-1 defines the WHC QA and safety class implementation, respectively, for radioactive material shipping packages.

5.4.1 Safety Classes

5.4.1.1 Safety Class 1

Components of a system or a system whose failure could result a significant impact on the health or safety of offsite persons. In the case of radioactive materials, the failure of a Safety Class 1 system/component could result in the an offsite receptor receiving an effective equivalent dose via inhalation equal to or greater than 500 mrem.

5.4.1.2 Safety Class 2

Components of a system or a system other than Safety Class 1 whose failure could result in a release of radioactive or hazardous material that could have a significant impact on onsite personnel. In the case of radioactive materials, the failure of a Safety Class 2 system/component could result in an onsite receptor receiving an effective equivalent dose via inhalation greater than 5 rem.

5.4.1.3 Safety Class 3

Components of a system or a system other than Safety Class 1 or 2 whose failure could result in a release of radioactive material or hazardous material that could have an impact on onsite workers. In the case of radioactive materials, the failure of a Safety Class 3 system/component could result in a release of radioactive materials that would cause an onsite receptor to receive an effective equivalent dose via inhalation less than or equal to 5 rem EDE.

5.4.1.4 Nonsafety Class 4

Components of a system or a system whose failure will have no significant effect on safety, health or environmental protection.

5.4.2 System Safety Class

The Safety Class of the CNS 1-13G packaging system was determined by a dose consequence study documented by *N Reactor Characterization Shipments Packaging Safety Class Analysis* (Goldberg 1994). This study assumed the total failure of the packaging system and the release of all of its contents to the environment at the worst possible location on the transportation route. For the N Reactor/SPR shipping campaign the worst case location is just north of the 300 Area.

The dose consequence study indicates that the maximum inhalation dose to an onsite receptor is 75 rem EDE and the maximum inhalation dose to an offsite receptor is 1.8 rem EDE. Therefore, the CNS 1-13G packaging system is a Safety Class 1 system.

5.5 DESIGN FORMAT

Development of the design drawings, design changes and other design documentation shall be in accordance with WHC-CM-6-1 and the *Drafting Standards* manual, WHC-CM-6-3.

5.6 ENVIRONMENTAL COMPLIANCE

Actions and conditions for the protection of the environment during transfer of the CNS 1-13G cask shall comply with the requirements of the *Environmental Compliance* manual, WHC-CM-7-5.

6.0 APPENDICES

6.1 REFERENCES

ChemNuclear, 1992, *Procedures, License and Safety Analysis Report for ChemNuclear Systems, Inc. CNS 1-13G Type A Radwaste Shipping Cask, USA/9216/B()*F, ChemNuclear, Inc, Columbia, South Carolina.

Goldberg, H. J., 1994, *N Reactor Characterization Shipments Safety Class Analysis*, (internal memo 22570-HJG-94-016 to P. F. Stevens, April 22), Westinghouse Hanford Company, Richland, Washington.

NRC, 1984, *NRC IE Information Notice 84-72*, September 10, 1984.

WHC-CM-1-3, *Management Requirements and Procedures*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-1-6, *WHC Radiological Control Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-2-14, *Hazardous Material Packaging and Shipping*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-11, *ALARA Program Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-9, *Radiological Design*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-1, *Standard Engineering Practices*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-6-3, *Drafting Standards*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-7-5, *Environmental Compliance*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990, *QA Program Plan for the Hazardous Materials Transportation and Packaging Program*, WHC-IP-0705, Westinghouse Hanford Company, Richland, Washington.

6.2 CONTAINMENT SOURCE AND A_2 VALUE CALCULATION

The A_2 value for a particular isotope is a measure of the relative hazard it would pose to persons during a release of radioactive material. For example ^{60}Co has an A_2 value of 7 Ci, while ^{239}Pu has an A_2 value of 0.002 Ci. If a payload has greater than 3,000 A_2 of radioactive material it is classified as Type B, HRCQ.

The formula for determining the equivalent A_2 value for the worst case payload mixture is $A_2 = (\text{Total Curies}) / (\text{Sum of Isotope } A_2\text{'s})$. Table 6-1 contains information on A_2 levels for the individual isotopes and the total number of A_2 's for a worst case payload.

Table 6-1. A_2 Values for Worst Case Payload

Nuclide	Curies of Material	A_2 (Ci)	No. of A_2 's	Nuclide	Curies of Material	A_2 (Ci)	No. of A_2 's
^3H	2.17 E+00	1000	0.00217	^{147}Pm	3.58 E+02	25	14.326
^{55}Fe	1.71 E+00	1000	0.00171	^{151}Sm	4.26 E+00	90	0.047333
^{60}Co	5.73 E-01	7	0.081857	^{154}Eu	1.23 E+01	5	2.45
^{63}Ni	9.12 E-02	100	0.000912	^{155}Eu	3.95 E+00	60	0.065833
^{85}Kr	3.84 E+01	1000	0.0384	^{235}U	3.23 E-03	0.2	0.01615
^{90}Sr	3.59 E+02	0.4	897.1115	^{238}Pu	4.94 E+00	0.003	1646.1
^{106}Ru	1.04 E+02	7	14.83857	^{239}Pu	5.80 E+00	0.002	2898.39
$^{110\text{m}}\text{Ag}$	4.75 E-02	7	0.006786	^{240}Pu	4.11 E+00	0.002	2056.25
^{125}Sb	2.75 E+01	25	1.0996	^{241}Pu	4.66 E+02	0.1	4656.2
^{134}Cs	5.81 E+01	10	5.805	^{241}Am	4.48 E+00	0.008	559.545
^{137}Cs	4.80 E+02	10	47.993	^{244}Cm	1.45 E+00	0.01	145.2466
^{144}Ce	1.17 E+02	7	16.7024	Total Ci	2050.9	Total A_2	12962.32

The equivalent A_2 value for the payload is 0.158 Ci. The worst case payload is 12,962 A_2 's, which makes the payload Type B HRCQ.