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Cask Fleet Operations Study

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1.0 Introduction

The Nuclear Waste Policy Act of 1982 assigned to the Department of Energy's (DOE) Office of Civilian Waste Management the responsibility for disposing of high-level waste and spent fuel. A significant part of that responsibility involves transporting nuclear waste materials within the Federal waste management system; that is, from the waste generator to the repository. The lead responsibility for transportation operations has been assigned to Oak Ridge Operations, with Oak Ridge National Laboratory (ORNL) providing technical support through the Transportation Operations Support Task Group. One of the ORNL support activities involves assessing what facilities, equipment and services are required to assure that an acceptable, cost-effective and safe transportation operations system can be designed, operated and maintained. This study reviews, surveys and assesses the experience of Nuclear Assurance Corporation (NAC) in operating a fleet of spent-fuel shipping casks to aid in developing the spent-fuel transportation system.

2.0 Fleet Usage Experience

2.1 General Information

2.1.1 Current Cask Fleet

NAC's spent-fuel shipping cask fleet currently consists of 11 legal weight truck (LWT) casks and two 100-ton rail casks. Six LWT casks are the NAC-1/NFS-4 model and five are the NLI-1/2 model. Both cask designs were originally licensed to transport light-water reactor (LWR) fuel; either one pressurized water reactor (PWR) fuel assembly or two boiling water reactor (BWR) fuel assemblies. The six NAC-1/NFS-4 model casks are no longer licensed to transport LWR fuel, but have been re-licensed for metallic fuels, and are being used for metallic fuel shipments. All 11 of the LWT casks are in service, transporting metallic fuels for DOE.

Both cask models have been used for shipments of spent LWR fuels and for shipment of high-level radioactive waste to burial sites.

The two rail casks, both NLI-10/24 models, are licensed to transport 10 PWR or 24 BWR fuel assemblies. These casks have not been used for loaded shipments, and are presently in storage.

Copies of the certificates of compliance of these casks are included in Appendix A. Both the authorized contents and the conditions of use of the casks change from time to time. These changes may result in revisions to the certificate. The certificates shown are those current at the time of the completion of this report.

License drawings for the casks that depict the basic design are shown in Appendix B.

2.1.2 and 2.1.3 Compliance and Other Maintenance

Cask maintenance activities fall basically into three categories: certificate of compliance maintenance, commonly referred to as "annuals"; maintenance performed on a "per-shipment basis"; and unscheduled maintenance, covering non-routine activities such as damage repair or replacement of parts subject to "wear and tear."

Cask maintenance is typically performed at the cask user's facility. Provisions for conducting maintenance, before and during fuel shipment campaigns, is included in NAC's contract with the user. While most users agree to this arrangement, some prefer NAC to perform any required annual maintenance at another facility before the cask arrives on their site.

The general resource requirements for annual maintenance include a crane to move the cask and other support equipment, a radiologically controlled area with the capability to handle several hundred gallons of contaminated water and gases, disposal of generated radioactive waste, health physics coverage for surveys and monitoring, anti-contamination clothing, compressed air, water and hand tools. Test equipment, such as pressure gauges, high-pressure pumps, fixtures and leak detectors, and cask spare parts are supplied by NAC. The annual maintenance procedures for the NLI-1/2 and NAC-1/NFS-4 model casks are shown in Appendix C. No annual procedure has been written for the rail cask. No special testing, such as shielding effectiveness or heat transfer capability, is required for the annual, but is required for acceptance testing of a cask after fabrication.

Special services may also be required, depending on the condition of the cask. These services may include assistance in decontamination, machine shop, welding, calibration, non-destructive testing, or special arrangements for grinding or cutting contaminated equipment or parts. Welding, calibration and non-destructive testing typically requires personnel with special qualifications that are also provided by the cask user. Cask user (site) personnel are utilized to the extent possible because site access requirements have become very stringent. Present access requirements, including background check, physiological and other testing, and conformance to site-specific entry requirements, make it time consuming and inefficient to use off-site personnel. Access requirements for both DOE and commercial reactor sites are expected to become even more stringent.

Research laboratories (hot cells), such as the Babcock and Wilcox (B&W) Lynchburg facility or the Battelle Columbus Laboratory facility at West Jefferson, Ohio, have been used on a contract basis to perform annual maintenance on casks. The major facility requirements are that the facility crane be able to lift the cask and that the facility radioactive materials license permit receipt, shipment and opening the cask. The contract sites selected are licensed to receive, ship, store and handle spent fuel, which is consistent with the use of the cask. These facilities are designed to receive spent fuel in casks, and therefore have small unloading pools and the ability to handle the radioactive waste products associated with the spent fuel. A facility designed to handle only empty casks for maintenance

or storage purposes would require a license for 20 to 30 curies (per cask) of mixed fission and corrosion products as well as millicurie amounts of fuel and its various oxides and daughter products. Both Battelle and B&W are relatively small facilities designed to handle only one truck cask at a time. Each facility contains a truck trailer bay, a small cask-handling (decontamination) area, and a small cask-loading/unloading pool. Overhead clearance for crane operation is approximately 30 feet.

The cost to lease a suitable facility to perform annual maintenance is on the order of \$30,000, or about \$10,000 per day for three eight-hour days. The cost includes: personnel (one technician, a crane operator), one health physics technician (half time) and one supervisor (half time); use of the crane; handling of radioactive water, gas and other generated waste; use of hand tools, service air and water, contamination monitoring and reporting (smear surveys, sample counting and exposure control) and anti-contamination clothing. Personnel with additional qualifications (such as inspectors, welders, and machinists) are billed on an hourly basis, as used. Cost items incurred, but that are not normally separately measured, such as the cost of lights, ventilation, filtering, insurance, and other overheads, are built into a use-of-facility fee, which is the major portion (about 70 percent) of the daily cost.

Maintenance performed on a "per-shipment basis" is typically limited to seal replacement for loaded shipments. Additional operations are performed but are more properly considered "containment verification testing."

The NLI-1/2 LWT and the NLI-10/24 rail cask use metallic O-rings (Inconel) to achieve the containment seal between the cask body and the inner lid. This O-ring is designed to be used five to six times before replacement, but experience has shown that it is more efficient to replace the seal for each loaded shipment. The metal O-ring is not forgiving of nicks or "trash" on either the seal surface or the surface of the O-ring, causing the seal to fail the containment pressure test. Replacing the O-ring each loaded shipment reduces time lost to returning the cask to the pool to replace the O-ring if it fails.

The NAC-1/NFS-4 model casks use an elastomer O-ring. This type of O-ring tends to maintain its ability to seal for many (up to 15) shipments.

No other cask parts are replaced on a "per-shipment basis."

Some parts, including quick disconnects (snap-tites), relief valves, manual valves, seals and other O-rings, may require repair, replacement or rebuilding as a consequence of failure to operate, but no routine, planned actions are required. The most frequent unscheduled maintenance item is

the replacement of "helicoils," an insert in drilled and tapped holes. Helicoils are used to prevent damage that could occur if the cask body was drilled and tapped to accept bolts. Helicoils can "back out" as bolts are removed, and thus require replacement.

The per shipment, containment verification "maintenance" for each cask model is shown in Appendix D.

Maintenance-related quality assurance is NAC's responsibility; however, user personnel typically verify test results, equipment calibration and procedure compliance.

2.2 Transport Vehicles

2.2.1 Ownership

NAC has both owned and leased trailers for the LWT casks and leases the rail cars for the NLI-10/24 rail casks. Currently, LWT casks are transported on trailers manufactured by Pratt Enterprises, Inc. and owned by the U.S. Department of Energy. In the past, the principal supplier of leased trailers has been Tristate Motor Transit of Joplin, Missouri. The principal supplier of trailers owned by NAC was Transport Systems Incorporated.

2.2.2 Transporter Maintenance Experience

Cask transport trailer inspections are scheduled and performed annually. The inspections include the lighting system, pressurized air and brake systems, axle hub and grease seals, tires, structural components and king pin (which attaches the trailer to the tractor), mud flap attachment and condition, all trailer welds, and the cask tie-downs system on the trailer. A sample check list for these and other items, is shown in Figures 2.2-1 through 2.2-3. Inspection of certain items of the cask tie-down structure and personnel barrier are recorded on the cask annual documentation. Rolling gear, specifically wheel bearings, are inspected and repacked at approximately 25,000 mile intervals as measured by a hub odometer on a trailer axle.

The tie-down structure of the NLI-1/2 cask uses a cantilevered arm for securing the lower end of the cask and for providing a rotation point to move the cask to the vertical position on the trailer. The welds and load bearing surfaces of the rotation trunnions on the arms, and the arms, are non-destructively (dye penetrant) tested in conjunction with the cask annual. The tie-down and rotation arrangement of the NAC-1/NFS-4 truck casks and the NLI-10/24 rail casks are less complex and no documented weld test is required as long as there are no visual indications of deformation or failure. The tie-down arrangements for each of these casks is shown in Appendix E.

It should be noted that increased state participation in spent-fuel shipments has rendered the performance of annual trailer inspections somewhat moot. It is common practice, especially for large shipping campaigns, for the (origin) State Department of Transportation or Highway Patrol, to inspect the cask trailer prior to the departure of each loaded shipment. In a campaign of more than one hundred shipments from New York

Trailer Maintenance-Active Systems List

This Table lists the Trailer Active Systems. These systems require inspection in accordance the check lists.

1. Landing Gear
2. Standard Axle
3. Tandem Axle Suspension
4. Brake Adjustment
5. Bearing Adjustment
6. Trailer Air Brake - System 121
7. Air Relay Quick Release Valve - Type RG-2
8. Skid Control Air Modular Valve - Type RS
9. Spring Set Safety Brake Chamber
10. Amplifying Air Relay Quick Release Valve Type RK
11. Air Line Connectors
12. Skid Control Electronic Components
13. Fuse - Junction Box
14. Logic Module
15. Electrical Cables and Connectors
16. Skid Control
17. Trailer Brake System
18. Air Ride Systems

MONTHLY CHECKLIST
(10,000 Miles Maximum)

✓ O.K.
X Adjustment Made
0 Needs Repair

	Code	Initial
<u>Tires, Wheels and Brakes:</u> -----		
Check Tire inflation and record (65 P.S.I.) -----		
Replace any missing valve caps -----		
Measure tread depth and record (Min. 8/32") -----		
Check lug bolts for tightness -----		
Check Hubodometer and record miles -----		
Check Anti-Skid Brake System -----		
Check Aluminum wheels for cracks -----		
<u>Lubrication:</u> -----		
Check oil level in hubs -----		
Check Automatic Lube System -----		
Lube landing gear case, legs and crank joints -----		
<u>Lights and Wiring:</u> -----		
Check all lights, Replace broken bulbs -----		
Check all reflectors -----		
Clean light socket of rust -----		
<u>Frame:</u> -----		
Inspect for cracks -----		
Check catwalks and fenders for tightness -----		
Check mud flaps - straighten frame; replace if torn ---		
Check license plate and light - clean -----		

Figure 2.2-2

ANNUAL CHECKLIST
(Every 12 Months)

	Code	Initial
Tire and Wheel Inspection		
Check tires for irregular alignment wear -----		
Check remaining tread depth and record -----		
Check dual mating with square -----		
Check for missing valve caps and stem locks -----		
Check tires for correct air pressure and decals -----		
Check wheels for cracks or loose lugs -----		
Rear Brake Lining Inspection - "S" Cam Brakes		
Remove lower dust shield -----		
Record drum condition -----		
Record remaining lining % -----		
Check brake adjustment, check worn or leaking hoses and fittings -----		
Wagner Anti-Skid System, check all items on Maintenance Schedule -----		
Lubrication		
Top-off automatic lubrication reservoir -----		
Check for loose and noisy bearings -----		
Check oil level in wheels -----		
Running Gear		
Check brake chambers, trailer valve, and lines for air leaks -----		
Check all air hoses and lines for chafing -----		
Check trailer relay valve emergency operation -----		
Drain air tank -----		
Check Springs and U-bolts -----		
Check cross-members and understructure -----		
Check King-pin and upper fifth-wheel plate for wear -----		
Check center frame for cracks and rusted areas -----		
Check catwalks and fenders - tighten all bolts -----		
Check mud flaps and license plate brackets -----		
Check license plate and renew inspection sticker -----		

Figure 2.2-3

	Code	Initial
Lights and Wiring		
Check all lights and reflectors; replace cracked lenses --		
Check for loose wiring; replace light cord socket -----		
Landing Gear		
Check leg braces and supports -----		
Check crank handle, retaining clip and pad swivels ----		
Fill gear box to level with correct lube -----		
Axle Alignment		
Use specified aligning tools and check alignment of front axle to king pin. Rear axle must be aligned to front axle. Record measurements on diagram on next page -----		

to Wisconsin, cask trailers were inspected first at a commercial facility (truck repair center), and were then inspected by a state inspector before shipment. Periodically, each trailer was subject to a deceleration test of the brake system. NAC expects that an important manifestation of states involvement in spent-fuel shipment will (continue to) be inspection of over the road equipment, including rail cars.

As a consequence of these inspections, even small, non-safety related defects in the trailer are repaired immediately. No trailer goes over the road that is not completely road worthy.

Transport trailers have been remarkably free of recurring maintenance problems. Those problems that have occurred, both in transit and found in inspections, have been readily repaired at commercial truck stops or truck repair facilities. Because of the use of "standard" components, it has never been necessary to return a trailer to its manufacturer for repair.

Specific items or components that have required repair include:

- **Trailer (Front) Landing Gear.** The front trailer landing gear is designed to be hand cranked down to lift the trailer from the king pin connection to the pulling tractor. The cask and trailer weight on the landing gear can reach 25,000 pounds, requiring considerable cranking effort. Occasionally, the tractor will be moved from under the trailer before the gear has the full load, causing the trailer to drop. The impact loading on the gear that results can, and frequently does, damage the landing gear so that it must be repaired or replaced.
- **Air Ride System.** Air ride suspension systems are designed to provide load leveling and a less springy ride, similar to the operation of gas struts in automobiles. Air ride system valving is susceptible to poor operation in very cold weather. No failures, except due to wear, have been experienced in temperatures above 40° Fahrenheit.
- **Grease Seals.** These seals, at the wheel/axle bearing, prevent oil and grease from affecting brake operation. Grease seals are typically replaced at the first hint of failure.
- **Non-Structural Welds.** Non-structural welds include those that support valves, air lines, electric wires, reflectors, mud-flap hangers, placard supports, drip pans,

fenders and the like. These welds fail due to continuous flexing in transit and due to use of the part for a purpose not intended, such as a step, hand hold or storage platform. These welds are repaired at the earliest convenience, unless the weld is road-worthiness related, such as a mud-flap hanger or placard support. No failures of trailer structural welds have been reported in the twin I-beam trailers currently in use.

- **Brake Systems.** The brake system, and its components, are closely monitored by the drivers and other inspectors. While frequent adjustment to the brakes is required, actual repair is much less frequent.
- **Lights and Air.** The operation of all lights is checked in the pre-shipment walk around. Spare bulbs are carried in the tractor and are replaced as necessary. The most frequent repair of the air system is at the "glad hand" connection between the tractor and trailer systems during very cold weather. Low temperatures can effect the rubber seal at the connection, resulting in loss of air pressure to the trailer brake system. Loss of air pressure will result in brake operation, locking one or more wheels.
- **Tires.** Tires are inspected frequently for side-wall damage and failure, signs of tread separation, and for tread wear. Tires are replaced with about 4/32 tread remaining. In general, recapped tires are not used and tire brands and sizes are not mixed.

Commercial truck stops and service facilities have demonstrated an excellent capability for both inspection and repair of cask trailers, and the tractors that pull them. Since the rolling gear and the trailer service systems (air, lights and suspension) are not unique, no problems have been encountered in making necessary repairs. For all practical purposes, the typical trailer is considered a "flatbed." Adequate spare parts and a welding capability are considered to be a satisfactory truck stop repair and support capability for the cask trailer.

Intransit repairs that must be made inside of the cask personnel barrier, or that require personnel to be within several feet of a loaded cask for more than one hour, are evaluated on a case-by-case basis.

Inside of the personnel barrier, repair personnel could come in contact with the cask surface, that may have small amounts of removable contamination. Precautions to prevent transfer or contamination are required. In addition, dosimetry would be required for any extended stay in the radiation field surrounding the loaded cask. Commercial facilities are not equipped for contamination or exposure control and no repairs are permitted without these controls in place.

Repairs inside of the personnel barrier, that are found to be necessary while the cask is at a shipping or receiving site are handled in accordance with circumstances. The preferred approach is to bring the required repair capability to the site. This provides the best radiological and procedural controls for work that must be done. An alternate approach is to remove the cask and personnel barrier from the trailer before sending the trailer to the repair facility. In either case, good practice dictates that the trailer bed be surveyed for contamination and decontaminated as necessary before any work is attempted.

NAC has limited experience with rail car maintenance. The rail casks have not been used to transport radioactive material and have not required repair for the few relocation moves that have been required. Inspections of the rail car rolling gear ("trucks") by railroad line personnel have been made on several occasions. Inspections are arranged with the railroad line operator at the origin (for shipments) and with the line that operates the rail siding for rail cars in storage. It is expected that repair or rolling gear problems encountered enroute would be arranged through the hauling railroad.

Inspections on the cask tie-down components and related gear are made by NAC personnel.

General guidelines for rail-car inspections are presented in Figure 2.2-4. Drawings of the rail car are presented in Appendix B.

2.2.3 Cask Mounting

The cask mounting equipment is designed to securely mate the cask to the trailer and provide a platform for removal and installation of the cask. The cask is bolted into a cradle which is an integral part of the trailer. Because of the inherently rugged design of the cask mountings, there is very little maintenance associated with these components beyond annual non-destructive examination of welds.

Pertinent Maintenance Inspections for Freight Cars *AAR Interchange Manual*

Air Brake Equipment:	Complete operational testing and servicing required every eight years. This work performed by Railroad and determined by stenciled date on car.
Air Brake Hose:	Should be inspected for conditions that indicate deterioration or damage. Must not be over eight years old as shown by manufactured date on hose.
Brake Shoes:	Composition brake shoes must be replaced if worn to 3/8" thickness.
Hand Brake:	Should be checked to determine that it is operable.
Couplers, Yokes, and Draft Gears:	The face opening between the knuckle and body should be checked by railroad gage No. 25623. The railroad has the parts to restore contour. If these new parts do not restore the contour, the coupler body must be replaced. The hydraulic end-of-car cushioning unit should be visually checked for fluid leaks and any indication of possible malfunction. If the unit does have a malfunction, it must be replaced.
Roller Bearing Lubrication:	Roller Bearings must be lubricated with an approved grease and in quantity shown every 48 months from lubrication date stenciled on car. The railroad will perform this work.
Roller Bearings:	Roller Bearings must be replaced by the railroad in the event the car is derailed.

Figure 2.2-4

Wheels:	Wheels can be gaged using railroad gage No. 34401. The railroad will perform the work of replacing wheels should they be worn to limits of gage or require replacement due to condition of wheel.
Trucks:	Inspect for wear, which should not occur for approximately 300,000 miles, and when trucks do show wear, it will be necessary to shop the car for general repairs.
Truck Springs:	Inspect for broken and/or missing springs. The railroad will replace them.
Stenciling:	AAR required stenciling must be legible. The paint system on the car should last approximately eight years. The re-painting will be performed by the owner. At the time of this shopping, the car should be thoroughly inspected, including jacking car off of trucks for inspection of body center plate and general condition of trucks.
Automatic Car Identification:	ACI labels will be checked for condition and replaced where necessary.
Safety Appliances:	Ladders, ladder treads, handholds and sill steps should be inspected and straightened where found bent or replaced where found broken. The car, as built, provides a 2 1/2 inch clearance for all handholds and this should be maintained where they are found bent.

Figure 2.2-4
(Continued)

The NAC-1 cask mounting consists of a front cradle and rear rotation trunnions that rest in a pedestal. The pedestal provides both the tie-down and rotation point.

The NLI-1/2 cask mounting consists of a front cradle and slots on the end of the cask. The slots receive trunnions mounted on a cantilevered arm. The arm and cradle assembly are mounted on a frame that is designed to separate from the trailer in the event of an accident, allowing the frame to move with the cask. This separation feature is designed to help ensure that the impact limiters remain with the cask.

The NLI-10/24 cask mounting consists of two cradles for both the front and rear of the cask. While resting in the cradles, in the transport position, the cask is pinned to the rail car structure. To remove the cask from the rail car, the pins are removed, and a pedestal is moved into a position below two rotation trunnions on either side of the cask. The cask is rotated to the vertical position using the rotation trunnions.

Sketches of the tie-down arrangements for these casks are shown in Appendix E.

Cradles are typically used on the forward end of the cask so that the lifting trunnions are "available" for yoke attachment and lifting. In addition, the cask typically will incorporate a machined groove or tab that fits in the cradle to allow the tie-down structure to meet the 10G horizontal load required by 10CFR71.45(B)(1), as shown in Appendix F. The rotation slot arrangement of the NLI-1/2 would seem to be a preferred method of achieving both tie-down ("G" loadings of the regulations) and rotation objectives, as it captures the bottom end of the cask yet requires no operations (work) to free the bottom end from the trailer. The cask merely lifts off when it is vertical.

2.2.4 Cask Covering

Casks are protected by an expanded metal personnel barrier which is designed to prevent access to a thermally hot cask and in addition prevents access to the potentially contaminated cask. The personnel barrier for the NLI-1/2 can be removed as one piece while the NAC-1/NFS-4 barrier has a removable top. The rail cask personnel barrier is a "clam shell" type structure which opens at the top and hinges out to the sides. Sketches of the personnel barrier configurations are presented in Appendix G.

The existing personnel barriers consist of "expanded metal" material. This design allows convective and radiative heat dissipation resulting from short cool time fuel and is lighter in weight than solid barriers.

The NLI-1/2 cask personnel barrier is expanded aluminum material which is subject not only to fatigue tearing due to flexing and vibration, but also to damage due to unintentional contact during removal, storage and installation. Frequent repairs (approximately every tenth shipment) to the barrier have been required, but no patterns of failure have been identified. The general structural weakness of expanded aluminum, combined with the difficulty of welding the material after failure, may lead to consideration of other materials or different configurations.

In addition to the generalized maintenance problem, the barrier must be removed in one piece from the trailer to access the cask. This requires storage space for the barrier when it is removed.

The NAC-1/NFS-4 personnel barrier is a painted carbon steel "fence" in a frame. The frame is welded to the trailer and is not removed. Gates in the barrier allow access to the cask. The top of the barrier is the same material and is removed as one piece. It requires much less area than the NLI-1/2 barrier because it can be rested on one edge. The top piece is clamped to the permanent frame during transport. Perhaps because of the strength of the carbon steel, no damage due to vibration or flexing in transit has occurred.

Expanded metal allows casks to be exposed to rain, dust and mud during transit in inclement or winter weather, but accumulation of grime on the cask has not been a significant problem except in very cold weather. Accumulation of road grime is discussed in Section 2.3.4.

The NLI-10/24 personnel barrier "clam shell" is also expanded aluminum. Because the rail cars have not been used extensively, there is no indication of the same kind of failures that have occurred with the NLI-1/2 truck cask. Since the rail car has a much more stable ride, it is expected that much less flexing damage would occur. Although the rail car personnel barrier stays on the rail car, when it is open, the clam shell design requires large side clearances to allow access to the cask.

2.2.5 Auxiliary Equipment and Tools

The only auxiliary equipment or special tools carried with the NLI-1/2 and NAC-1/NFS-4 truck casks are slings for removing the personnel barrier, or personnel barrier top. The lifting yoke is typically transported on another

truck in its own container. A separate container for the yoke is required because the yoke becomes contaminated during use. It is not cost effective to clean the yoke to unconditional release limits (less than 200 dpm (beta/gamma) per 100 sq cm), so cleaning is done to either "limited quantity" or "low specific activity" limits. In either case, the yoke is packaged in a strong, tight container and (usually) shipped by exclusive-use vehicle. (Note that limited quantity shipments do not require exclusive-use vehicles).

Items needed for special lifting and handling requirements, such as a lifting yoke extension for lowering the cask into the spent-fuel pool without wetting the crane hook, or large volume vacuum pumps for evacuating the cask cavity when shipping high-heat load fuel, are also typically shipped on a separate truck.

The NLI-10/24 rail car carries with it an auxiliary cooling system that is used to keep the cask cooler than it would be if no auxiliary cooling was used. This allows the receiver to unload the cask without waiting for cool-down once the cask is received. Operation of the auxiliary cooling system is not required during transport, it would only reduce the amount of handling time at the receiving point. The location of the system with respect to the cask is shown in Figure 2.2-5.

2.2.6 Problems

In summary, casks are rugged in design and use passive systems resulting in a low unscheduled maintenance requirement. Truck trailers require frequent maintenance and are the largest source of cask system downtime. The personnel barrier of the NLI-1/2 cask frequently requires repair due in large part to the materials of construction. Operationally, the personnel barriers take up storage space in the cask-handling area. This is frequently a problem, though more of an inconvenience than an operational limitation.

Figure 2.2-5

2.3 Transportation Process

2.3.1 Escorts and Convoys

Escorts are used as required by federal regulations, 10CFR73.37, "Requirements for physical protection of irradiated reactor fuel in transit, and NUREG-0561, "Physical protection of shipments of irradiated reactor fuel," which was issued to assist in implementing the regulation. Escorts are required whenever transiting an "Urban" area as defined in the NUREG. The escort typically consists of one armed, law enforcement officer in a marked, radio equipped vehicle. The escort is required to keep the shipment vehicle in view at all time, including necessary rest, food or fuel stops. The purpose of the escort, as described in the regulations, is to summon assistance in the event of an attempted diversion of the shipment, and to impede the diversion to the extent possible while awaiting assistance.

The preferred escort is from the state police, or highway patrol, since they are not constrained by limited jurisdiction within the state as are county or city police officers. Using state police therefore eliminates the need to coordinate "swapping" escorts as the shipments moves through an urban area that covers numerous local, political jurisdictions.

Private, armed security agents may be used if state or local law enforcement is unable, or in some rare cases, unwilling to provide escorts where they are required. These agents must be trained in accordance with 10CFR73, Appendix D. NAC provides the required training, as well as film badges and survey instruments for the escorts when it is necessary to use private agencies. Local law enforcement officers, including state police and highway patrol officers, are presumed to meet the requirements of Appendix D; but are provided shipment (and container) specific radiological training, if they request it.

Escort requirements can be effected by both state and local laws. Certain states, such as Ohio and Pennsylvania, have "portal to portal" escort requirements. These laws result in escorts accompanying the shipment that could be police, fire or environmental emergency response personnel.

Each cask transport tractor has two drivers, one of whom acts as the escort, to allow continuous transit of the loaded shipment without overnight rest stops. The drivers are not currently required to be armed. When stops are required for fuel, food or maintenance, the cask must remain in view of one of the drivers at all times. If the shipment is also being accom-

panied by an armed escort in compliance with local, state or federal regulations, then that escort must also maintain the cask in unobstructed view during the stop. The tractor is equipped with citizen band radio and radiotelephone that may be used to summon aid if necessary. The radiotelephone is used to periodically report shipment progress, in accordance with a pre-arranged plan. Deviations from the check-in procedures and schedule initiate pre-planned actions on the part of the carrier, and possible the shipper.

The shipment schedule and route are planned in advance. The route is approved by the Nuclear Regulatory Commission, as provided for by 10CFR73.37(B), (7). The schedule for the shipments is provided to the NRC at the same time as the route information. Schedule and routing information is also provided to the states in accordance with 10CFR73.27. Shipment routing information is considered to be public, but schedule information is withheld as "safeguards information," except from those with a demonstrated need to know. Safeguards information is discussed in NUREG-0794.

Convoy shipments of two or three truck casks have been previously used for spent fuel shipments, but escort and transit arrangements must generally be discussed with the affected state(s).

Copies of 10CFR73.27, 10CFR73.37 and 10CFR73, Appendix D are presented in Appendix F.

2.3.2 Inspections

Pre-transit inspections are performed to ensure that the transport vehicle meets the Department of Transportation's (DOT) requirements for transporting radioactive materials. Trailers are inspected by the carrier prior to departure to be sure that lights, signals, tires and brakes work properly and that the load is secure. This inspection may also be conducted by the cask user. Vehicle inspections are also discussed in Section 2.2.2, "Transporter Maintenance Experience." A typical vehicle inspection preshipment check list is shown in Figure 2.3-1.

As discussed in Section 2.2.2, states have become more active in spent-fuel shipment inspections, especially in large shipping programs. These inspections can be quite detailed and have included measurement of brake actuator travel and deceleration tests. States also inspect shipments in transit, but usually do not delay the shipment to correct any observed minor non-safety related deficiency. The typical practice is to issue a citation and prevent the trailer from re-entering the state until the

Pre-shipment Check List

TRACTOR NO.	INSPECTING TERMINAL	DATE
-------------	------------------------	------

Tires (no fabric exposed through tread or sidewall, no cuts or injuries into fabric, steering axle minimum 4/32", tread groove pattern, drive axle minimum 2/32")

Tread groove pattern good

RECORD T.S.M.T. TIRE BRAND NO.

Steering Axle	Drive Axle	Tractor Spare Tire
LF <u>good</u>	RFO <u>good</u>	NONE
RF <u>good</u>	RFI <u>good</u>	LPO <u>good</u>
	RRI <u>good</u>	LRO <u>good</u>
		LFI <u>good</u>
		LRI <u>good</u>

Remarks

Engine, Cab, Chassis-Clean, No excessive Oil or Grease	<u>OK</u>	Dim	<u>OK</u>
Head Lights (2)	<u>OK</u>	Bright	<u>OK</u>
Turn Signals-Singular	<u>OK</u>	Four Way	<u>OK</u>
Clearance Lights	<u>OK</u>	Oil or Water Leaks	<u>OK</u>
Tail & Stop Lights (2)	<u>OK</u>	Air Brakes (including emergency)	<u>OK</u>
Reflectors Rear of Cab (2) Red	<u>OK</u>	Parking Brakes	<u>OK</u>
Speedometer or Tach Reading	<u>OK</u>	Air Warning Device	<u>OK</u>
Windshield Wipers (2)	<u>OK</u>	Air Pressure Loss	<u>OK</u>
Windshield and Door Glass	<u>OK</u>	Tractor Protective Valve	<u>OK</u>
Horns & Rear View Mirrors	<u>OK</u>	Air Hoses Complete	<u>OK</u>
Steering Mechanism	<u>OK</u>	Batteries & Cables	<u>OK</u>
Exhaust System & Muffler	<u>OK</u>	Mud Flaps	<u>OK</u>
Headache Rack	<u>OK</u>	Coupling Device	<u>OK</u>
Chains	<u>OK</u>	Electric Wiring	<u>OK</u>
Cab Card, Prorate Stickers and License	<u>OK</u>	Brake Shoes-Drums	<u>OK</u>

EMERGENCY EQUIPMENT AND SPARE PARTS

3 Red Emergency Reflective Triangles	3	Hydraulic Jack	1
2 Chuck Blocks	2	Tire Chains	4
1 Lug Wrench	1		
No. Fire Extinguishers	2		
Bulb Kit	1		

TRAILER NO.

Tires (no fabric exposed through tread or sidewall, no cuts or injuries into fabric, Tread groove pattern minimum 2/32") good

RECORD T.S.M.T. TIRE BRAND NO.

Trailer Axle	Trailer Spare Tire
RFO <u>good</u>	
RFI <u>good</u>	
RRO <u>good</u>	
RRI <u>good</u>	
LFO <u>good</u>	
LFI <u>good</u>	
LRO <u>good</u>	
LRI <u>good</u>	

BRAND NO. ON TRI AXLE

Remarks

Clearance Lights: Front	<u>OK</u>	Rear	<u>OK</u>	Stop Lights	<u>OK</u>
Side Markers: Left	<u>OK</u>	Right	<u>OK</u>	Tail Lights	<u>OK</u>
Reflectors: Right	<u>OK</u>	Left	<u>OK</u>	Rear	<u>OK</u>
Wiring	<u>OK</u>			Rear End Protection	<u>OK</u>
Air Loss	<u>OK</u>			Frame	<u>OK</u>
Brake Tubing	<u>OK</u>	Drums	<u>OK</u>	Connections	<u>OK</u>
Relay Valve	<u>OK</u>			Brake Hoses	<u>OK</u>
Mud Flaps	<u>OK</u>				
Cab Card, Prorate Sticker and License	<u>OK</u>				
Other Defects, List	<u>none</u>				

ARGO INSPECTED	YES	NO	B/L No.
----------------	-----	----	---------

Cargo Taped	<u>OK</u>	Seals Intact	<u>OK</u>
Height of Cargo	<u>N/A</u>	Placards Correct	<u>OK</u>
Driver's Physical Cards	<u>OK</u>	Driver's Logs	<u>OK</u>
Driver's Pre-Trip & Vehicle Condition Report Up to Date	<u>5-15-86</u>	Yes	<u>X</u>
		No	

Driver's Signature:	Inspector's Signature:
---------------------	------------------------

Figure 2.3-1

deficiency is corrected. In the case of a safety related deficiency (such as brakes, tires, etc.), the state may detain the shipment. However, due to the comprehensive nature of regular and pre-shipment inspections, any safety-related deficiency is most likely to be found and corrected prior to shipment.

Radiation surveys of the cask are necessary to be sure that the general area radiation (both gamma and neutron) and surface contamination are within the limits of the DOT regulations (principally 49CFR173 and 177). Documentation of the survey results must accompany the shipments. Typical survey documents are shown in Appendix H.

Placards are posted on the trailer to indicate to emergency personnel the type of material being shipped.

States have the authority to survey the cask to make sure radiation levels are within Federal regulatory limits and several states have done this. Normally, only radiation levels are measured since surface contamination is of less concern and access to the cask is restricted by the personnel barrier.

2.3.3 Dispatch Operations

Dispatch operations are normally handled by the carrier, and NAC is not directly involved. NAC does audit the carrier to assure that procedures are in place for notifying the proper personnel in the event of emergencies; obtaining permits and clearances; handling safeguards information; and training drivers. The basis for NAC's audit is to verify compliance with the requirements of 10CFR73.37, including Appendix D, portions of which are presented in Appendix F. Additional guidance for formulating the audit plan can be developed from NUREG's 0561, "Physical Protection of Shipments of Irradiated Reactor Fuel," and 0794, "Protection of Unclassified Safeguards Information."

The carrier obtains permits for over-dimensional loads (if required) and for radioactive materials transport where required by state law. NAC has requested carriers to obtain overweight permits for shipments where it has been necessary to transport the lifting yoke with the cask. Addition of the yoke weight (approximately 2,000 pounds) can make a given axle set overweight, even though the total vehicle weight is less than 80,000 pounds.

Tractors used for transporting spent nuclear fuel are checked by the NRC to meet certain safeguards requirements including alarms and means of immobilizing the vehicle to prevent diversion of the shipment, and communication equipment to summon assistance. NRC personnel conduct on-site visits at the carriers facilities to verify operation of disabling devices and other equipment.

Drivers must be trained in radiological safety and threat response according to NRC guidelines (10CFR73, Appendix D). Driver training is periodically reviewed by the NRC.

NAC coordinates delivery of equipment and also monitors shipment status through the dispatcher or in special cases by establishing contact with the tractor or escort vehicles.

2.3.4 Accumulation of Road Grime

Accumulation of road grime and dirt is not a significant in-transit problem except in winter when ice, slush and road salt can build up on the cask. Buildup can occur when the contents have a low thermal output or the cask is empty. This allows the cask surface temperature to reach the point that slush can freeze on it. Slush must be removed before the cask is used. During handling operations, the impact limiters and personnel barrier must be placed in an area where any ice melt or runoff can be controlled since it is potentially contaminated. The cask is washed off in the cask decontamination pit, unless there is a separate washdown pit, to prevent salts and road contaminants from entering the spent-fuel pool. In NAC's experience with truck casks, road grime and dirt has not been a significant problem and the cask is frequently used in the "as received" condition.

2.3.5 Problems

The most common in-transit problem in winter, is associated with weather delays. NAC attempts to avoid in-transit delays by not releasing shipments until weather is not likely to be a factor. In-transit delays should be avoided since they increase safeguards costs and public concerns. Weather also influences equipment performance. Cold temperatures reduce the effectiveness of gaskets and seals on the transport vehicle and can result in delays for repairs.

A significant problem associated with the transportation process has been coordinating shipment escorts. This problem can range from a reluctance or refusal to provide escorts, to a relatively simple matter of escorts meeting the shipment at a given location and/or time.

While the cask and transporter system are extremely rugged and reliable, two hardware-associated problems involve personnel barriers and "weeping." As described in Section 2.2.4, the barriers often require repair, and should therefore be designed to accommodate transport conditions. They should also provide more protection against weather to reduce exposure to ice, salts and road dirt.

Casks operated by NAC that have experienced the so-called "weeping" phenomenon, where by casks that have been decontaminated to below regulatory limits for shipping, arrive at the destination with measured smearable contamination above the regulatory limits.

About one percent of the total number of shipments made (including empty shipments) have had increased levels of contamination at one or more spots. To date, extensive research has not been done on the weeping problem. NAC has taken an operational step intending to control the tendency of the cask to weep, requiring that beta radiation readings be taken periodically during use, as an indicator of the amount of radioactive material on the surface of the cask. If the reading is above 25 mr per hour, NAC recommends aggressive decontamination methods be used to reduce the amount of material on the cask surface. Aggressive decontamination may include the use of citric acids and permanganates, or commercial active cleaners. Choice of the decontamination method is left to the user, to allow compatibility with waste-handling systems and site environmental concerns. Since NAC has recommended the use of beta measurements, since about 1981, there has been no clear pattern of reportable contamination incidents; prior to 1981, high cask surface beta readings were always found.

It should be noted that some cases of high smearable found on receipt result strictly from poor decontamination techniques (on a per-shipment basis) and from differences in smear efficiency between the shipping and receiving site.

While it is important that future cask designs consider decontamination and weeping in the selection of materials for the exterior, there is no body of data supporting one material over another (among the logical materials of choice). An important aspect of weeping is not only the elimination of reportable incidences, but achieving a reduction in the increase in smearable levels between shipment and receipt.

NAC has experienced no damage to its casks or their contents during transport except as discussed in Appendix J. Damage has occurred to personnel barriers, due to vibration and flexing, and in one case, a main support beam of a trailer failed in transit.

The main frame I Beam on the right side of the trailer cracked near the rear of the trailer, through the bottom flange and extending upward through the web approximately 15 inches toward the top flange.

Repair of the damaged area was completed at a local equipment repair shop. To complete the repair, the main frame was jacked up to a point where the separated metal was brought together. The cracked area was then ground out so that a full penetration weld could be made over the entire cracked area. The weld was made from both sides of the flange and the web. After completion of the welding, the outside of the web (over the cracked area) was reinforced with a 3/8 inch thick by 5 inch radius half moon type reinforcing plate which spanned the crack. The plate was welded in place.

The top side of the flange, both inboard and outboard, was also reinforced using an A-36 material.

All welding was done with 7018 and 7024 filler rod. Additional visual inspection of the same area on the other side of the trailer did not disclose any signs of failure. The remainder of the trailer and cask tie downs were visually inspected with no evidence of damage or base material failure.

I-beams on other trailers of the same design were reinforced with steel plates as shown in Figure 2.3-2.

Human error has caused only minor problems in past shipments and has not been a significant factor in transporting spent fuel.

1. IDENTIFICATION - NAME & DATE OF BIRTH.
 2. ADDRESS & PHONE NO. ROOM NO. & FL.
 3. STANDARD ROOM NO. & FL. LAST NAME.
 4. STANDARD ROOM.
 5. STANDARD ROOM NO. & FL.

[illegible]

ALL INFORMATION CONTAINED
HEREIN IS UNCLASSIFIED
DATE 08-11-2010 BY 60322

SECTION AA

Reinforcement Added

Reinforcement of the NLI-1/2 Cask TSI Trailer

Figure 2.3-2

2.4 Preparation for Lifting

2.4.1 Transport Packaging Removal

Upon arriving at the destination, the personnel barrier, front and rear impact limiters and cask tie down bolts must be removed. This can be accomplished in the cask receiving area using an auxiliary crane or they may be removed using a portable crane before entering the receiving area.

Both the front and rear impact limiters of the NLI-1/2 cask are attached by bolts to the cask body. The impact limiters are removed by removing the bolts and attaching slings to the impact limiters at lifting points. The slings are stored in the same box as the lifting yoke. The auxiliary crane is normally used to move limiters to a preselected storage location, but the main crane or a mobile crane can also be used. The handling steps are outlined in Appendix I.

The NAC-1/NFS-4 cask has built in impact limiters at the bottom and on the side of the cask at the top. These limiters are not removable, being an integral part of the cask body. A removable limiter does cover the top of the cask and it must be moved to remove the cask from the trailer. It is attached by bolts which must be removed, but it rests on a tray that allows it to slide away from the cask after it is unbolted. This has the advantage of not requiring a crane. The handling steps for this cask are also outlined in Appendix I.

The NLI-10/24 impact limiters are attached by pins, which must be removed before the impact limiters can be moved. Once the pins are removed, the impact limiters are moved by crane to a storage location. As in the case of the truck casks, the handling steps are outlined in Appendix I.

The lifting yoke, which may be shipped on a separate truck in its own container, is installed on the cask handling crane using suitable diameter pins. A variety of pin sizes and sleeves are available for a proper fit, and spacers are used to center the yoke on the hook. The yoke is adaptable to single pin (for J-hook) or double pin (for sister hook) cranes. When attached to the crane hook, the yoke is lifted and positioned directly above the lifting trunnions of the cask. The yoke is then lowered and the lifting arms are attached to the cask trunnions.

After checking for proper engagement, the cask is lifted off the transporter by raising the crane hook and allowing the cask to pivot on the lower trunnions from the horizontal to vertical position. To ensure that the load is centered below the crane, the crane must move slowly rearward or the transporter must be moved forward. When in the upright position, the crane cables, hook and lower trunnions must be aligned in the vertical plane to prevent swinging the load when it is lifted off the lower trunnions. A wooden disk is attached to the cask bottom to protect both the floor and the cask from damage when the cask is clear of the transporter. The cask is then moved to the cask washdown pit to prepare it for immersion in the spent-fuel pool.

When removed, the personnel barriers require storage space, but this can be outside of the cask handling area. The impact limiters, which are roughly twice the cask diameter, should be stored in an area where they will not be damaged. The impact limiters for the NAC-1 can be stored on the trailer. The yoke shipping container should be stored in an area near the cask decontamination pit since it also contains test fixtures and spare parts.

2.4.2 Storage Requirements

When removed, the personnel barriers require storage space (approximately 8 1/2 feet x 25 feet for the NLI-1/2), but this can be outside of the cask handling area. The NLI-1/2 impact limiters, which are 6 1/2 feet in diameter, should be stored in an area where they will not be damaged. The impact limiter for the NAC-1, and those for the rail cask, can remain on the transporter. The yoke shipping container should be stored in an area near the cask decontamination pit since it also contains test fittings and spare parts.

2.4.3 Operating Time

The time required to prepare the cask for lifting and actually moving it off the transporter is about two hours (for the truck casks, and about six hours for the rail casks) if the operators have no experience with the particular cask.

With experience, removal of the NLI-1/2 and NAC-1/NFS-4 casks can be completed in about 30 minutes. The NLI-10/24 cask can be removed in about 90 minutes, if the auxiliary cooling system is not in operation.

Failure to prepare for receipt of the cask can result in much lost time. It is important that the receiving site have tools, personnel and storage space available as well as a load tested crane; and that the receiving and handling procedure be reviewed by the site personnel. In some cases, up to a day and a half has been lost gathering technicians and equipment to begin work on the cask.

2.4.4 Special Equipment

No special equipment is normally supplied by the cask user during lifting, unless a hook to yoke adaptor is required and the user has elected to supply it. The lifting yoke, accessory fittings and slings for lifting the personnel barrier are provided by NAC. Since the yoke pins may weigh up to 100 pounds, NAC provides a pin handling tool to make handling the pins easier. In addition, pin trays can be attached to the yoke to support the pin during insertion or removal. The pin tray(s) are shown in Figures 2.4-1 and 2.4-2. The pin handling tool is a 3 foot long, 1 inch diameter steel rod, threaded on one end to screw into the end of the pin. The leverage provided by the rod facilitates pin handling. Other tools required for cask disassembly/assembly are supplied by the facility.

2.4.5 Grime Removal

Grime accumulation on the cask surface has not been a significant problem except in winter weather. If the cask is empty, or the contents have a low thermal output, the cask surface can become sufficiently cold that slush, snow and freezing rain will stick to the surface. Mud and salts that are in the slush must be removed before the cask is placed in the pool. This is normally done in the cask decontamination pit, although some facilities have separate washdown pits. In any case, material washed from the cask is considered to be contaminated due to its contact with the cask surface, and it is processed through the liquid radioactive waste system. Site personnel make the determination to washdown or not, usually during the receiving survey.

Normally, only service water is used for "grime" removal. Decontamination is not (normally) done, because the cask is being prepared for either loading or unloading and will enter a pool or hot cell.

Decontamination is discussed in Section 2.8.5.

NL 1/2 LWT LIFTING YOKE A

Figure 2.4-1

NL 1/2 LWT LIFTING YOKE B

Figure 2.4-2

2.4.6 Damage Experience

Damage has occurred when the alignment guide bracket (required when attaching the yoke to the cask underwater) was not removed prior to lifting an NLI-1/2 cask off the trailer. With the bracket installed, the yoke cannot rotate on the trunnions as the cask is raised from the horizontal to vertical position. The yoke must be checked to verify that the brackets are not installed prior to use of the yoke for cask removal.

The impact limiters can be damaged relatively easily if improperly handled during removal or storage. They have been damaged by over-tightening attachment bolts, lifting without verification that the limiter is free of the cask, dropping and other "impacts" that could split weld seams, and puncture with fork lifts and other equipment. Repairs must be made to ensure that the limiter is in compliance with the original, license design parameters.

Since most damage that does occur in this phase of cask operations is due to operator error, only careful training and attention to detail by the cask operators will prevent damage. Cask operators who understand the reason for specific actions are less likely to make mistakes. For example, it is not clear to casual observer that the yoke cannot rotate with the alignment bracket installed. The need for removal must be explained. (The alignment bracket is shown installed on the yoke in Figure 2.4.2.).

2.4.7 Radiological Experience

NAC has no specific data on radiological exposure relative to this phase of cask operations. However, the exposure is more a function of the radiation levels of the controlled area than of the casks. The general area radiation level is frequently higher than that from the empty cask. Cask surface contamination does not measurably contribute to radiological exposure, even if weeping occurs. Since the closure lid(s) are still in place during lifting, there is no danger of spreading internal contamination.

As previously stated, it is unusual for the empty cask to have a general radiation level that is measurable above the background once the cask is in an unloading bay. At most stations the general radiation level is .5 to 2 mr per hour, but in certain cases, background has been 10 to 15 mr per hour. High levels result from waste and irradiated or contaminated equipment stored in the work area.

The radiation field associated with the loaded cask is a function of the contents. With the design basis contents (one PWR assembly, 3.35 w/o enrichment, 40,000 MWD/MTU burnup, cooled 150 days), the calculated dose rate is 50 mr per hour at two feet from the cask surface. Measured dose rates have varied from two mr per hour to about 70 mr per hour. The calculated dose is about three times higher at the top (front end) of the cask at the same distance. Calculated dose rates with the outer lid of the NLI-1/2 and NLI-10/24 casks removed is shown in Figure 2.4-3, 2.4-4 and 2.4-5.

2.4.8 Auxiliary Equipment Maintenance

The lifting yokes require annual load testing in accordance with ANSI 14.6, and are inspected prior to each use. The NLI cask yokes use remote operators for attachment/removal from the cask when it is underwater. Maintenance on this system may include replacing hoses, cylinder or valves associated with the pneumatic actuators. Personnel barrier removal slings also require annual load testing and disposal when they are frayed.

Sketches of the lifting yoke(s) used with the NLI-1/2 cask are shown in Figures 2.4-1, 2.4-2, 2.4-6 and 2.4-7, including the redundant configuration and the general load test arrangement. Two types of yokes are available. The type A yoke is designed for use with either "J" hooks or "sister" hooks. The type B yoke is used with "J" hooks.

The lifting yokes used with the NLI-10/24 rail casks are identical in design to the NLI-1/2 yokes, but are larger.

The NAC-1/NFS-4 yoke is designed for use with "J" hooks, and requires an adaptor for use with a "sister" hook.

The configuration used for load testing is not considered to be critical. It is only necessary to ensure that the test load is applied with the yoke arms perpendicular to the strong back and that the entire load path is tested. The NAC-1/NFS-4 yoke is load tested to 1.5 times the working load (49,000 pounds) and the NLI cask yokes are tested to two times the working load. Testing to 1.5 times the working load is required by current standards; in its operating procedures NL Industries included the factor of two for load testing and it has not been changed by NAC.

A description of the visual inspections of the yokes is presented in Figure 2.4-8.

NLI-LWT Cask
 Estimated Dose Rates in Mrem/Hr.
 1 PWR Fuel Assembly (454 Kg Uranium)
 Enrichment 3.35 w/o U-235
 Burn-up 40000 MWD/MTU
 Specific Power 40 Kw/Kg
 150 Day Decay

Impact Structures
 Outer Closure Head
 Inner Closure Head
 Cask Cavity

Removed
 Removed
 On
 Dry

Figure 2.4-3

NLI-LWT Cask

Estimated Dose Rates in Mrem/Hr.

1 PWR Fuel Assembly (454 Kg Uranium)

Enrichment 3.35 w/o U-235

Burn-up 40,000 MWD/MTU

Specific Power 40 Kw/Kg

150 Day Decay

Impact Structures

Outer Closure Head

Inner Closure Head

Cask Cavity

Closure Head Cavity

Removed

Removed

On

Dry

Water Filled

Figure 2.4-4

Figure 2.4-5

HEADROOM REQUIREMENTS LIFT YOKES "A" AND "B"

NLI 1/2 LWT CASK

Figure 2.4-6

ARRANGEMENT FOR LOAD TESTING
TRUNNIONS AND LIFT RIG

Lift Rig and Lifting Trunnions Tests and Inspections

Before each use, lift rigs will be inspected for visual damage or distortion that would jeopardize the safety of the lift. If a lift rig is dropped, structurally damaged or subjected to a load greater than the design load of 48,000 pounds, a detailed visual and penetrant test is necessary before further use.

Annually, a penetrant test is required on all welds. Also, a yearly hydraulic inspection is required on lift yokes so equipped. Connect the hydraulic master unit to the cylinders on the lift rig and test for leaks by operating the system. Check for undue pressure build-up, over 30 psig, that may signify a bind in the arms or in the cylinders themselves. Check the condition of the attachment hoses, all lengths, and snap tight fittings for wear and leakage. If any of the hydraulic cylinders are found to be defective, disassemble and inspect; and repair or replace.

A load test must be performed at least once a year. The method of load testing is as follows:

Test Conditions:

- a. Shipping cask assembled with all internals and filled with water to the following extent: Water jacket filled with deionized water - ethylene glycol mixture. The top and bottom impact structures will not be attached.
- b. Hydraulic jacking arrangement including fixturing to provide supplementary loading on lifting rig and cask trunnions.

Test Procedures:

Lower the lifting rig over the cask and engage two (2) opposing trunnions. Lift cask approximately one (1) inch from floor. With the aid of fixturing that will transmit the load from the face of the cask to the underside of the center of the hook, a calibrated hydraulic jack will apply an additional equivalent load of 50,000 pounds. The jack and gauge should be calibrated as a unit. Hold load for ten (10) minutes. Release load. When this test has been completed for lift rig "A," the load test will be repeated on the other two (2) trunnions with lift rig "B." After all four (4) trunnions and both lift rigs have been tested, perform visual inspection of cask trunnions and lift rig surface. Visually check bearing surfaces for deformation. All weld joints on lift rigs and attaching joint of trunnions to cask are to be liquid penetrant inspected for cracks.

The NLI cask, both truck and rail, yoke arms are actuated by pistons attached to the yoke frame. Although this system has been referred to as a "hydraulic" system, it actually is "pneumatic" that operates on station service air. No hydraulic fluids, which would be incompatible with most pool cleanup systems, are used. Cylinders, couplers, valves and hoses on the yokes are replaced infrequently, with almost all required replacements due to operator damage of the parts. Some replacement of cylinders and couplers occurs due to corrosion because of the sequence of wet use and dry storage.

Occasionally, replacement of the hydraulic hose that connects the yoke control unit and the yoke (approximately 50 feet) is required because user health physics personnel are reluctant to allow shipment of long lengths of hose that could contain water.

2.4.9 Problems

The major problems associated with this phase of cask handling are with support equipment.

Shipment of the cask lifting yoke separately from the cask results in additional cost, handling and coordination problems. The use of special slings, special tools and testing fixtures needed in other phases of cask handling in some sense justifies the use of separate shipment of the yokes because the special equipment can be shipped with the yoke.

Handling of the impact limiters results in damage to the limiters as they are lifted and stored.

Future cask system designs should consider reductions in the amount of handling the impact limiters require, a reduction the use of "special" tools and equipment, and the possible transport of the yoke on truck cask trailers (transport of the yoke on rail cars is not considered to be a problem so long as there is space available).

Transport of the yoke with a truck cask should not be considered if it would reduce the payload of the cask. However, the transport of the yoke is considered more of a weight distribution and packaging problem, than a reduced payload problem for legal weight truck casks designed for one PWR or two BWR assemblies. A yoke could likely not be accommodated on a trailer for a legal weight cask designed to transport more than one PWR or two BWR assemblies.

"Weeping" is also a concern. Future designs should incorporate cask surface features, finishes, or materials that reduce or eliminate the tendency for the level of smearable contamination to increase over time.

2.5 Crane Movement

2.5.1 Special Equipment

During crane movement, no special tools are required beyond those needed to attach the yoke to the cask and crane as described in the previous section. If redundant load path lifting is required, a second yoke must be attached to the cask after the cask is lifted from the trailer. The need for redundant lifting is determined when planning the shipment so the second yoke will be available when needed. A sketch of the NLI cask redundant yoke configuration is shown in Section 2.5-1. Redundant lifting of the NAC-1/NFS-4 cask would not be possible except with uniquely designed equipment, since it has only one set of lifting trunnions.

Extension pieces are required if the facility procedures or technical specifications prohibit the crane hook or block and tackle from coming in contact with the fuel pool water. Using extension pieces requires an additional crane operation since the cask must be placed on an intermediate set-down shelf in the pool to add the extension pieces.

NAC normally designs and fabricates extension pieces, or other special equipment that is needed; but there is no requirement that NAC do so. NAC usually does this work because it is familiar with working with cask lifting clearances, hook and yoke dimensions, NUREG-0612 and ANSI 14.6 requirements, testing and quality assurance documentation. Extension pieces consist simply of long bars with bails on each end that are designed to mate with the user hook and the yoke to be used. The length of the adapter is selected to keep the hook just out of the pool water when the cask is resting in the loading pit at the bottom of the pool.

Shorter extension pieces have been required in cases where the yoke will not mate with the user hook, or if the hook would get wet when the cask is set on an intermediate shelf in the pool. These cases are unusual, however.

The need for special equipment can only be established by review of site cask handling steps by knowledgeable personnel. This is a step that is frequently overlooked by personnel in preliminary planning for shipments.

REDUNDANT YOKES
FOR NLI 1/2
LWT CASK

Figure 2.5-1

2.5.2 Special Handling Requirements

Crane movement generally involves two lifts. The first lift is from the transport vehicle to cask decontamination pit and the second lift is from the decontamination pit into the pool. Special handling requirements are site specific and may place limits on the cask travel paths and lift height. In all cases, care must be taken to verify that the yoke is fully engaged with the trunnions prior to lifting the cask.

Special cask-handling requirements exist in remarkable variety, but do not always involve the use of special equipment. Examples include requirements to:

- Keep the hook dry (requiring extension pieces);
- Meet NUREG-0612 when existing equipment does not meet it;
- Limit lift height of the cask above the floor at all times;
- Limit travel path of the cask;
- Mate the yoke to the hook when they are initially incompatible;
- Limit the rate of fall of the cask in the event of a drop accident; and
- Limit the impact energy of the cask by use of supplemental limiters.

Sample check lists, used internally to help ensure that the major issues associated with making a shipment are addressed, are shown in Figures 2.5-2, 2.5-3 and 2.5-4.

2.5.3 Operating Times

General operating steps, in outline form are presented in Appendix I. The operating times for each general task are presented in the appropriate sections below. The number of personnel required for the entire loading or unloading operation is two, provided one can operate the crane. The number actually assigned at a typical reactor is four. Two technicians, one

PRESHIPMENT CHECKLIST

DATE _____

Shipper _____	Est. Start Date _____
Contact _____	Est. Completion Date _____
Receiver _____	Type Fuel _____
Contact _____	# Shipments _____
	Contract Number _____
	P. O. Number _____

1. Cask Number(s) _____	2. Yoke Number(s) _____
3. Approved Route _____	4. Procedures Sent _____
5. Pressure Test Equipment Available _____	
6. Basket Correct _____	7. Spacer Correct _____
8. Contingency Plan Sent _____	9. Documentation Available _____

10. Notes:

Do you have a current copy of the Certificate of Compliance for the cask?

Is your proposed shipment within the constraints of the Certificate of Compliance or is revision required?

Are you an authorized user of the cask?

Is NAC on your approved vendors list?

Do you have documentation for the cask and its handling equipment? (Drawings, certifications as to required maintenance and inspections and copies of procedures.)

Do you know how NAC cask handling equipment will interface with station handling equipment? (Are special adaptors required? Can station gear go into pool? Is it OSHA and ANSI inspected? Is it operable?)

Has the NAC generic procedure been incorporated into a site specific procedure and been approved by the site and by NAC?

Has station supervision committed to the required level of maintenance, quality assurance and health physics support for receiving, handling, loading, decontaminating and shipping the cask?

Do you require technical assistance for the various cask operations?

Has a route for the loaded shipment been selected and approved by the NRC?

Has provision been made for various notifications of the loaded shipment move?

Is the fuel failed? If so special precautions or actions on unloading may be required.

Figure 2.5-2

Cask Operations Plan

EQUIPMENT AND PRICING CHECKLIST

☐ Proposal ☐ Contract

Shipper _____

Contact _____

Receiver _____

Contact _____

S and M Contact _____

Date _____ By _____

Est. Start Date _____

Type Fuel _____

Shipments _____

Est. Completion Date _____

P. O. Number _____

Proposal Number _____

1. Cask Relocation Plan (Start/End) _____

2. Yoke Relocation Plan _____

3. Fuel Basket Changeout Plan _____

4. Spacer Plan (Fabrication/Installation/Disposal) _____

5. Rod Holder Plan _____

6. User Handling Equipment Plan _____

7. Demurrage Plan _____

8. License Revision Plan _____

9. Pressure Test Equipment/Spare Parts _____

10. Documentation Plan _____

11. Route Submittal Plan _____

12. Engineering Assistance _____

13. Operations Assistance _____

14. Transportation (Carrier) _____

15. Transportation Contingency Plan _____

16. Transportation Management _____

17. Inspections/Maintenance Action Required Prior to Shipment _____

18. Notes: _____

Approved by: _____

Mgr., Cask Ops.

Figure 2.5-3

PRESHIPMENT CHECK LIST

Experience has shown that careful planning and attention to detail can significantly reduce the actual costs and the level of risk of a spent fuel shipment. By addressing the items listed below, prior to the scheduled use of the cask, the user can eliminate most potential problem areas.

1. Documentation

- Are the shipper and receiver registered users of the cask?
- Is NAC an approved vendor?
- Do users have current NAC generic cask handling procedures?
- Is the site handling procedure complete. (Does it incorporate the NAC procedure?)
- Do the users have current copies of the Certificate of Compliance?
- Do fuel parameters meet C of C constraints?
- Is a license amendment required?
- Are cask or yoke compliance notices required? If so, to whom should they be addressed?
- Are drawings of cask or cask handling equipment required?
- If so, to whom should they be sent?
- Is a Quality Assurance Audit of NAC required?
- Is there an Approved Route for the shipment?
- Who will be the contact for the Emergency Plan?
- Who can copies of cask/trailer HP surveys be obtained from?

2. Personnel

- Is NAC technical assistant required?
- Who are the user's lead people?
- Are there identified QA/QC/HP holdpoints?
- What Health Physics/Security Training is required?
- What are the scheduled work days/hours?

Figure 2.5-4

3. Equipment

- How will the cask yoke interface with the station hook?
- What is the plan for cask handling?
- What is the plan for yoke handling? Will it stay on or be removed during loading?
- How will the cask lid be handled?
- Has the station crane been inspected?
- What basket is required in cask?
- What spacer(s) are required? Will they be installed prior to cask arrival at site?
- Are special tools or equipment required at the shipper or receiver's site?

4. Operations

- Is any testing of the cask or yoke required prior to loading?
- How many shipments are scheduled?
- When are the shipments scheduled to start/stop?
- Is any fuel to be shipped, failed?
- Who will handle transportation?
- Who will notify drivers?
- Who will make pre-notification of shipments?
- How will cask decontamination be accomplished?
- What are site radiological release/acceptance levels?

5. Miscellaneous

- Are there any contractual arrangements unique to this site or contract?

Figure 2.5-4
(continued)

supervisor and one H.P. technician. Many more will be "involved" including quality assurance, security, accountability, safety and shipping personnel.

Once the cask is raised off the trailer, travel time to the decontamination pit is approximately 15 minutes. Some sites have unique transfer requirements that can extend the crane movement time. For example, at Connecticut Yankee the cask is transferred to a rail car in order to enter the controlled area. At Oyster Creek, a plate that effectively increases the surface area is attached to the bottom of the cask before it is set down on the refueling floor.

2.5.4 Operator Training

Operator training and experience is vital to crane movement. The crane operator's training varies, but whenever possible, the most experienced operator should be used. The operator should be thoroughly briefed prior to the lift. The briefing should familiarize the operator with the sequence of events and the importance of maintaining the crane cables vertical (centered over the load) to prevent the cask from putting torsional loads on the cask supports and from swinging once it is free of the cradle and rotation fixtures. It should be noted that cask owner (NAC) personnel are normally not permitted to operate cranes in a user facility.

2.5.5 Damage Experience

Damage to cask components has occurred during crane movement due to operator error. If the operator fails to keep the crane centered over the load, the cask will swing once it is free from the lower trunnion supports. On two occasions, a personnel barrier has been damaged by a swinging cask. In one of the cases, the barrier was not repairable. Rotation blocks on the NLI-1/2 lower trunnions have also been broken because of crane operator error.

Because of the very large inertia of a swinging cask, it is very dangerous to lift the cask without due care. NAC does not recommend that personnel be on the transport near the lift-off point when the cask is being lifted from the rear support.

The best safeguard against damage in this phase is to use at least two people to verify alignment of the cask during the lift. NAC is not aware of any mechanical aids designed to ensure proper lifting of the cask.

2.5.6 Problems

This phase of cask operations is highly dependent on the skill of the crane operator. Only qualified operators should be used. The requirement to maintain the cables vertical must be stressed as the key to safe cask movement. Before attachment of the NLI yoke to the cask, the alignment brackets must be removed. The yoke cannot rotate with the brackets installed.

2.6 Preparation for Fuel Loading

2.6.1 Special Equipment

Since a given cask can usually accept both PWR and BWR fuel and many fuel sizes, the appropriate cask internals must be loaded into the cask before loading the fuel in the cask. The correct basket is installed and spacers are provided to ensure that the active fuel length is centered with the neutron shield. Slings to remove the cask lid(s) are required, as well as alignment pins to aid in re-installing the lid underwater.

As a general rule, NAC tries to avoid changing the baskets in the casks. The baskets tend to collect "crud" in use, requiring both exposure controls and decontamination in handling. Sketches of the baskets of the NLI-1/2 and NLI-10/24 are shown in Figures 2.6-1 and 2.6-2. The only significant difference between the NAC-1/NFS-4 and NLI-1/2 baskets is that the NLI-1/2 basket contains a slot for a drain tube in one side. The NAC-1/NFS-4 cask is designed with drains at the bottom of the cask so a drain tube in the basket is not required. For the NLI casks, the drain valve is at the top of the cask, requiring a tube to extend to the bottom of the cask.

Removal of the baskets is accomplished by connecting suitable slings to lifting lugs in the top of the basket and pulling the basket straight out. For the NLI cask baskets, the drain tube must be disconnected from a mounting in the cask cavity wall prior to lifting the basket. The drain tube is designed to remain with the basket; however in practice, the tube is usually removed from the basket and installed in the basket that is to be put in the cask.

The baskets are not bolted or otherwise attached to the cask body, so removal is not a complex operation. The baskets are prevented from rotating by anti-rotation tabs in the NAC-1/NFS-4 casks, and by the drain line attachment block in the NLI casks.

As stated above, changing baskets is avoided if possible. Because of the relatively high radiation level of the basket (from crud that accumulates in the basket), shipping the basket to another location can be difficult. To be shipped, the basket must meet low specific activity limits, or it must have a certified shipping container of its own. This is not cost effective from either a shipping or storage perspective. Some facilities have been "stuck" with baskets for long periods of time (years), because once removed they generally must stay in a pool or hot cell.

Figure 2.6-1

NLI-10/24 Rail Cask

BWR Basket Detail

Figure 2.6-2

Fuel assemblies of different designs have different lengths which are accommodated by the use of spacers. Spacers can be installed in the bottom of the basket, bolted to the under side of the lid, or may be installed in both places. Sketches of typical spacer designs are shown in Figures 2.6-3 and 2.6-4. Bolts are used to attach spacers to the under side of the lid. Spacers installed in the bottom of the basket are merely lowered into position using a rope or a long rod that is threaded on the end. (Such a rod must be used to remove a bottom spacer).

Spacers are usually fabricated by NAC and installed by NAC or the cask user. They are installed when the cask is empty, just prior to loading. In general, the facility that changes a spacer must dispose of the removed spacer.

Alignment pins for the NLI casks inner lid must be manually installed as part of the loading or unloading procedure. Alignment pins for the outer lid are not required because the lid is accessible and can be aligned by hand. The pins are installed before the cask is placed in the pool for either loading or unloading. The NAC-1/NFS-4 cask has only a single lid and the alignment pin for the lid is built into the cask body. Alignment pins are required in order to ensure that the bolt holes in the lid and threaded portion of the bolt hole in the cask body align so that bolts can be installed without difficulty.

The outer lid of the NLI casks is removed during cask preparation for loading or unloading. Shielding and containment is provided by the inner lid. The inner lid must stay on, and be removed underwater, if the cask is being unloaded. It must be installed underwater if the cask is being loaded. The lid handling for the NAC-1/NFS-4 cask is the same as for the handling of the NLI inner lid.

2.6.2 Special Handling Requirements

After removing the lid(s) from the empty cask, sealing surfaces and seals are inspected and seals are replaced if required. Verification of liquid neutron shield is required prior to loading fuel. NAC provides snap-tite connectors to connect cask valves with the facility inert gas (if loading), air and water supply.

Only common hand tools are required to remove lid bolts, port cover bolts, seals and O-rings. When removing lid bolts and port covers, good mechanical maintenance practices should be followed to protect sealing

PWR Spacer

Assembly As Shown
Scale: 1" = 1"

PWR SPACERS

Part Number	A	B	Case Case Length	Case Case Length	Material	Material
SP-1-1	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-2	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-3	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-4	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-5	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-6	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-7	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-8	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-9	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-10	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-11	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-12	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-13	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-14	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel
SP-1-15	1.00	0.50	12.00	12.00	304 SS	304 Stainless Steel

Typical Bottom Spacer

Typical Lid Spacer

Truck Cask Spacer Assembly (PWR)

Figure 2.6-3

60

surfaces and threads from damage when not installed on the cask. A plywood sheet is required to protect the bottom of the cask when it is set on the floor and on the bottom of the fuel pool.

2.6.3 Experience With Wet/Dry Loading

Casks can be used for either wet or dry fuel loading. Truck casks have been used extensively for both kinds of loading and no significant differences in handling (other than filling and draining in wet handling) have been noted. To date most rail shipments (IF-300) have been wet loading and unloading.

2.6.4 Operating Times

As previously mentioned, operating times are discussed in conjunction with the activity. Two technicians are assumed to be assigned, although in practice other personnel are also present.

Pre-loading operations take from one to two hours. Wet loading times take about two hours primarily due to the need to fill the cask with demineralized water prior to lowering it into the fuel pool. This is required to prevent turbulence and splashing that would occur if pool water rushed into the empty cask cavity, possibly resulting in airborne contamination. Dry loading preparation takes about one hour.

2.6.5 Damage Experience

Damage that has occurred in this phase of cask operations has been to improperly protected bolts and valve port covers. The bolts are replaced and port covers can be polished or ground to remove scratches, if necessary.

2.6.6 Problems

No significant mechanical problems have occurred during preparations for loading. Handling removed baskets can be an operational problem because of the radiation field as discussed in Section 2.6.1 and in Section 3.3.

2.7 Fuel Loading

2.7.1 Special Equipment

Some special equipment is required for fuel loading. Calibrated torque wrenches of various sizes used to reassemble the cask after fuel is loaded are supplied by the facility. A closed circuit TV system with an underwater TV camera is recommended to monitor the fuel assembly insertion into the cask and the underwater cask lid installation. Since fuel pool lighting is typically poor, underwater drop lights which can be lowered from the pool edge or bridge crane are usually required.

Shipment of failed fuel or fuel that is warped, bowed, flattened or blistered can be made in the NLI-1/2 cask (only) but requires an inner liner to containerize the fuel. This precaution is taken so that in the event of further fuel degradation during transit, damage and contamination of the cask cavity is minimized.

The inner container, referred to as the NLI-1/2 configuration A, is shown in Figures 2.7-1 through 2.7-3. The inner container consists of a steel liner that has basket inserts to accept either PWR or BWR fuel. This liner replaces completely, the regular basket configuration shown in Figure 2.6-1. An Additional procedural step is required when configuration A is used, that is associated with removal of (pool) water from the space between the configuration A liner and the cask cavity after loading. The step is not significant and adds no more than 15 minutes to the cask handling time.

None of the NAC operated casks can be shipped with water in the cask cavity. All shipments, empty, spent fuel or high level radioactive waste, must be made with the cavity (and contents) dry. For spent fuel shipments, the cavity must contain an inert gas (helium, nitrogen or argon) supplied by the cask user.

2.7.2 Handling Requirements

The cask is lifted into the pool and placed in the designated set-down area. When the cask is properly positioned, the yoke is released remotely and the cask is ready for fuel loading.

Using the spent fuel handling machine or bridge crane, the fuel assembly is grappled, lifted from the storage position and lowered into the cask cavity. The underwater TV camera is useful in observing this operation. When the fuel is properly positioned in the cask, the closure lid is lifted by

Configuration A

NLI-1/2 General Arrangement

Figure 2.7-1

Configuration A PWR And BWR Baskets

NLI-1/2 Cask

Figure 2.7-2

slings attached to the yoke and lowered onto the cask. With the aid of the TV camera, the lid is properly positioned with the alignment pins and lowered into position. Care must be taken to prevent damaging the sealing surface of the lid as it is lowered into position.

With the lid in position, the cask is re-engaged by the yoke, and after proper engagement with the trunnions is verified, the cask is raised to the pool surface. When the cask top is at a convenient height relative to the fuel handling bridge, the lift is stopped and lid bolts are installed hand tight. When the lid is fastened, the cask is sprayed with demineralized water as it is lifted out of the pool and moved to the decontamination pit. When the cask is positioned in the pit, the lid is sealed by tightening the lid bolts using the sequence and torque value specified in the cask handling procedure. It is unusual for the loading or unloading process to take more than one hour. A large percentage of the handling time is the cask raising and lowering time, a function of the speed of the crane.

2.7.3 Fuel Condition

More than 99 percent of the fuel that NAC has shipped has been considered "sound" fuel, having not more than pin-hole leaks or very small cracks in the cladding. The remaining fuel is classified as unsound, either failed or distorted. Distorted fuel is fuel that has damaged grids or bowed rods but is not known to be failed or leaking. Failed fuel is leaking fuel with broken rods or gross cladding failures.

In either case, the approach is to use separate containers to ship unsound fuel.

Shipment of fuel that is failed, but in other respects is sound, (that is the dimensions of the assembly are still within the original design dimensions of the fuel) is accomplished using the NLI-1/2 configuration A and an inert atmosphere around the fuel to inhibit oxidation of exposed fuel.

For fuel that is dimensionally distorted, the fuel is inserted in a separate container that will fit in the cask basket, and then the container is loaded in the cavity. The reason for using a separate container is to avoid the possibility that the distorted assembly will become jammed in the basket and be difficult or impossible to remove.

It is relatively simple to snip off grids that are torn or project outside of the design envelope of the assembly, and distorted rods can usually be put back in position by using bands around the assembly. Other defects may call for other measures, but in general, fuel can be shipped if it must be.

Shipments of failed fuel in inert environments has proven to be relatively risk free, but as stated, additional containerization is used.

2.7.4 Damage Experience

Damage to the sealing surface of the NLI-1/2 cask has occurred in this phase of cask operations as a result of missing the basket opening when lowering containers of metallic fuel or waste into the basket.

Containers of metallic fuel or waste (as opposed to fuel assemblies) are not normally loaded in a PWR or BWR basket, but are inserted directly into the cavity. For these larger containers, there is increased likelihood that the container will strike the seal surface.

A guide to protect the seal surface of the NLI-1/2 cask, shown in Figure 2.7-4, has been designed for fuel assembly loading, but has never been used. A guide for use with the larger waste or metallic fuel containers would be more useful perhaps, but one has not been designed.

If the seal surface is damaged such that it will not pass the seal test, the contents must be removed so that the cask can be removed from the pool and returned to the surface. The damage can then be polished out, or may, in the worse case, require weld overlay and grinding to restore the surface.

No instances of damage to fuel assemblies, or damage to seal surfaces due to an attempted loading is known, except as discussed in Section 3.2.3. Further no damage to seal surfaces of the NAC-1/NFS-4 cask has occurred.

2.7.5 Problems

The most significant problem during fuel loading is usually inadequate pool lighting. Although a relatively simple matter, it can delay or complicate cask operations in the pool.

PWR SEAL PROTECTOR

BWR SEAL PROTECTOR

2.7.6 Radiological Experience

Most radiation dose is derived from general area radiation levels (2-3 mr per hour) of the spent-fuel pool area. Radiation from the cask is a function of the age of the fuel. Incorrect sizing of the fuel assembly spacers could result in higher, but still acceptable, radiation levels by allowing the fuel to be improperly positioned with respect to the cask shield.

Calculated dose rates for the NLI-1/2 and NLI-10/24 casks for the design basis fuel assembly are shown in Figures 2.4-1 through 2.4-3. The calculated dose rate for the NAC-1/NFS-4 cask are within 10 percent of the NLI-1/2 values.

NAC has no measured dose data that has been obtained on an operational step basis. It must be noted that a very good estimate of total dose could be obtained by measuring the background in the (specific) work area and multiplying it by the time spent in the area.

2.8 Preparation for Shipment/Receiving

2.8.1 Special Equipment

To prepare the cask for shipment, an adequate supply of helium, nitrogen or argon, is needed to purge the cask cavity after it is drained of water. Test fittings and gages used to monitor pressures while testing cask seals are provided by NAC. If high-thermal output (greater than two kilowatt) assemblies are to be shipped, a vacuum pump is used (after the draining operation) to evacuate residual water from the cask cavity which could change to steam, resulting in an unacceptable pressure rise.

2.8.2 Handling Requirements/Procedures

To prepare the cask for shipment, the cask cavity (filled with pool water for wet loading), should be flushed with demineralized water through the drain and vent valves on the cask. Approximately two cask cavity volumes of water (approximately 180 gallons) are replaced, with water samples taken for activity analysis before and after flushing.

The lid seal is checked by pressurizing the cask cavity as specified in the cask-handling procedure, and checking for evidence of leakage. If the seal is unsatisfactory, re-torquing the lid bolts, or moving the cask back to the fuel pool, and removing the fuel may be required to allow inspection of the seal surfaces and replacing the seal to achieve a satisfactory seal.

2.8.3 Cleaning Operations

The only operation that may be considered as "cleaning" is the flushing of the cask cavity prior to the removal of the pool water as discussed above.

The purpose of flushing is to remove as much of the contaminants of the pool water as possible, as well as to flush out any "crud" that may have come off of the fuel assembly as it was inserted. It should be noted that the path from the basket to the drain valve is tortuous and flushing is not a highly effective means of crud removal in the present cask designs.

All other internal cleaning operations are more properly considered decontamination, and are discussed in Sections 2.9.9, 3.3.3 and 3.3.4.

2.8.4 Drying Operations

After the lid is sealed, the water remaining in the cask cavity is forced out into the decontamination pit drain, or the pool, using low-pressure (25 to 30 psig, normally) compressed air or an inert gas. If high-thermal output assemblies are loaded, the vacuum pump would then be used to evacuate the cask to ensure that the cask cavity is dry. The cask is then back-filled with an inert gas and maintained near atmospheric pressure for shipment.

When the cask cavity is sealed, dried and backfilled, the outer lid (NLI-1/2 and NLI-10/24 casks) is installed. The outer lid seal is then checked by pressurizing the cavity between the inner and outer lids using low pressure air.

NAC's operating procedures require that the minimum vacuum should be less than three mm (millimeters of mercury) for at least five minutes. Tests have shown that at this pressure free water does not exist, and that the pressure is not achieved in the presence of free water or ice at temperatures above -100°F.

2.8.5 Decontamination

Decontamination of the cask can proceed simultaneously with the cask sealing operations to whatever extent is convenient. Once the cask is sealed, decontamination can proceed until the cask is within acceptable limits for release. Decontamination has been performed using both manual and automated methods; however, facilities that do not routinely handle casks will manually decontaminate the cask. Two or three technicians start at the top of the cask and work toward the bottom, using wiping cloths, water and whatever decontamination solution is typically used by the facility. The bottom of the cask is decontaminated as the cask is lifted off the floor of the decontamination pit. Commercially available cleaning solutions are commonly used. Automated methods may include the use of steam cleaners or power sprayers. Decontamination and radiation survey of the cask usually takes two to four hours.

2.8.6 and 2.8.7 Cask Contaminants

The source of contaminants on the cask is the spent-fuel pool water. The contaminants are composed of fission products principally cesium, with small amounts of cerium and traces of strontium and other isotopes. Cor-

rosion product isotopes of cobalt, manganese, iron, zirconium and carbon are also present. Analysis of the contaminants is normally not performed. The weeping mentioned earlier is comprised mostly of cesium.

NAC has not attempted to measure contamination residue on a per-shipment basis and has no per-shipment data.

Once placed in service, contaminant material accumulates on the cask surface, in the cask cavity, and in the basket, during the remaining service.

Figure 2.8-1 shows smearable and radiation measurements taken from an NLI-1/2 cask cavity prior to a recent internal cleaning. (Note that surveys of the basket interior would likely yield generally higher numbers.) Analysis of the contaminants was reported as Cobalt (62 percent), Cesium (36 percent) and Europium (two percent).

As a practical matter, casks are frequently shipped empty as having less than three curies of residual radioactive material.

2.8.8 Testing Requirements

The testing requirements for the three cask models are shown in Appendix D. The procedure steps were outlined in Appendix I.

2.8.9 Damage Experience

No major damage has occurred to a cask in preparing a cask for shipment, except for an instance of seal damage when loading a waste container as discussed in Section 3.2.3. Turning blocks, which mate the NLI-1/2 cask to its tie-down structure have been broken by failure to align the blocks with the cask as it is lowered onto the trailer.

2.8.10 Problems

Cask contamination is the principal problem encountered in shipping/receiving casks. New cask designs should incorporate very smooth surfaces and features that isolate the surface of the cask from the contaminated pool water. Using consistent methods of performing smear surveys for surface contamination would likely reduce incidences of reportable (exceeding limits) contamination. NAC's standard practice for extended shipping campaigns is to bring health physics personnel from

NLI Cask Cavity Radiological Survey

SAMPLE NUMBER	DESCRIPTION AND LOCATION	DPM/100CM ² RESULTS			
		1	2	3	4
	NAC CASK #5462-4	2	88		MR/HR
1	TOP/OUTSIDE LID FLANGE SURFACE	28	12,290		
2	INSIDE LID TOP SURFACE	28	21,630	4.0	MRAD/HR
3	INSIDE LID BOTTOM SURVEY	—	—	100.0	MRAD/HR
4	TOP OF CASK AT HEAD LEVEL	—	—	6.0	MRAD/HR
	3/18/87				
5	INSIDE CAVITY = BOLT HOLES AT 1"	—	—	800	MRAD/HR
6	INSIDE CAVITY = GENERAL AREA	—	—	140	MRAD/HR
7	Sides (Inside) of Cask Average	900	6,000,000	—	—
8	Side (Inside) of Cask Maximum	9000	37,000,000	—	—
9	Inner Bolt Hole Flange	190	1,200,000	—	—
10	Inside Bolt Holes	840	4,300,000	—	—
11	Inside side above flange	40	73,000	—	—
12	Inside Bottom	1100	6,100,000	—	—
	WET TOWEL FROM BOTTOM			400	MRAD/HR
	FUEL BASKET GENERAL			80	MRAD/HR
	FUEL BASKET BOTTOM			350	MRAD/HR
COMMENTS: NMC #341863, CALIB. DUE 8/3/87		TYPE OF SAMPLE: SOIL ☐ WATER ☐ AIR ☐			
2 BKG .3, EFF. 4.3		SMEAR ☒ OTHER ☐ (identify)			
88 BKG 42, EFF. 3.6		TYPE OF ANALYSIS:			
RD-2 #140574, CALIB. DUE 6/1/87		RADIOMETRIC ☒ BERYLLIUM ☐			
LEDGER ACCOUNT _____ CONTRACT OR ORDER _____ SUB-ACCOUNT _____ WORK RELEASE _____		OTHER _____ (identify)			
LOG BOOK NO. _____ PAGE _____					

Figure 2.8-1

each site together so the method of smearing, the number of smears, method of counting and the meaning attached to smear results at each site is understood by both sites.

2.8.11 Radiological Experience

Radiological experience with casks has been fairly consistent. Casks have routinely been found to be in compliance with regulatory radiation limits for shipping after fuel loading. Cask surfaces require decontamination to reduce them to the regulatory limit of 2,200 dpm per 100 sq cm for departure from the facility. There have been instances, however, of casks arriving at their destination with surface contamination levels above the arrival limit for receiving casks of 22,000 dpm per 100 sq. cm, even though contamination levels were within limits when the cask was released for shipment. Casks that are received with levels of contamination above 22,000 dpm per 100 sq cm are not normally decontaminated prior to further handling, unless the smearable is in the range where the site would require respirators. Decontamination is usually the choice over handling the cask with respiratory protection.

Both the Department of Transportation and the Nuclear Regulatory Commission regulations require prompt notification to the shipper, carrier and their regulatory offices for shipments received with reportable levels of smearable contamination. More than a single occurrence between sites that are making repeated shipments is cause for evaluation of techniques and procedural steps to attempt to find the cause.

There have also been a few cases of reported high radiation levels in the cab of the truck upon arrival at the destination. These instances have been attributed to operator and instrument error or high background radiation levels. Confusion as to how and where the measurements should be taken have also led to errors, but these errors have generally disappeared as facilities have gained experience in radioactive material (including low-level waste) shipments.

For shipment of a loaded truck cask, operator dose typically averages 25 to 30 mr each for the technicians (usually two) who do the hands-on handling of the cask. Most of this exposure occurs during decontamination of the loaded cask, which requires close proximity to the cask for about two hours. Other support personnel have much smaller exposure, around 10 mr.

It must be recognized that total exposure from cask handling is a strong function of the age and burnup of the fuel, the number of personnel involved and the time spent handling the cask. Fuel with long decay times will not normally generate a field around the cask that is very much above the loading area background.

The major contributing factors to total dose received by the crew is: first, background level of radiation; and second, exposure during decontamination.

2.9 Fuel Unloading

2.9.1 Special Equipment

The same tools used at the loading facility are required to move the cask and unload fuel at the receiving facility. A pyrometer is required to ensure that there is no more than a 100°F difference between the pool water temperature and the cask surface temperature. Such a large difference is not encountered unless the thermal output of the fuel is near the thermal rating of the cask, approximately 10 kW. The line used to vent the cask should be rated for high temperatures (100°F), but it is not considered a special tool. A high temperature rating is required because water that is introduced to the cask cavity can turn to steam as it reaches the fuel assembly, if the thermal output of the assembly is sufficiently high.

2.9.2 Handling Requirements and Procedures

In general, the steps for unloading the cask are the same as those for loading the cask. Some additional tests are made to avoid thermal shock to the cask surface and to assess the "level of threat" of the contents before the cask is opened.

The fuel assembly generates decay heat which is transferred to the cask surface by conduction, convection and radiation during transport, raising the cask surface temperatures. The maximum surface temperature expected is about 200°F when the cask has the maximum heat load (10 kW thermal) contents. Typical pool temperatures average about 90°F, but can be significantly higher for some weeks following reactor refueling. Good practice dictates that no more than 100°F difference exist between the pool temperatures and the cask temperature; but there is no regulatory or certificate requirement that the temperature difference be controlled. Cooling of the surface is achieved by external water spray, if cooling is required.

NAC has never had a shipment where greater than 70°F temperature difference existed, and external cooling has not been used. No cask has ever generated steam upon immersion in the pool.

The fact that cask surface temperatures can exceed 150°F establishes the requirement for the cask personnel barrier. The purpose of the barrier is to prevent accidental contact with a surface that can be thermally hot.

Before the lid bolts are loosened, the pressure in the cavity is measured and the gas in the cavity is sampled.

The activity of the gas sample is measured as an indication of possible fuel rod failures in transit. In general, readings are not considered significant unless they are in the high tens of mr per hour range. If the activity is high, the sample can be analyzed to determine the major isotopes. The presence of large amounts of Kr-85 in the gas sample can be an indicator that a new fuel failure has occurred.

Trace amounts of Kr-85 will be found in gas samples of sound fuel shipments and some Kr-85 will be present in samples for failed fuel. In general, much of the Kr-85 will out gas when the failed assembly is stored in the pool. In dry transport, the fuel will reach a higher temperature, resulting in internal pressures that will drive additional Kr-85 from failed rods. Failed fuel canisters are not completely sealed, unless the fuel is containerized at a hot cell. Containers loaded in a pool have screened openings so that water may be drained, and these openings allow fission gases to escape to the cask cavity.

High gas sample activity does not preclude unloading; it indicates that problems could be encountered in removing the assembly and that a special procedure may be required.

Pressure in the cask cavity should be 10 psig or less before lid bolts are loosened. Higher pressures can unseat the lid (after the bolts are loose) and allow an uncontrolled release of cavity gas to the work space. As a practical matter, the cavity pressure does not reach 10 psig in normal transport conditions. The vent valve is connected to the off-gas waste handling system and the cask is filled with water prior to the start of bolt removal.

The NLI-10/24 rail cask has a supplemental cooling system that allows water to circulate around the cask cavity cooling the fuel and basket (if necessary) before the start of the cavity filling operation. The truck casks do not have this feature and water enters the cavity directly at the start of the filling operation. For fuel that exceeds two kW thermal, water must be added to the cavity slowly because steam will be generated at the fuel/water interface. Steam will tend to cool the fuel as it rises to the vent valve but the entire fill process can take up to four hours. Rapid filling in high-heat load conditions greatly increases the cask basket and cavity contamination because water turning to steam along the rod surface will remove quantities of corrosion and products from the rod walls and make them available to coat cask surfaces.

For heat loads less than two kW, the addition of water to the cask is of somewhat less concern from a thermal effects perspective.

2.9.3 Fuel Conditions

There have been no known instances of changes in the fuel condition in transit in NAC operated casks except for the 1980 fuel oxidation problem. Conditions surrounding that shipment and the consequences were presented in a paper by Mr. R. W. Klingensmith at a Patram conference in 1981. A copy of a summary of the paper is presented in Appendix J.

The cask basket is designed to support the fuel assembly over its length in transportation and an inert atmosphere is used in the cask cavity. Shipment in casks has not been shown to be a harsh environment for fuel assemblies.

2.9.4 and 2.9.5 Cask Contaminants

Fuel is held in position within the cask cavity by the fuel basket which protects the cavity somewhat from gross contamination. Fuel that is structurally unsound is placed in a container which provides an additional barrier for contamination before it is loaded into the basket. Gross contamination in the form of solid particulates, as well as high levels of "smearable" surface contamination exist on the basket interior surfaces. Fuel rods and grids are in contact with the basket during loading, transit, and unloading, which results in transfer of "crud" to the basket. In addition, particulates vibrate loose from the fuel rods during transport and can collect on the basket. When the cask is in the vertical position, as it is for loading and unloading, most particulates settle to the bottom of the basket. Here they become trapped on ledges and in seams, where a substantial portion of them remain even after flushing operations. Individual particles can have radiation levels from 1 to 10 rems per hour. Particles that escape the basket can become trapped in the bottom of the cask and result in radiation levels in the 10s of rems per hour inside the cask. Without cleaning, surface contamination levels on the cask cavity surface can be in the millions of dpm per 100 sq cm. Even after considerable flushing, the cask basket measures 500 mr per hour at two inches from the outside wall if it is removed from the cask. The interior will measure 10s of rem per hour at the bottom, and 80 to 100 mr per hour at the top. NAC has no specific analysis of cask cavity or basket contaminants; however, it is believed that they are the same as those that contaminate the exterior surface and they are typical of the contaminants found in a pool. Because of the crud which vibrates loose from the fuel, there is more activity associated with corrosion products, consisting of cobalt, manganese, iron, zirconium and similar metal oxides.

2.9.6 Damage Experience

A few cases of damage to fuel has been discovered in the fuel unloading process. In 1980, a fuel assembly was damaged by oxidation of exposed fuel when shipped with air in the cask cavity. Since then, dry shipments have been made using an inert gas (nitrogen or helium) in the cavity. This incident is discussed in Appendix J.

Failure to properly center the fuel-handling crane over the cask cavity has resulted in damage to the fuel assembly grid straps during loading and unloading. This failure was attributed to operator error.

Damage to an assembly end fitting has occurred when a spacer that was one-eighth inch too long was used to position the assembly within the basket. When the lid was bolted into place, damage to the end fitting resulted. The spacer was sized from fuel assembly design information and did not include an allowance for thermal growth of the assembly in reactor use.

The principal reason for the lack of damage to assemblies during loading and unloading operations is that the basket cross section is large (8.88 inch typical PWR) compared to the assembly cross section (7.8 inch typical PWR). The same relative clearances exist for the BWR configuration.

It should be noted that there have been two or three instances of assemblies being only partially grappled during transfer of the assembly from the cask to the rack during unloading. This problem is discussed in Section 2.9.7.

2.9.7 Problems

The most significant problem associated with fuel unloading is the accumulation of activity in the bottom of casks and baskets. Future basket designs should incorporate features that facilitate decontamination or removal of particulates by hydrolazing or other flushing methods.

An additional problem that exists, to which cask design is a contributing factor, is the occasional partial grappling of a fuel assembly while it is being moved from the cask to the storage rack after unloading.

Procedurally, the fuel assembly is grappled using the fuel-handling tool (commonly called the fuel-handling grapple), normally used to move fuel at a reactor site. Care must be exercised by the operator in attaching to the fuel in the cask because the view of the fuel is obscured from the top by the grapple and from the four sides by the sides of the cask. Frequently,

verification of correct grappling cannot be done until the top assembly is raised above the cask top surface. Partial grappling could result in the assembly being dropped during the transfer.

2.9.8 Radiological Experience

NAC has no data on the accumulation of exposure on a per-task basis. In general, the total exposure from unloading operations are less than those for loading operations. The major reason for this is that much less work close to the loaded cask is required, since containment verification testing (1+ hours) and decontamination while loading (2+ hours) are avoided. Average exposure for each of two technicians performing hands-on work unloading the cask is estimated to be 10 to 15 mr, again depending to a large extent on background radiation levels.

2.9.9 Decontamination/Cleaning Experience

Baskets are usually decontaminated or cleaned using water jets while the basket is suspended below the surface of the pool. No effort has been made to decontaminate a basket that has been used for fuel transport to an unconditional release limit. Low specific activity (LSA) levels have been adequate for routine, out of the cask, transport of the contaminated basket. Cask cavities have been cleaned using acids, steam, water jets and long-handled mops. Mops are used with active decontamination solutions, such as Turco products. On the average, smearable levels of 50,000 dpm per 100 sq cm have been achieved in the cask cavity after cleaning. However, these levels have been observed to increase due to weeping, to 250,000 dpm per 100 sq cm or more.

With regard to cask cavities and baskets, there has been no perceived need for a particular level of cleanliness, or radiation level, to be maintained (or not exceeded) in routine use. The major concerns are maintenance near the open end of the cask and basket changeout.

In practice, maintenance done near the top end of the cask with the lid off is done with the cask cavity (and basket) full of water. By filling the cask with water, there is reduced concern about air-borne contamination and the radiation field from the basket is reduced dramatically.

When the basket must be changed, it is normally rigged to be pulled underwater, and is only brought out of the water to remove the drain tube (NLI casks). While it is underwater the basket can be cleaned with water jets and wiped down with long-handled mops. No active decontamination

agents are ever used while the basket is in the pool. Out of the pool, baskets are normally wiped down using locally-applied decontamination solutions.

For purposes of decontamination, NAC has somewhat arbitrarily divided decontamination solutions into two categories: those that attack the protective oxide film on the stainless steel surface (active cleaners) and those that do not (passive cleaners).

In general, NAC recommends the use of active cleaners only when there is evidence (beta radiation readings) that the cask surface is beginning to accumulate contaminants even though passive cleaners or methods are being used. Use of active cleaners, principally weak nitric, citric or other acids followed by permanganates and perhaps oxalic acid, requires the approval of the user facility. Needless to say, approval is not easily obtained. Use of active cleaners means typically that the effluent must be captured (by plugging a drain) to prevent entry into the normal liquid waste-handling system, and treated separately. Normally, 5 to 10 percent acids are used, followed by a one percent or less, potassium permanganate as a neutralizer. Commercial decontamination agents (for example, Turco Decontaminant 4502, followed by Turco Decontaminant 4521) have also been used.

Active decontamination has been uniformly successful in dramatically reducing the amount of radioactive material resident on cask surfaces.

Most users use a decontamination agent that is classified as "passive." These agents include water, Windex[®], 409[®], Pride[®], Easy Off[®], alcohol, acetone, Con-trol[®], Tide[®], Big K[®], etc. The list is endless, imaginative, and site specific. As a general rule, sites select a decontamination agent that they feel is compatible with their liquid waste-handling system and no other solutions are permitted. Worse, many sites do not allow liquids other than water, so all decontamination solutions must be a spray-on, wipe-off, dispose of rag, type. Nonetheless, the overall record of shipments decontaminated by the various and sundry methods is very good. The technique and conscientiousness of the decontaminators seems to be somewhat more important than the decontamination agent used.

The relative success of passive cleaners, and the infrequent necessity for using active cleaners, probably shows that contaminants fall into two categories: first, those that are either strongly or loosely (ionically) bonded to the oxide film on the steel; and second, those that are trapped in microscopic dimples in the cask surface.

Passive cleaners, if vigorously and efficiently applied, can remove contaminants in the second category and some of the loosely bonded material of the first category. Both loosely bonded and surface material have the opportunity to become mobile under the rigor of transport. The most likely mobilizer is temperature and moisture change, with vibration having a somewhat less effect.

Over time, and given the right pool conditions, contaminants in the first category can bring the cask to a point that it must be actively cleaned.

NAC has very little data on the effectiveness of decontamination solutions. Based on experience, both steam cleaning and high-pressure water spray seem to be more effective than other manual methods. Among manual methods, detergents (such as Tide[®] or Big K[®]) are significantly more effective than window cleaners, grease cutters and other volatile liquids (such as alcohol and acetone), but there are few sites that allow their use (because of foaming, fire hazard and possible chlorides).

Methods used to clean the outside of the cask can be applied to the cask cavity since the materials of construction are the same.

There is little data on the makeup of the contamination that exists on the cask surface or in the cavity. The data that does exist demonstrates that the makeup is essentially the same as typical spent-fuel pool water. For example, an analysis was made of the smears taken from the cask cavity whose results are shown in Figure 2.8-1. Those results show that the major isotopes were: cobalt, 62 percent; cesium 137, 36 percent; and europium, 2 percent. Other analysis have had the percentages of Cobalt and Cesium reversed, and Europium is rarely mentioned. Trace amounts of many isotopes have been reported.

3.0 Maintenance and Repair of Cask Fleet

During routine operations, some components of spent-fuel transport casks are subjected to conditions which make regular maintenance essential. Components which perform a sealing function (lid seal O-rings, valve seats, etc.) are replaced on a defined time scale or after a defined number of transport operations.

Components subjected to mechanical wear (lid bolts, trunnions, etc.) are inspected as a regular program operation and are replaced as necessary.

3.1 Hydrostatic, Leak, Thermal, and Other Testing

3.1.1 Testing Requirements and Frequency

There are three categories of tests required to be performed annually on casks in service:

- Pressure
- Leak rate
- Mechanical load

Pressure tests are required on three cask parts: the fuel cavity, the neutron shield and the impact limiters, where the integrity of the container must be verified.

The fuel cavity, which includes the valves and seals in the containment boundary, must be checked because any leakage of the cask contents, including the inert gas, is likely to release active material to the environment.

For the NAC-1 cask, there are five "devices" in the cask containment boundary: the lid (inner) O-ring; three valves (one vent and two drain); and one cavity rupture disk. Each of these devices is tested to the same pressure, 100 psig, during the performance of the cask annual.

For the NLI cask, there are three devices in the cask containment boundary: the O-ring on the inner lid; and the O-rings in two valve covers, one each on the vent and drain valves. The containment test pressure is 10

psig. However, in addition to the pressure test, the NLI casks require a leak rate test using a tracer gas (helium), of the (inner) lid and valve port cover O-rings.

The cask cavity test pressure is set by the cask certificate of compliance. It is based on the maximum pressures expected, as presented in the cask safety analysis, during the cask post accident condition.

The NLI and NAC-1/NFS-4 casks have integral water tanks which, when full, provide neutron shielding. To prevent freezing, ethylene glycol is added to the water. Boron, in a soluble form, may also be added to enhance the neutron shielding. Any leakage during service would reduce the casks neutron shielding and increase neutron radiation levels in the vicinity of the cask.

The neutron shield test pressure is set by the cask certificate of compliance. It is based on the specific analysis that is presented in the cask safety analysis report, submitted in conjunction with the licensing process.

Impact limiters take the form of an energy absorbing material, such as balsa wood, contained in a sealed jacketing material, such as stainless steel or aluminum. The jacket is sealed to prevent the entry of water that could degrade the energy absorbing material inside. The integrity of the jacket is checked by pressure testing, typically to 5 psig for 30 minutes, through a drilled and threaded port in the jacket material. The port is sealed using a pipe plug during normal impact limiter use.

The criteria for acceptance of pressure testing is prescribed in the cask certificate of compliance. However, the typical requirement is no pressure drop in a 10 minute test period. The test period is relatively independent of the test pressure. The impact limiter pressure test is longer because wood can "absorb" air that can be mistaken as a leak when pressure drops. The annual test requirements are summarized in Appendix C.

The trunnions are subjected to mechanical load testing in conjunction with the yoke load test, as shown in Figure 2.4-7. The mechanical load applied in the test is cask/yoke specific and is specified in the yoke load test procedures. It is typically based on the design load rating of the yoke, which is based on the loaded weight of the specific cask (assuming water in the cask cavity).

Currently, NAC casks do not require periodic heat load testing.

Bolts and other items subject to mechanical wear are inspected visually. NDT is not typically used as a test of integrity.

No routine maintenance is performed on the cask other than that prescribed by the annual inspection established by the certificate. Maintenance in routine use is limited to the replacement of the inner lid O-rings of the NLI casks on a per (loaded) shipment basis and the replacement of the NAC-1/NFS-4 O-rings about every 10 (loaded) shipments. NAC-1/NFS-4 cask O-rings are used until failure or until visual inspection finds defects in the O-ring material. All other maintenance is performed on an as needed basis.

3.1.2 Special Equipment and Tools

The equipment and tools needed to handle casks during fuel loading and unloading operations are also needed during maintenance. These include slings, pressure test fixtures, torque wrenches, etc. In addition, some special items are required including:

- **Hydraulic Testing Equipment.** Water pressure above 80 psig is required for pressure testing the fuel cavity. Pumps, hoses, connectors/adapters, gauges, etc. of suitable rating are required.
- **Helium Leak Detection Equipment.** Helium is used for leak testing the NLI cask fuel cavity. A bottled helium supply and helium leak detectors are normally used.
- **Neutron Shield Testing Equipment.** Cask are required to operate in a range of climatic conditions including temperatures down to -40°F. A tester is required that can measure the freezing point of the neutron shield fluid. In addition, the neutron shield tank is pressure tested, in accordance with the cask certificate requirements, requiring hydraulic testing equipment as described above.
- **Thermal Testing Equipment.** When heat load testing is required, the equipment used includes electric fuel cavity heaters and instrumented cask lids. Heat load testing is not normally required except as an acceptance test.
- **NDT Inspection Equipment.** For both qualification for continued use, and for qualification of (weld) repairs, non destructive test equipment is required. Dye penetrant, magnetic particle, ultrasonic and radiograph techniques may be used depending on the material to be tested, the site capability or the preference of testing personnel. In

any case, the test procedure must be compatible with the material being tested. For example, magnetic particle testing can not be used on stainless steel equipment, and ultra sonic testing is usually not used on fabricated parts.

- **Spare Parts.** Seals, relief valves, rupture discs, repair kits and other spare parts are required to allow components to be replaced or repaired as needed. Repair kits are required for relief valves and for the manual valves used on the NAC-1/NFS-4. It should be noted that use of equipment and tools generates dry, active waste as a consequence of contact with surfaces that are contaminated, or with contaminated water. Replaced parts, wiping rags, hoses and the like will go into the site waste handling system for disposal.

3.1.3 Special Handling Requirements/Operating Time

There are no special handling requirements for the cask itself other than moving it to a suitable position out of an operational area for the maintenance period. Also, there is no requirement to remove the fuel cavity basket as all operations can be done with it in place.

Some materials required during annual maintenance may not generally be used at reactor sites and special arrangements may be required. For example, the use of antifreeze for neutron shield tank testing noted above may be outside the experience of the site concerned. Also, the fuel cavity testing operations will generate about 200 gallons of contaminated water that the site must be prepared to process.

Annual maintenance and testing typically takes two working days. Since NAC must usually perform this maintenance at the users facility, problems in scheduling the use of the facility crane or crane operators, having access to the work area because of other activities, adding water to the waste handling system, and other similar "invited use" restrictions can significantly extend the amount of time it takes to complete the scheduled maintenance. No such delays would be expected in a facility designed, equipped and staffed to support cask maintenance.

It should be noted that "surprise" problems are not typically encountered in annual maintenance. Problems are found in routine handling and are fixed as they are found. The cask must be, and is, in strict compliance with its certificate in order to be shipped.

3.1.4 Cask Contaminants, Amounts, Types

The isotopic distribution in contamination found during maintenance is the same as that found during cask loading and unloading operations described in Section 2.9.9, principally fission products leaked from the fuel and reactor coolant system corrosion products.

At the start of maintenance operations, the lid and exposed surfaces of the fuel cavity are usually wiped down to remove loose surface contamination for housekeeping reasons. During maintenance periods with the lid(s) removed, the fuel cavity is usually kept full of water to avoid surfaces drying out and increasing air-borne activity levels. High levels of smearable contamination, or air-borne, can require the use of respirators.

3.1.5 Contaminant Analysis

NAC has done no specific analysis of contaminants encountered during maintenance operations, but believes the isotopic distribution is the same as for routine cask handling as described in Section 2.9.9.

3.1.6 Damage Experience

NAC has no record of damage to casks, associated equipment or installed plant items sustained during cask maintenance operations. Cask maintenance is performed by trained, experienced personnel who are familiar with the operations.

3.1.7 Radiological Experience

A cask is usually maintained close to a fuel storage pool. The radiation field from the empty cask is considerably less than the background field in that area from other operations and equipment. Consequently, most of the personnel radiation exposure results from working time in the operational area rather than exposure to the cask itself.

NAC has no exposure record for the individual tasks associated with maintenance. As mentioned above, 95 percent of the dose is due to background in the facility where the maintenance is performed. During scheduled maintenance (annuals), the only work that must be done over the open cask cavity (highest cask related radiation source) is the seal surface inspection. This activity does not contribute significantly to the total dose. It is understood that if seal surface repair or polishing is necessary,

then the dose could be a higher percentage of the total. However, any extensive work would be done by filling the cavity with water, cutting the dose rate from the cavity considerably.

The accumulated dose for the typically annual, usually done by two technicians, is estimated at 60 man-mr.

3.1.8 Problems

NAC has not encountered any significant engineering or operational problems during cask maintenance. However, organizational and scheduling difficulties have been experienced because cask maintenance is normally done at one of the cask user sites. Cask work has on occasion been limited or delayed for a number of reasons by the host utility, including:

- Site policy;
- Health physics actions that result when the utility does not know the level of risk involved;
- Quality assurance actions resulting from not knowing the relative importance of tasks;
- Limited access to parts or machine shop equipment; and
- Plant operations work having priority for crane use and support personnel services.

As a consequence of using a cask user's facility for maintenance operations, the site operator is responsible for disposing of the contaminated equipment and materials, although it is typically negligible compared to the total site waste-management requirement. Processing contaminated water is a significantly more important problem.

3.1.9 Decontamination/Cleaning Experience

During cask maintenance, there is no operational requirement for routine decontamination. Consequently, decontamination is done as a housekeeping measure to meet ALARA requirements in limiting personnel radiation exposure during maintenance operations on items of equipment.

Prior to release from cask users' sites, some cask handling and associated operation equipment is decontaminated as a routine operation. This applies principally to equipment which comes into contact with pool water.

Equipment decontamination is usually done manually, using a suitable decontamination agent. Smear surveys are used to verify that contamination levels are within release limits.

3.1.10 Handling Equipment (Lift Beam, Hook Adapters)

The casks currently used to transport spent fuel are handled by the main station overhead crane. For handling those components removed during maintenance (impact limiters, personnel barriers, cask lids, etc.) the lower rated auxiliary crane is often more appropriate, since it is faster.

During maintenance, the cask trunnions and lift gear are subjected to a load test. This is done with the cask suspended from the main station crane in the manner used during normal cask handling operations. An additional load is applied using a jack between the cask and the crane hook to increase the effective load to that required for the test.

All lifting equipment maintenance, inspection and use is performed to comply with ANSI 14.6., with two exceptions. The first is that annual load testing is used in order to verify continued compliance of the lift device; and the second is that the NLI cask lift gear is tested to 200 percent of the design rated load (versus 150 percent as required by the standard). This latter exception is because the original design, testing and acceptance criteria for the NLI equipment was at 200 percent, and this load test requirement has been maintained.

Lift equipment that NAC currently designs and fabricates, including yokes, hook adaptors and extension pieces, meet the ANSI 14.6 Requirements For Critical Loads (Section 7), unless a specific customer requirement states otherwise.

3.2 Repair Operations

3.2.1 Repair Experience

Those items most frequently handled during operations have required, as expected, more frequent repair and unscheduled attention. Large or heavy items, such as impact limiters and personnel barriers, have suffered superficial damage during removal and refitting. Cask trailers have infrequently required weld repair to structural components, but repairs to structural components and tiedown structures require the use of qualified welders and materials.

The current generation of twin I-beam trailers have proven to be structurally sound. Two incidences of repair to structural welds that have been required have been attributed to operator error.

One incidence occurred during attempted coupling of the trailer to a tractor. The king pin structure attachment to the I-beams was damaged when a (vertical) misalignment caused the tractor to strike the king pin structure. In another incident, a structural weld repair to a tie down structure was required after a side load was applied to an NLI-1/2 cask tie down arm. The load was applied during an attempted cask reloading onto the trailer.

All structural welds, on either the trailer or tie down structure, are NDT inspected using (typically) dye penetrant technique. Magnetic particle testing is not routinely used, but could be used on carbon steel parts. Most of the trailer structure is carbon steel, and the NAC-1/NFS-4 cask tie downs are carbon steel. The NLI cask tiedown structure is aluminum.

There are numerous non-structural welds on transporters that do not require qualified (certified) welders or materials for repair. These welds are usually repaired by commercial truck repair personnel.

Items subjected to mechanical wear, such as trunnion bushings, are replaced on an "as needed" basis that depends on frequency of operations and the manner in which they are treated. The basis of replacement is, typically, visual inspection. Helicoils are not routinely replaced. Replacement occurs on failure, either by cracking or by "backing out" of the thread in the base metal.

Other components like valve seats and seal surfaces require attention periodically depending on the quantities of particulate material present in flush or pool water and on the effectiveness of flushing during fuel handling operations in spent fuel pools.

Despite these instances where repair or unscheduled maintenance is required, no part has needed consistent or frequent attention to the extent that it routinely interferes with transport operations.

3.2.2 Special Equipment and Tools

Repairs to weld seams on impact limiters and expanded metal sections of personnel barriers require welding, as may repairs to seal surfaces and trailer sections. For these repairs, it is necessary to have suitably qualified welders.

To replace trunnion parts, it is necessary to have replacement parts available that have been manufactured to the appropriate specification and/or design drawings.

Valves and helicoils are repaired or replaced as necessary using repair kits or replacement parts as identified on license drawings.

3.2.3 Special Handling Requirements/Operating Time

Handling equipment required for routine cask operations and scheduled maintenance will normally meet the handling requirements of repair operations. Special procedures may be required for repair operations outside the scope of normal operations and maintenance. For example, if impact limiters must be repaired, procedures must specify the minimum level of training and qualifications for the technicians completing the repair. Full specification of materials and techniques used in the repair, and qualification testing requirements of the repaired impact limiter must also be included.

Repair procedures are based on the original fabrication process codes and standards. In general, deviation from the original procedures, personnel qualifications and/or material specifications is not recommended, since these items were approved in conjunction with the (NRC) package approval. Any change would likely require a rather extensive review and perhaps involve a resubmittal to the licensing authority.

There have been very few incidences of special repairs, that is, repairs to damage that has occurred to the cask in handling. Three cases of what is considered special repair are discussed below.

1. A neutron shield tank was damaged during a lifting operation by bolts protruding from a scaffold. The gouge was evaluated to determine the depth and extent. An analysis was done to assess the possible

effect of the gouge and the anticipated grinding to remove the gouge from the tank material. The gouges were ground out and the surface was refinished. Use of a respirator was required for the grinding and polishing work. Three days (24 hours) were required to evaluate and complete the repair. Exposure was estimated as 12 mr, due entirely to background.

2. The seal surface for the inner lid of an NLI-1/2 was damaged by improper lowering of a waste canister on to the seal surface and a seal could not be obtained. A qualified welder using controlled, certified weld rod, made a weld overlay to remove the "dent" in the surface. Excess weld was removed by hand grinding and polishing. Welding, grinding and polishing was respirator work. Because of the presence of qualified personnel and material and a weld procedure at the site, the repair was evaluated and completed in about six hours. Exposure was estimated at 35 mr due to radiation from the cavity and from background.
3. A fork lift ran into a stored impact limiter, punching a two and one half by four by three inch deep hole through the aluminum skin and into the balsa wood used as the impact absorbing material. The opening was enlarged until the damaged section of wood could be removed and replaced. The hole was patched using a qualified welder and certified material. The weld procedure used was the original impact limiter fabrication procedure. The impact limiter was then pressure tested to verify the weld. Time lost for this repair was 12 days due to the difficulty of locating certified balsa wood and aluminum. No exposure record was kept, however dose would have been due to background.

No special repairs have been made to the NLI-10/24 casks.

3.2.4 Cask Contaminants, Amounts, Types

The contaminants and contamination levels on those parts and items subjected to regular maintenance are given in Section 2.9.9.

The isotopic distribution of contamination on impact limiters, personnel barriers and trailer components will be similar to that found on the cask, although the levels are, in general, significantly lower. Every effort is made to keep impact limiters, personnel barriers and trailers free of contamination and they are occasionally stored outdoors away from operational

areas where they may become contaminated. The highest levels of smearable activity measured are typically in the 200-300 dpm/100 sq cm range.

One part of the trailer that may have levels of smearable activity somewhat higher than those indicated above is the "drip pan." The drip pan is a length of corrugated sheet steel or aluminum attached between the two I-beams beneath the cask. It protects the cask from water, mud and dust coming up from the roadway. It also catches water that drips from the cask surface. Because of the second action, the drip pan smearable activity may be an order of magnitude higher than on other trailer surfaces. In general, the activity is higher at the front of the drip pan (trailer) than at the rear. The location of the drip pan is shown in Figures 3.2-1 and 3.2-2.

3.2.5 Contaminant Analysis

Contaminant isotopic distributions are as given in Section 2.9.9. NAC has no other information on the makeup of the cask contaminants.

3.2.6 Damage Experience

Spent-fuel shipment operations are the subject of detailed planning with respect to all other site operations. The high standard of control and organization the shipments are given results in very little damage. When damage does occur, it is corrected either prior to further operations or at the earliest opportunity after the cask arrives at an appropriate facility.

Incidences of major damage have been very few, and were discussed in Section 3.2.3 and in Appendix J.

Minor damage occurs from time to time, primarily from operator error. The most frequent source of damage is from lifting equipment without verifying that the equipment is disconnected and ready to be lifted. For example:

- Two NLI-1/2 lifting yokes connected for redundant lifting of a cask were being separated for repacking after use. The top yoke was lifted from the bottom yoke without disconnecting the hydraulic lines that allow the lift arms to move in unison. Consequently, the hydraulic lines snapped and several fittings were damaged beyond continued use.
- The NLI-1/2 impact limiters fit over the ends of the cask so that they must be moved horizontally to clear the cask before they can be lifted clear. There have been several

Figure 3.2-1

Figure 3.2-2

occasions where the lifting eye has been damaged because of failure to move the impact limiters horizontally before lifting.

- Slings must be frequently replaced because of the method of storage of the slings. Slings that are placed "free" in the storage box become kinked or cut in transport due to the presence of other items, making the slings unfit for use at the next site.

While this damage is not serious, it nevertheless requires both time and materials in order to correct the problems and can result in unnecessary delay. Further, it is easily avoided by careful attention to detail.

3.2.7 Radiological Experience

Except as indicated in Section 3.2.3, NAC has no separate records of radiation exposure due to repair activities.

3.2.8 Problems

The facilities available at the cask users' sites, although suitable for most functional maintenance and repair operations, are not all able to perform all of the operations that would probably be available at a facility specially designed for cask maintenance. For example, weld-dressing and surface polishing to the standards desirable to ensure ease of decontamination are not always available.

The major concern is that, while there is typically substantial capability in (radiologically) "clean" shops on site, there is very limited "hot shop" capability. Very few cask components can be cleaned to the point that any work can be done in a clean shop.

3.2.9 Decontamination/Cleaning Experience

It is not normal practice to extensively decontaminate casks and associated equipment during maintenance. However, decontamination may be done as part of the cleaning and preparatory work in the immediate vicinity of the work area. This is a normal preparation practice when repairing sealing surfaces by welding. Without such preparation, welding may cause significant quantities of airborne activity. Decontamination is normally done manually. It is unusual to decontaminate parts being replaced other than to avoid spreading contamination during the repair operations.

3.3 Basket Removal

3.3.1 Special Equipment and Tools

The equipment and tools which must be available for cask handling can also be used to remove the basket from the cask. The lifting lugs used for basket removal can be used with either slings with suitable "eyes" or C-clamps which are expected to be available at any site with heavy lifting gear. Lifting lugs are typically designed into the basket, as shown in Figure 3.3-1 and 3.3-2 for the NLI-1/2 and NLI-10/24 casks.

3.3.2 Special Handling Requirements/Operating Time

Cask cavity lengths are dictated by fuel assembly lengths; which, with minor differences depending on the fuel assembly type, are approximately 14.5 feet long. Baskets also range up to approximately 14 feet in length, and essentially fill the cavity. Since it is impractical to remove a basket from a cask if the axis is not vertical, basket removal requires head room in excess of 30 feet, if the removal is not being done underwater.

Most of the radioactive "crud" brought into the basket settles at the bottom of the basket and is trapped there. Consequently, when the basket is lifted from the cask, radiation levels increase very significantly as the bottom of the basket is exposed. Operations and health physics technicians are advised in advance to expect and prepare for this. Also, to minimize any increase in airborne activity levels, the basket is kept wet during removal operations. To prevent contaminated water dripping on to clean surfaces and to eliminate airborne, a plastic sleeve is usually pulled down around the basket as it is lifted from the cask. When the basket is clear of the cask, the sleeve is sealed under the basket before it is moved clear of the cask. This procedure is relatively easy if the drain tube is to remain with the basket. If it is to be removed, it must be disconnected and stored before the plastic sleeve is used.

No more than two technicians are required to remove a basket, although more are frequently used. No more than 10 to 15 minutes are required to remove a basket from a cask that is not to be placed in the pool (unloading the basket dry). Slightly longer times (about double) are required to remove a basket if the cask must go into the pool for basket removal.

Figure 3.3-1

PWR Basket - NLI-10/24 Rail Cask

Figure 3.3-2

3.3.3 and 3.3.4 Cask Contaminants and Analysis

Cask contaminants and contaminant analysis have been previously discussed in Section 2.9.9.

As previously stated, NAC has not routinely or periodically removed baskets and has not cleaned them unless it is necessary. It has only been necessary to clean baskets to ship them outside of the cask.

Smears on cask baskets before cleaning will range to the 10s of millions of dpm per 100 sq cm, which means the smear reads mrem's itself, and dose rates can be in the few rem's. The contaminants are principally corrosion products - cobalt, manganese and nickel and fission products principally cesium (mostly 137) and cerium. A typical analysis is 60 percent corrosion product, 35 percent fission product and five percent "other." No fuel pellets or parts of fuel rods have ever been found in a removed basket.

3.3.5 Damage Experience

An NLI-1/2 cask basket drain line was damaged when the top of the drain line was not secured to the top of the basket during a basket removal. As the basket cleared the top of the cask, the tube fell away and rotated around the bottom attachment point, bending the tube. The tube was replaced. No damage occurred to the cask.

No other incidents of damage have been recorded during basket removal.

3.3.6 Radiological Experience

Because "crud" tends to collect at the bottom of the basket, radiation levels and the resulting personnel exposure is higher during basket removal and maintenance than during other cask maintenance operations. However, the requirement for breaking and remaking the drain line connection to the bottom of the basket of the NLI casks is the only routine operation which requires working in this high radiation field.

NAC has no data on exposures due to basket removal. However exposure is low because no more than two people are required to remove the basket, (one crane operator, one technician to attach lifting slings and detach drain line), a substantial percentage of the radiation is beta which is only effective close to the basket and most dose is received in the extremities due to reaching into a high field (500 mr to 2 r typically) to detach the drain line. Detachment of the drain line takes two to three minutes. Attaching the slings to the basket also takes about five minutes. The basket

is usually removed from the cask underwater, so the dose is considered "background" for the 20 to 30 minutes it takes to put the cask in the pool, attach the auxiliary hook to the basket slings and pull the basket.

This operation has also been discussed in Section 3.3.2.

3.3.7 Problems

Problems associated with basket handling have also been discussed in Section 3.3.5.

A specific problem area is the NLI cask basket drain line configuration. It attaches to the cask body at the top and the basket at the bottom. Disconnecting the bottom attachment requires that the cask be raised above the pool surface, increasing operator dose.

3.3.8 Decontamination/Cleaning Experience

Decontamination and cleaning of the cask baskets is discussed more fully in Section 2.9.9.

Decontamination or cleaning of cask baskets is not usually done. If it is necessary, it is first hydrolazed or scrubbed with long handled mops while submerged in the facility's spent-fuel pool. Hydrolazing (high pressure water lancing) is preferred because it is faster and the water can be directed more easily. Because it is faster, it results in less personnel exposure than manual scrubbing with long-handled brushes.

Only gross loose contamination is removed by either of the above methods, in most cases leaving smearable activity in the range of 250,000 to more than 1,000,000 dpm per 100 sq cm and dose rates up to several hundred mrem per hour. Considerable additional effort such as extensive manual decontamination and repeated smear testing is required to reduce these levels further. It also results in significantly increased personnel dose. Such work is only undertaken when essential and is kept to the absolute minimum.

3.4 Maintenance Quality Assurance

For this discussion, it is assumed the quality assurance and quality control are synonymous because NAC does not operate a separate Quality Control Department, and because user quality control personnel are seldom involved in shipment. All cask activities are required to be performed under the control of an NRC approved quality-assurance program in accordance with 10CFR71 Subpart H shown in Appendix F. The NAC quality assurance program implements these requirements and is not included here because of its size. To assure that all critical functions are performed, a check-off sheet is provided in the cask-handling procedure for each cask shipment. The check-off sheet is kept as a permanent record, and includes names of personnel involved with the shipment and fuel assembly information. A copy of a check off sheet for the NLI-1/2 cask is shown in Figure 3.4-1.

When moving the cask, several factors must be checked. Load tests of the crane, yoke and trunnions, as well as qualification of the crane operator, must be valid. The approved load path must also be verified. Quality control personnel would verify that the yoke is properly engaged prior to lifting the cask, if they were involved in the loading. In most cases, supervisory personnel perform the checking and verification functions.

Tests of the cask and basket should be performed in accordance with the NRC license certificate for the cask. All gages and test equipment must be calibrated and labeled.

Prior to loading the cask, the spacer length should be verified to ensure the effectiveness of the cask radiation shielding and to prevent damage to the fuel assemblies when the cask is sealed and transported.

Special equipment is required for calibrating gages and test equipment, although this equipment is usually available at the facility. After using the test equipment, however, internal contamination is a problem area. NAC routinely discards calibrated gages after use at the facility because it is difficult to certify that the internal components are not contaminated. A small 10 foot by 10 foot pool would be helpful in controlling contamination when handling baskets, spacers or other contaminated components.

No dedicated quality assurance office space is currently required for maintenance performed at the user facility.

Vehicle maintenance is performed on a contract basis by commercial truck servicing companies on at least the manufacturers recommended frequency. NAC inspects maintenance performed to ensure that it is satisfactory. It is unlikely that a significant

NLI-1/2 Cask

UTILITY CHECK-OFF SHEET

Date _____	Assembly Identification No.(s) _____
Utility _____	Type of Fuel _____
Location _____	Manufacturer _____
Operator(s) _____	Burnup _____
_____	Reactor Discharge Date _____
_____	Est. Heat Rate _____
HP Technician(s) _____	Time of Arrival at Plant _____
_____	Time of Departure from Plant _____
Shipper _____	Cask Serial _____
Driver _____	Trailer Serial _____

INITIAL CONDITIONS

	<u>DATE/TIME</u>	<u>INITIALS</u>
4.4 Cask handling areas cleared	_____	_____
4.7 Decontamination equipment in place and operable	_____	_____
4.13 Required tools and materials available	_____	_____
4.15 Station equipment available	_____	_____
4.18 Internal authorization granted	_____	_____
4.21 Arrival of Cask	_____	_____

UNLOADING CASK FROM TRANSPORTER

5.1.1 Personnel Barrier and Impact Limiters Removed	_____	_____
5.1.4 Cask ready to lift	_____	_____
5.1.9 Cask on decon pad and washed	_____	_____
5.1.12 Covers and outer closure head removed	_____	_____
5.1.13 Outer Closure lid O-rings inspected	_____	_____
5.1.16 Inner Closure head removed and metallic O-ring inspected	_____	_____
5.1.19 Cask cavity inspected	_____	_____

Figure 3.4-1

<u>CASK LOADING</u>	<u>DATE/TIME</u>	<u>INITIALS</u>
5.2.6 Cask in position and closure lid removed	_____	_____
5.2.9 Cask loaded	_____	_____
5.2.18 Closure head installed and yoke attached to cask	_____	_____
5.2.20 Inner head bolts installed	_____	_____
 <u>CASK PREPARATION FOR SHIPMENT</u>		
5.3.2 Cask on decon pad	_____	_____
5.3.7 Lid lift gear removed and lid bolts torqued	_____	_____
5.3.14 Coolant flush sample	_____	_____
5.3.15 Completion of cask cavity flushing	_____	_____
5.3.24 Cask inner cavity seal tested	_____	_____
5.3.30 All water removed from inner cavity and replaced by Helium atmosphere	_____	_____
5.3.36 Inner cavity valve covers installed and bolts torqued	_____	_____
5.3.37 Inner cavity valve cap o-rings tested	_____	_____
5.3.41 Outer cavity lid installed and lid bolts torqued	_____	_____
5.3.45 Outer cavity o-ring tested	_____	_____
5.3.49 Outer cavity valve covers installed and bolts torqued	_____	_____
5.3.51 Outer cavity valve cover O-rings tested	_____	_____
5.3.52 Decontamination to site release limits complete	_____	_____

Figure 3.4-1
(continued)

Loading Transporter

	<u>DATE/TIME</u>	<u>INITIALS</u>
5.4.6 Cask installed on tractor	_____	_____
5.4.7 Radiation survey complete	_____	_____
5.4.10 Cask Properly tied down, personnel barrier & Impact Limiters installed	_____	_____
5.4.12 Truck and trailer placarded	_____	_____
5.4.16 Truck driver has proper papers	_____	_____
5.4.18 Transfer completed procedure to tech staff	_____	_____

Equipment Calibration Data

STEP	ITEM	RANGE	MANUFACTURER	SERIAL #	CALIBRATION	
					DATE	BY
5.3.7	Torque Wrench	50-400 ft lbs				
5.3.23	Pressure Test Assy T-3	30 ^m -0-30 psi				
5.3.35	Torque Wrench	5-75 ft lbs				
5.3.36	Pressure Test Assy T-10	30 ^m -0-30 psi				
5.3.41	Torque Wrench	15-100 ft lbs				
5.3.45	Pressure Test Assy T-3	30 ^m -0-30 psi				
5.3.49	Torque Wrench	5-75 ft lbs				
5.3.50	Pressure Test Assy T-10	30 ^m -0-30 psi				
5.4.8	Torque Wrench	50-400 ft lbs				

This cask handling and unloading has been completed in accordance with this procedure and other applicable NAC-1 Operating Procedures.

Completed by: _____ of _____
Qualified Operator Organization

Surveyed by: _____ of _____
Health Physics Organization

Verified by: _____ of _____
Organization

Figure 3.4-1
(continued)

improvement in transporter performance would be achieved by applying quality assurance to transporter maintenance. However, if a resident quality assurance function existed at a dedicated facility it would surely be applied.

Presently, the NAC quality assurance program applies only to the cask tie down structure. Maintenance records are kept on each trailer, consisting principally of completed check lists.

While no figures are available for direct quality assurance costs associated with cask handling and maintenance, typical costs for annual maintenance, parts, and labor, excluding capital and facility use costs are \$3,200 per year, per cask. Because of the rugged nature of the casks, unscheduled maintenance costs are on the order of \$1,000 per year per cask.

Appendix A
Cask Certificates of Compliance

NLI-1/2

**CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES**

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. PACKAGE IDENTIFICATION NUMBER	d. PAGE NUMBER	e. TOTAL NUMBER PAGES
9010	22	USA/9010/B()F	1	10

2. PREAMBLE

- a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71 "Packaging and Transportation of Radioactive Material."
- b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

- a. ISSUED TO (Name and Address)
- b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Assurance Corporation
5720 Peachtree Parkway
Norcross, GA 30092

Nuclear Assurance Corporation application
dated December 12, 1985, as supplemented.

c. DOCKET NUMBER 71-9010

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

- (1) Model No.: NLI-1/2
- (2) Description

A depleted uranium, water, and lead shielded shipping cask, encased in stainless steel, and equipped with balsa impact limiters. The cylindrical cask body is 195-1/4 inches long by 47-1/8 inches OD. The principal shielding consists of 2-3/4 inches of depleted uranium, 2-1/8 inches of lead, and 5 inches of (borated) water-ethylene glycol mixture.

A 7/8-inch thick stainless steel outer shell is welded to a solid stainless steel forging at each end of the cask. The outer shell of the cask is surrounded by a 1/4-inch thick steel water jacket that is also attached to the end forgings. A water expansion tank is welded to the water jacket shell. The inner cask cavity is formed by a 1/2-inch thick, stainless steel cylindrical shell; welded at its top end to the upper cask forging and at its bottom end to a circular plate.

There are four separate configurations of the cask.

Configuration (A): The containment vessel is a right circular stainless steel shell, 12-5/8 inches ID by 178 inches inside length by 1/4-inch thick, located within the inner cask cavity. The containment vessel is closed and sealed by a 5-inch thick, composite steel and uranium closure head, twelve, 1-inch diameter bolts, and a silver plated, metallic O-ring. Eight of the twelve closure bolts are used to secure the containment vessel to the upper cask forging. Closure of the cask cavity is by a 1-1/2-inch thick steel closure head, eight, 1-inch diameter bolts, and elastomer O-ring. The radioactive contents are positioned and supported within the containment vessel (inner container) by an aluminum basket and internal support structure.

5. (a) Packaging (continued)

(2) Description (continued)

Configuration (B): The containment vessel is the 1/2-inch thick inner cavity shell. The 1/4-inch thick inner container is not used. The cask cavity is closed by two closure heads. The inner head is a 6-inch thick, composite steel and uranium plate secured to the upper cask forging by twelve, 1-inch diameter bolts and sealed with a silver plated, metallic O-ring. The outer head is 1-1/2-inch thick steel plate secured to the top of the upper cask forging by eight, 1-inch diameter bolts and sealed with an elastomer O-ring. The radioactive contents are positioned and supported within the containment vessel (inner cask cavity) by a modified aluminum basket and internal support structure.

Configuration (C): Same as Configuration (B), above, except the radioactive contents are positioned and supported within the containment vessel (inner cask cavity) in a stainless steel structure containing Boral sheets positioned so as to provide necessary neutron absorption.

Configuration (D): Same as Configuration (B) above, except that the radioactive contents are positioned and supported within the containment vessel (inner cask cavity) in a 3-element stainless steel structure as shown in NAC Drawing No. 347-291-F12, Rev. 1.

The package, including impact limiters, has an overall length of 237 inches and an outside diameter of 75 inches. The maximum weight of the contents is 3,000 pounds. The weight of the package is approximately 49,250 pounds.

(3) Drawings

The Model No. NLI-1/2 shipping cask is constructed in accordance with the following National Lead Company Drawing Nos.:

General

70514F, Sheet 1, Rev. 7, Cask and Trailer General Arrangement
70514F, Sheet 2, Rev. 8, Cask and Trailer General Arrangement
70885F, Sheet 1, Rev. 3, Spent Fuel Cask Details
70885F, Sheet 2, Rev. 2, Spent Fuel Cask Details
70885F, Sheet 3, Rev. 2, Spent Fuel Cask Details
70885F, Sheet 4, Rev. 1, Spent Fuel Cask Details
70887F, Sheet 1, Rev. 1, Outer Closure Head

5. (a) Packaging (continued)

(3) Drawings (continued)

Configuration (A)

70516F, Sheet 1, Rev. 8, Spent Fuel Cask General Assembly
70562F, Sheet 1, Rev. 10, Inner Container
70562F, Sheet 2, Rev. 6, Inner Container
70562F, Sheet 3, Rev. 0, Inner Container*
70562F, Sheet 4, Rev. 0, Inner Container*

Configuration (B)

70888F, Sheet 1, Rev. 3, Spent Fuel Cask General Assembly
70886F, Sheet 1, Rev. 2, Basket Concept
70884F, Sheet 1, Rev. 2, Inner Closure Head

Configuration (C)

70888F, Sheet 1, Rev. 3, Spent Fuel Cask General Assembly
460-052-F8, Sheet 1, Rev. 4, Rockwell Fuel Basket-NLI-1/2 Cask*
460-052-F9, Sheet 1, Rev. 3, Container - Fermi Fuel, Rockwell
Basket, NLI-1/2 Cask, Assy of*

Configuration (D)

70888F, Sheet 1, Rev. 3, Spent Fuel Cask General Assembly*
347-291-F12, Rev. 1, Liner - 3 Element, NLI-1/2 Cask, Fuel
Movement Project*. The cask may be enclosed in a closed
shipping container (e.g., NAC Drawing No. 347-586-F1, Rev. 0).

*Nuclear Assurance Corporation drawings.

5. (b) Contents

(1) Type and form of material

(i) Irradiated PWR or BWR uranium oxide fuel assemblies of the following specifications:

	<u>PWR</u>	<u>BWR</u>	<u>Consolidated Fuel Rods</u>
Fuel form	Clad UO ₂ pellets	Clad UO ₂ pellets	Clad UO ₂ pellets
Cladding material	Zr or SS	Zr or SS	Zr or SS
Maximum initial fuel pin pressure at 100°F, psig	550	200	550
Maximum initial U content/assembly, kg	475	197	950
Maximum average initial U-235 enrichment, w/o	3.70	2.65	3.70
Maximum bundle cross section, inches	8.75	5.75	8.75
Fuel pin array size	14x14/15x15 16x16/17x17	7x7 8x8	Pins from 7x7, 8x8, 14x14, 15x15, 16x16, 17x17 in triangular pitch

5. (b) (1) (i) (continued)

	<u>PWR</u>	<u>BWR</u>	<u>Consolidated Fuel Rods</u>
Maximum active fuel length, inches	144	145.25	144
Maximum specific power, kw/kgU	40	27	40
Maximum average burnup, MWD/MTU	40,000**	34,000	40,000
Maximum decay heat, kw	10.6	10.6	0.6
Minimum cooling time, days	150*	120	4,380

The PWR type assembly may be shipped either with or without burnable poison rods or control rods.

*Four (4) fuel rods may have minimum cooling time of 120 days.

**PWR fuel assembly may have a maximum average burnup of 56,000 MWD/MTU provided the minimum cooling time prior to shipment is 450 days and the neutron shield fluid contains 1.0 weight percent boron. (The borated fluid may be left in the shielding tanks during the shipment of other contents.)

(ii) Irradiated metallic fuels of the following specifications:

	<u>Fermi-1</u>	<u>EBR-II Blanket</u>
Fuel form	Uranium-Molybdenum alloy pins	Uranium metal cylindrical slugs
Cladding Material	Zr	Aluminum containers
Max. initial U content/assembly, Kg	18.7/assy. 300/16 assy. cask load	292/container
Max. avg. initial U-235 enrichment, w/o	26.0	0.21 (3.88 kg Pu/canister)

CONDITIONS (continued)

Page 6 - Certificate No. 9010 - Revision No. 22 - Docket No. 71-9010

5. (b) (1) (ii) (continued)

	<u>Fermi-1</u>	<u>EBR-II Blanket</u>
Max. bundle cross section, inches	2.93 sq	4.875 dia
Fuel rods per canister	140	41
Max. active fuel length, inches	30.5 / assy 122 / cask	157
Max. Average Burnup, MWD/MTU	2,840	2,400
Max. Decay Heat, watts	20	300
Min. Cooling Time, days	5,000	365

(iii)

	<u>Research Reactor</u>
Fuel Form	Uranium metal rods
Cladding Material	Aluminum
Maximum initial U Content/Assembly - Kg	54.5
Maximum average initial U-235 enrichment	Natural
Maximum bundle cross-section, inches	1.36
Intact Fuel Rods per canister, maximum	7
Canisters per cask	3 intact fuel
Max. Active fuel length, inches	120.5
Maximum average burnup MWD/MTN	1,600
Maximum decay heat, watts	750
Minimum Cooling Time, days	365

CONDITIONS (continued)

Page 7 - Certificate No. 9010 - Revision No. 22 - Docket No. 71-9010

5. (b) (1) (Continued)

(iv) Irradiated PWR or BWR uranium oxide fuel rods of the following specifications:

	<u>PWR Rods</u>	<u>BWR Rods</u>
Fuel form	Clad UO_2 pellets	Clad UO_2 pellets
Cladding material	Zr or SS	Zr or SS
Maximum initial fuel pin pressure at 100°F, psig	550	200
Maximum initial U content, kg	56	40
Maximum average initial U-235 enrichment, w/o	3.70	2.65
Maximum bundle cross section, inches	8.75	5.75
Maximum active fuel length, inches	144	145.25
Maximum specific power, kw/kgU	40	27
Maximum average burnup, MWD/MTU	55,000	50,000
Maximum decay heat, kw	1.65	1.18
Minimum cooling time, days	150	150

5. (b) (1)(v) Solid, non-fissile, irradiated hardware and neutron source components.
- (vi) Byproduct and special nuclear material in the form of irradiated uranium and plutonium oxide fuel rods. Prior to irradiation, the maximum average enrichment in U-235 plus plutonium not to exceed 3.70 w/o and the maximum enrichment not to exceed 4.0 w/o.
- (vii) Irradiated PWR uranium oxide fuel assemblies including additional irradiated fuel rods inserted and secured in the guide thimbles. The fuel assemblies must conform to the maximum active dimensions as described in Item 5(b)(1)(i) except that maximum initial U content must be 495 kg and the maximum average initial U-235 enrichment shall be 3.35 w/o.
- (viii) Irradiated Connecticut Yankee fuel assembly with a maximum average initial U-235 enrichment of 4.0 w/o and each of the 15 x 15 fuel rods clad by stainless steel. 204 rods/assembly; active length of 121.4 inches.

(2) Maximum Quantity of material per package

- (i) Items 5(b)(1)(i) or 5(b)(1)(vii) above: one PWR fuel assembly; two BWR fuel assemblies; or one consolidated fuel canister.

Above assemblies to be contained in their respective fuel baskets as shown on National Lead Company Drawing No. 70562F, Sheet 1, Rev. 10 or 70886F, Sheet 1, Rev. 2. The consolidated fuel canister to be contained in Configuration (A) fuel basket as shown on National Lead Company Drawing No. 70562F, Sheet 1, Rev. 10.

- (ii) Item 5(b)(1)(ii) above: four canisters per cask. The fuel canisters and fuel basket must be in accordance with Configuration (C) above.
- (iii) Item 5(b)(1)(iii) above: Three canisters of unfailed fuel containing up to seven fuel rods per canister. The fuel canisters and fuel basket must be in accordance with Configuration (D) above.
- (iv) Item 5.(B)(1)(iv) above: up to 24 fuel rods per cask, in configuration A or B. The maximum initial uranium content is limited to 56 kg.
- (v) Item 5(b)(1)(v) above, weight not to exceed 1,600 pounds.
- (vi) Item 5(b)(1)(vi) above, the maximum mass of U-235 plus plutonium must not exceed 4.0 kg. Fuel rods must be contained in fuel baskets as shown on National Lead Company Drawing No. 70562F, Sheet 1, Rev. 10 or 70886F, Sheet 1, Rev. 2.

5. (b) (2) (Continued)

(vii) Item 5(b)(1)(viii) above: One Connecticut Yankee intact irradiated fuel assembly.

(c) Fissile Class

III

Maximum number of packages
per shipment

One

6. The cask cavity and containment vessel (inner container) must be dry (no free water) when delivered to a carrier for transport. Residual moisture must be promptly removed from the cask cavity and containment vessel by the methods described in Section XV of the Application. Removal of residual moisture from cask cavity when package is used in Configurations (B), (C), or (D) is not required providing the decay heat load does not exceed 2.0 kw.
7. For the shipment of irradiated fuel assemblies or a canister of consolidated irradiated fuel, the cask cavity canister of consolidated irradiated fuel (if present), and containment vessel must be promptly inerted following removal of the water from the cavity. For contents not vacuum dried, the cask cavity and containment vessel must be purged at least three times with argon, nitrogen, or helium. Each purge volume must be equivalent to or greater than the cask cavity and containment vessel volume. After the final purge, or following vacuum drying, the cavity and containment vessel must be promptly filled with argon, nitrogen, or helium at 1.0 atm pressure.
8. Known or suspected failed fuel assemblies (rods) and fuel with cladding defects greater than pin holes and hairline cracks must be shipped in Configuration (A).
9. The consolidated fuel canister must be provided with vent and drain lines (openings) to permit free draining of the canister. No valves can be installed on the vent and drain lines.
10. Prior to each shipment, the package must meet the tests and criteria specified in Section XVI of the Application.
11. The neutron shielding tank must be filled with a mixture of water and ethylene glycol (52% by volume). This mixture must not freeze or precipitate in a temperature range from -40°F to 330°F. The neutron shield tank may be empty when the cask is in Configuration D.
12. The structures used to support the package on the transport vehicle must be as described in the Application.
13. Any system used for cooling down the package must be provided with a pressure relief device set so that during the cool-down process, the maximum pressure in the containment vessel cannot exceed 310 psig when the package is used in Configuration (A) or 365 psig when the package is used in Configuration (B).
14. The systems and components of each packaging must meet the periodic tests and criteria specified in Section XVI of the Application.
15. Repair and maintenance must be as described in Section XVI of the Application.

CONDITIONS (continued)

Page 10 - Certificate No. 9010 - Revision No. 22 - Docket No. 71-9010

16. As needed, appropriate component spacers must be used in the cask cavity to limit movement of contents during shipment.
17. Prior to first use, each packaging must meet the acceptance tests and criteria specified in Sections XIII and XIV of the Application when used in Configuration (A) and in Appendix A to Sections XIII and XIV when used in Configuration (B).

Neutron transmission measurements of the Rockwell Fuel Basket - NLI-1/2 cask must be conducted in accordance with NAC letter dated August 21, 1986. No transmission measurement may deviate more than 10 percent from any other measurement.

18. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.
19. Expiration date: January 31, 1991.

REFERENCES

Nuclear Assurance Corporation application dated December 12, 1985.

Supplements dated: July 18 and 30, August 21, and October 3, 6, and 17, 1986; and February 11, March 24, May 29, and July 7, 1987.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

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

JUL 29 1987

Date: _____

NLI-10/24

**CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES**

U.S. NUCLEAR REGULATORY COMMISSION

1. CERTIFICATE NUMBER 9023	2. REVISION NUMBER 5	3. PACKAGE IDENTIFICATION NUMBER USA/9023/B()F	4. PAGE NUMBER 1	5. TOTAL NUMBER PAGES 5
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2. PREAMBLE

- a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."
- b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (Name and Address)

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Assurance Corporation
5720 Peachtree Parkway
Norcross, GA 30092

NL Industries, Inc. application dated
February 27, 1976, as supplemented.

c. DOCKET NUMBER

71-9023

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: NLI-10/24

(2) Description

A lead, water, depleted uranium and high temperature polymer shielded shipping cask, encased in stainless steel, equipped with balsa impact limiters, and mounted to a railcar which is considered to be an integral part of the packaging for normal conditions of transport. The cask body is 204-1/2 inches long by 96 inches in OD. The principal shielding consists of 6 inches of lead and 9 inches of water. Depleted uranium plates are encased in the bottom end forging and cask inner closure head. High temperature polymer sheet is encased in the bottom end and positioned between the inner and outer closure heads at the top end.

The lead shield is bonded between a 3/4-inch stainless steel inner shell and a 2-inch stainless steel outer shell. The outer shell is surrounded by a 3/4-inch stainless steel water jacket shell. The three shells are welded to stainless steel forgings at both ends. Four water expansion tanks are mounted to the railcar, and are connected to the water jacket by a flexible metal hose.

CONDITIONS (continued)

Page 2 - Certificate No. 9023 - Revision No. 5 - Docket No. 71-9023

5. (a) Packaging (continued)

(2) Description (continued)

The primary containment vessel is comprised of the 3/4-inch inner shell and the inner closure head. It is 179-1/2 inches long and has a 45-inch inside diameter. The inner closure head is held in place by sixteen bolts, and is sealed with a metallic O-ring. Secondary containment is provided by the outer closure head which is bolted, and has a Viton or silicone O-ring seal. There is no direct penetration between the containment cavity and the ambient. The two penetrations into the containment cavity are from the space between the inner and outer closure heads, which has a single penetration through the cask body connecting it with the ambient. The two lid penetrations are sealed with 1-1/2-inch quick disconnect valves and metal O-ring seals each in a valve box arrangement.

The radioactive contents are positioned within the containment cavity using neutron poisoned aluminum baskets and internal support structures. The PWR and BWR fuel basket cavities are lined with neutron absorber sleeves composed of a silver-indium-cadmium (80-15-5 w/o) alloy.

An auxiliary cooling system, mounted to the railcar, is used to maintain the cask and fuel temperatures so as to facilitate handling and cooldown.

The fully loaded cask, excluding the railcar, is approximately 194,000 pounds, which includes a maximum gross weight of the cavity contents of 34,100 pounds (fuel, spacers, fuel basket, etc.).

(3) Drawings

The Model No. NLI-10/24 shipping cask is constructed in accordance with the NL Industries, Inc. and National Lead Company Drawing Nos. as specified on page XVIII-1, Rev. 9 and page XVIII-2, Rev. 8, in Section XVIII of the Application.

5. (b) Contents

(1) Type and form of material

Irradiated PWR and BWR uranium oxide fuel assemblies of the following specifications:

CONDITIONS (continued)

Page 3 - Certificate No. 9023 - Revision No. 5 - Docket No. 71-9023

5. (b) Contents (1) (continued)

	<u>PWR</u>	<u>BWR</u>
Fuel form	Clad UO ₂ pellets	Clad UO ₂ pellets
Cladding material	Zr or SS	Zr or SS
Maximum initial U content/assembly, kg	475	200
Maximum average initial U-235 enrichment, w/o	3.5	2.8
Maximum initial U-235 content/assembly, kg	16.6	5.6
Maximum bundle cross section, inches	9.00	5.75
Fuel pin array size, number of pins	14x14/15x15 16x16/17x17	7x7/8x8
Maximum active fuel length, inches	144	144
Maximum specific power, kw/kgU	40	27
Maximum average burnup, MWD/MTU	35,500	29,700
Minimum cooling time, days	150	150

The PWR type assemblies may be shipped either with or without control rods.

(2) Maximum quantity of material per package

The maximum decay heat load per package not to exceed 70 kilowatts, and:

Ten PWR fuel assemblies or twenty-four BWR fuel assemblies.

Above assemblies must be contained in their respective fuel baskets as shown on IIL Industries, Inc. and National Lead Company Drawing Nos.:

70652F, Sheet 1, Rev. 7 PWR Fuel Basket,
Sheet 2, Rev. 5 10/24 Rail Cask
70653F, Sheet 1, Rev. 7 BWR Fuel Basket,
Sheet 2, Rev. 5 10/24 Rail Cask

CONDITIONS (continued)

Page 4 - Certificate No. 9023 - Revision No. 5 - Docket No. 71-9023

5. (c) Fissile Class III

Maximum number of packages
per shipment for Class III

One (1)
6. The maximum gross weight of the cavity contents must not exceed 34,100 pounds (fuel, spacers, basket, etc.).
7. The containment vessel must be dry (no free water) when delivered to a carrier for transport. Residual moisture must be promptly removed from the containment vessel by the methods described in Section XVI of the Application. The containment vessel must be promptly filled with helium to 1.0 atm pressure.
8. Known or suspected failed fuel assemblies (rods) and fuel with cladding defects greater than pin holes and hairline cracks are not authorized.
9. Prior to each shipment, the package must meet the tests and criteria specified in Section XVII of the Application.
10. The cask contents must be so limited under normal conditions of transport that the following measured dose rates be satisfied:
 - a) at one meter from the external radial midplane surface of the package: 625 times the neutron dose rate plus 2.5 times the gamma dose rate will not exceed 1,000 millirems per hour; and
 - b) at one meter from the external surface of the bottom of the package: 115 times the neutron dose rate plus 2.0 times the gamma dose rate will not exceed 1,000 millirems per hour.
11. The neutron shielding system and auxiliary cooling system must be filled with a mixture of water and ethylene glycol (53% to 58% by weight ethylene glycol).
12. The neutron shielding system must be equipped with two pressure relief valves (one on the cask and one on an expansion tank) set at 220 psig.
13. Any system used for cooling down the package must be provided with a pressure relief device set so that the maximum pressure in the containment vessel cannot exceed 233 psig during the cooldown process.
14. The systems and components of each packaging must meet the criteria for the periodic tests specified in Section XVII of the Application.
15. Repair and maintenance must be as described in Section XVII of the Application. During inactive periods, the maintenance and testing program may be disregarded provided that the package is brought into full compliance prior to the next use of the package.

CONDITIONS (continued)

Page 5 - Certificate No. 9023 - Revision No. 5 - Docket No. 71-9023

16. Prior to first use, each packaging shall meet the criteria for the acceptance tests specified in Sections XIV and XV of the Application, except that the prototype railcar test meeting the stated design criteria need be performed only once.
17. Packaging is authorized for rail mode of transport only.
18. Expiration date: August 31, 1991.

REFERENCES

NL Industries, Inc. application dated February 27, 1976.

Supplements dated: June 4, 1976; October 10, 1978; and July 6, 1979.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and
Material Safety, NMSS

Date: AUG 14 1986

NAC-1/NFS-4

U.S. NUCLEAR REGULATORY COMMISSION

**CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIALS PACKAGES**

1 a. CERTIFICATE NUMBER 9183	b. REVISION NUMBER 5	c. PACKAGE IDENTIFICATION NUMBER USA/9183/B()F	d. PAGE NUMBER 1	e. TOTAL NUMBER PAGES 3
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2. PREAMBLE

- a. This certificate is issued to certify that the packaging and contents described in Item 5 below, meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."
- b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (Name and Address)

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION:

Nuclear Assurance Corporation
5720 Peachtree Parkway
Norcross, GA 30092

Nuclear Assurance Corporation application dated
June 30, 1984, as supplemented.

c. DOCKET NUMBER **71-9183**

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: NAC-1

(2) Description

A steel and lead shielded shipping cask. The cask is a right circular cylinder with upper and lower steel encased balsa impact limiters. The overall dimensions are 214 inches in length and 50 inches in diameter. The gross weight of the cask is approximately 49,000 pounds. The inner cavity is 178 inches long and 13.5 inches in diameter. The thickness of the inner shell is 5/16 inch and 1-1/4 inches for the outer shell. The two stainless steel shells are welded to a 2-inch thick stainless steel shield disc at the bottom. The annulus between the inner and outer shells is filled with lead (max. lead thickness 6-5/8 inches, minimum 5 inches).

The lid is stainless steel frustum of cone 7.5 inches thick. The lid is secured to the cavity flange by six, ASTM-A320, Grade L43, 1-1/4 inch diameter bolts. The seal is provided by two polytetrafluoroethylene O-rings. Four trunnions, two located on either side of the upper or lower impact limiter, are provided. Other cask features include two drain valves located in the bottom shield disc, vent valve, head closure gasket leak check valve, and rupture disc - pressure relief valve system located in the cavity flange. For transport the cask may be enclosed in an expanded metal cage.

(3) Drawings

The Model No. NAC-1 shipping cask is constructed in accordance with Nuclear Fuel Services, Inc., Drawing No. E 10080, Sheets 1 through 4, Rev. 21, as modified by Nuclear Assurance Corporation letter dated July 24, 1986.

CONDITIONS (continued)

Page 2 - Certificate No. 9183 - Revision No. 5 - Docket No. 71-9183

5. (b) Contents

(1) Type and form of material

- (i) Clad, irradiated metallic natural uranium fuel rods.
- (ii) Solid nonfissile irradiated hardware.

(2) Maximum quantity of material per package

The cavity content must not exceed a thermal decay heat load of 750 watts and a weight of 3,700 lbs including weight of component spacers (or fuel basket) used in the cask cavity to limit movement of contents during shipment. Fuel rods are additionally limited as follows:

- (i) 21 intact rods or 10 encapsulated (defective) rods
- (ii) 1,600 MWD/MTU average burn-up
- (iii) cooled for at least 365 days after irradiation

(c) Fissile Class

I

- 6. The cask cavity must be dry (no free water) when delivered to a carrier for transport.
- 7. As needed, appropriate component spacers (fuel basket and axial spacers for shipment of fuel rods) must be used in the cask cavity to limit movement of contents during accident conditions of transport.
- 8. The neutron shield tanks must be drained and maintained in a dry condition in accordance with Section 7 of the application, as supplemented.
- 9. In lieu of the requirements of 10 CFR §71.87(e), the licensee must perform periodic maintenance and testing of O-rings, drain and vent ball valves, relief valves, and rupture discs of the cask as indicated in the table given below. During inactive periods, the maintenance and testing frequency may be disregarded provided that the package is brought into full compliance prior to the next use of the package.

CONDITIONS (continued)

Page 3 - Certificate No. 9183 - Revision No. 5 - Docket No. 71-9183

<u>Cask Component</u>	<u>Period</u>	<u>Test/Action</u>
Ball Valve	Each shipment	Hydro test to 30 psig*
Ball Valve	Annually	Replace seats and seals
O-rings	Each shipment	Test to 30 psig*
O-rings	Annually	Test to 100 psig*
Inner Containment Vessel	Annually	Test to 100 psig*
Cavity Relief Valve	Annually	Test at set point
Cavity Rupture Disc	Annually	Replace
Neutron Shield Tank Rupture Disc	Annually	Replace
Impact Limiters	Annually	Test to 5 psig*

*There must be no visual (pressure gauge) indications of pressure drop for the component under test during a 10-minute test period. Otherwise, corrective action must be taken and the test repeated until such time as the component meets the specified test. (Test to pressures equal to or greater than those indicated.)

- 10 Fabrication of additional packages is not authorized.
11. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.
12. Expiration date: September 30, 1989.

REFERENCES

Nuclear Assurance Corporation application dated June 30, 1984.

Supplements dated: September 10, 1984; July 24, 1986; and February 10, 1987.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

 Charles E. MacDonald, Chief
 Transportation Certification Branch
 Division of Fuel Cycle and
 Material Safety, NMSS

Date: MAR 20 1987

Appendix B
Cask License Drawings

NLI-1/2

8 7 6 5 4 3 2 1

70514F
SHEET 1 OF 2

DETAIL "C"

SECTION D-D

SECTION "A-A"

SECTION "B-B"

REVISIONS			REVISIONS		
REV	DESCRIPTION	DATE	REV	DESCRIPTION	DATE
1	AS BUILT		3	REVISED & REDRAWN	12/1/70
2	ADDED 2 INCHES TO VIEW OF REAR SUPPORT	1/1/71	4	REVISED EXPANSION TANKS	12/1/70
3	DELETED NAME OF REAR SUP		5	REMOVED 2 INCHES FROM CASK PLATE	12/1/70
4	ADDED FLOOR UNDER CASK PLATE	4/20/70			
5	DELETED 1/2" FILLER WELD	1/1/71			

		REVISIONS			
FORM	REV	DESCRIPTION	DATE	BY	CHKD
	3	REVISED 4 REDRAWN	1/1/71	CP	CP
	4	REVISED EXPANSION TANK			
	5	REVISED BEAR & PAGES 2 & 3			
		ADDED DETAIL C 1/2" O.D.

REAR SUPPORT

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REV	QTY	NAME	UNIT	SPEC	QWS	IN	SECTION
LIST OF MATERIAL							
DRAWN TAT		DATE 1/1/71		NL NATIONAL LEAD COMPANY			
CHKD CFE				NUCLEAR DIVISION			
ENG CFE				WARRINGTON PLANT			
QC							
PROD							
NL 1/2 CASK & TRAILER							
GENERAL ARRANGEMENT							
ECONOMY		PAGE 2		REV		REV	
200000		A-5325		70514F		0	
SCALE				SHEET 2 OF 2			

H
G
F
E
D
C
B
A

TOS 14F
SHEET 1 OF 2

REV	DESCRIPTION	DATE	BY
1	REORAWN	1/10/76	CM
2	REVISED DIMS & REFERENCE	2/2/77	CM
3	REVISED EXPANSION TANKS	3/24/77	CM
4	ADDED EXPANSION TANKS FOR TANKS HEAD T.B. 5/1/77	5/1/77	CM
5	REVISED WELDING DATA AT 5/1/77	5/1/77	CM
6	REVISED PICTURE OF VALVE COVER	1/1/77	CM
7	3/4" FILLET WELD HAS 3/8"	3/1/77	CM

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DATE 1/10/76	NAME TOS 14F	REV 1	DESCRIPTION GENERAL ARRANGEMENT
NATIONAL LEAD COMPANY NUCLEAR DIVISION WASHINGTON PLANT			
NLI 1/2 CASK & TRAILER			
GENERAL ARRANGEMENT			
DRAWN BY CHECKED ENG. BY QC PROJ.	PROJ. NO. A-5325	SHEET 1	DRAWING NO. TOS 14F
2000 39932		7

REV	DESCRIPTION	DATE
1	REMOVED MATERIAL FROM ORIGINAL FORM TITLE	11/1/76
2	ADDED WORD "OPTIONAL" TO 1/2 IN. SLOTS, TWO PLACES	11/1/76

DRAWN BY CHKD BY ENG. BY QC PROJ.	DATE 11/1/76	NAME NATIONAL LEAD COMPANY NUCLEAR DIVISION WILMINGTON PLANT	DESCRIPTION NLI 1/2 SPENT FUEL CASK DETAILS
CODE IDENT 20032	PAGE NO A-5325	REV 2	SHEET 3 OF 4

PLAN VIEW
TOP END
IMPACT LIMITER REMOVED

SECTION G-G
ALTERNATE CONFIGURATION

FORM NO.		DESCRIPTION
1		REVISED WAVE SYMBOLS AND SECTION AT 1500' TO 1600' OF SECTION C-W
2		ADDED WAVE SYMBOLS AT SECTION

PROD ID#	NAME	DATE	SPFC	SPFC WT	DESCRIPTION
			LIST OF MATERIAL		
DRAWN BY DES. BY ENG. P Q.C. PROC.	DATE 1/17/79 1/17/79	NLI (NLI)	NATIONAL LEAD COMPANY NUCLEAR DIVISION WILMINGTON PLANT		
		NLI 1/2 SPENT FUEL CASK DETAILS ALTERNATE CONFIGURATION			
COOL UNIT 29932	PROD BY A-5325	BILL 1	DRAWING NO 7088-F	SHEET 2	UNIT 2 OF 4
WT	DATE

SECTION A-A

REV	DATE	NAME	MR.	SPEC.	QTY	DESCRIPTION
1	10/10/66	W. J. B.				OUTER COOLING HEAD
2	10/10/66	W. J. B.				NLI V2 SPENT FUEL CASK
3	10/10/66	W. J. B.				
4	10/10/66	W. J. B.				
5	10/10/66	W. J. B.				
6	10/10/66	W. J. B.				
7	10/10/66	W. J. B.				
8	10/10/66	W. J. B.				
9	10/10/66	W. J. B.				
10	10/10/66	W. J. B.				
11	10/10/66	W. J. B.				
12	10/10/66	W. J. B.				
13	10/10/66	W. J. B.				
14	10/10/66	W. J. B.				
15	10/10/66	W. J. B.				
16	10/10/66	W. J. B.				
17	10/10/66	W. J. B.				
18	10/10/66	W. J. B.				
19	10/10/66	W. J. B.				
20	10/10/66	W. J. B.				
21	10/10/66	W. J. B.				
22	10/10/66	W. J. B.				
23	10/10/66	W. J. B.				
24	10/10/66	W. J. B.				
25	10/10/66	W. J. B.				
26	10/10/66	W. J. B.				
27	10/10/66	W. J. B.				
28	10/10/66	W. J. B.				
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97	10/10/66	W. J. B.				
98	10/10/66	W. J. B.				
99	10/10/66	W. J. B.				
100	10/10/66	W. J. B.				

DRAWN BY: W. J. B.
 CHECKED BY: W. J. B.
 DATE: 10/10/66
 SCALE: 1/2" = 1"
 SHEET: 1 OF 1

NLI INDUSTRIES
 NUCLEAR DIVISION
 WASHINGTON PLANT

OUTER COOLING HEAD
 NLI V2 SPENT FUEL CASK

EDDM 39033
 SCALE: 1/2" = 1"
 SHEET: 1 OF 1

[illegible]

DATE	REV	BY	CHKD BY	DESCRIPTION
1/1/78	1	WJ		

DRAWN BY: **WJ**
 CHKD BY: **WJ**
 ENG: **WJ**
 CEC: **WJ**
 PROJ: **WJ**

N

N I INDUSTRIES
NUCLEAR DIVISION
WINDMILLION PLANT

1/2 SPENT FUEL CASK
GENERAL ASSEMBLY
CONFIGURATION "B"

CASE NAME	PROJ. NO.	SIZE	DRAWING NO.
29932	4-2525	F	70628F
	SCALE 1/1"		SHEET 1 OF 1

147

MATERIAL SPECIFICATION-
 ASTM-B-419
 NL INDUSTRIES, INC. URANIUM
 SPECIFICATION NR 7605, 4/10/72,
 ISSUE NR 1

DATE	NAME	REV	SPEC	DWG NO	DESCRIPTION
1/15/72	DR				NATIONAL LEAD COMPANY NUCLEAR DIVISION WARRINGTON PLANT
1/15/72	ENG				NLI 1/2 SPENT FUEL CASK URANIUM SHIELD DETAIL
1/15/72	QC				
1/15/72	PRD				
1/15/72					

CODE 39932	PAGE 14	REV	DRAWING NO	REV
39932	14		70825F	1
			SHEET 4 OF 4	

		DESCRIPTION
DATE	REV	
	1	REVISION 1: THE FOLLOWING INFORMATION IS FOR THE PURPOSE OF THE PROJECT AND IS NOT TO BE USED FOR ANY OTHER PURPOSE.
	2	REVISION 2: THE FOLLOWING INFORMATION IS FOR THE PURPOSE OF THE PROJECT AND IS NOT TO BE USED FOR ANY OTHER PURPOSE.

ADIL: SAME AS
PWR BASKET
EXCEPT AS SHOWN

SECTION A-A (200112)
BWR FUEL ELEMENT

PWR FUEL BASKET

NO	SPT	NAME	DWG	SFC	DWG NO	DESCRIPTION
			SPT OF MATERIALS			
DRAWN BY	CHECKED BY	DATE	NL	Q7	NL INDUSTRIES NUCLEAR DIVISION NEWINGTON PLANT	
ISSUED BY	REVISED BY	DATE				
QC	PROD		LWT SYSTEM BASKET CONCEPT CONFIGURATION "B"			
CODE SHEET	PAGE NO.	TOTAL	REVISION NO.	BY	DATE	NO.
28923	6-525	1	70-525	J	10-1	2
WT	PLATE	FE	SHEET	OF	1	2

70561P
SHEET 1 OF 2

REV	DESCRIPTION
1	DESIGN CHANGE 10-23
2	ADD VIEW E-E
3	ADD VIEW F-F
4	REVISED PIPING LIFTING LUGS
5	ADD VIEW E-E
6	ADD VIEW F-F

SECTION J-J

1/2" DIA - 12" LG HEX HD BOLT
1/2" BUNC - 2" OF THD
(TYP 2 PLACES)

SECTION H-H

1/2" DIA - 12" LG HEX HD BOLT
1/2" BUNC - 2" OF THD
(TYP 2 PLACES)

SECTION G-G

1/2" DIA - 12" LG GUIDE PIN
1/2" BUNC - 2" OF THD
(TYP 2 PLACES)

SECTION F-F

SILICONE RUBBER
COMPOUND 1235-70

SECTION L-L

VIEW E-E

1/2" LONG BELLOWS
SEAL VALVE - TYPE
SIG 100
CAT 114 4395 (HMO)

1/4" X 45" CHAMFER

1/4" SNAPTITE COUPLING
CAT 114 SPEL 4-45 (SIA)
1/4" INNER CONTAINER FLANGE
CASK CAVITY SUCTION
DRAIN LINE

1/4" SNAPTITE
PLAIN NIPPLE
SERIES "E"
CAT 114
SPEL 8-BF (SIG)

INNER CONTAINER
SUCTION DRAIN LINE

SECTION K-K

REV	DATE	NAME	SPEC	OWG	DESCRIPTION
1	12/17/70	W. B. G.	100		NATIONAL LEAD COMPANY NUCLEAR DIVISION WASHINGTON, D.C.
LWT SYSTEM					
1/2" INNER CONTAINER CONCEPT					
CODE NAME	PROD BY	SITE	DRAWING BY	REV	
29932	5360-10	1	70561P	1	
DATE	1/1	SHEET	2	OF	2

REV	DATE	DESCRIPTION
1		ISSUED FOR CONSTRUCTION
2		REVISIONS TO DRAWING
3		REVISIONS TO DRAWING
4		REVISIONS TO DRAWING
5		REVISIONS TO DRAWING
6		REVISIONS TO DRAWING
7		REVISIONS TO DRAWING
8		REVISIONS TO DRAWING

PWR BASKET APPROX 798 LBS
 BWR BASKET APPROX 1000 LBS
 INNER CONTAINER APPROX 548 LBS
 INNER CLOSURE HD APPROX 262 LBS

REV	DATE	NAME	SPC	DWG NO	DESCRIPTION
1					
2					
3					
4					
5					
6					
7					
8					

NATIONAL LEAD COMPANY
 NUCLEAR DIVISION
 WASHINGTON PLANT

LWT SYSTEM
 1/2 INNER CONTAINER CONCEPT

CODE IDENT: 20032
 PROD NO: 5350-10
 SHEET: 70562P
 REV: B

SCALE: 1/4" = 1'-0"

SHEET 1 OF 2

FIGURE 3A

1/2 LWT CASK WITH INNER CONTAINER PWR BASKET
CLEARANCES FOR FUEL AND GRAPPLE

- (1) Drain tube connector
- (2) Lifting lugs for basket

FIGURE 10
1/2 LWT CASK PWR BASKET
CLEARANCES FOR FUEL AND GRAPPLE

NAC-1/NFS-4

PORT COVER DETAIL B-B
SCALE 2/1

SECTION L-L

CASH BASE DETAIL G
SCALE 2/1

**MISER FIRE VALVE
INSTALLATION DETAIL-B**
SCALE (TYP SPACES)

**COOLANT RUPTURE DISK
INSTALLATION DETAIL-C**
SCALE

**UPPER SIDE IMPACT LIMITER WELDMENT
SECTION D-D**
SCALE

**RING GROOVE
IN TAIL**
SCALE

FLANGE 1 END
SCALE

FLANGE 2 END
SCALE

SECTION J-J
SCALE

E 10080

NUCLEAR FUEL SERVICES			
NFS 4			
SPENT FUEL SHIPPING			
CASH			
E 10080			

NLI-10/24

REVISED		DESCRIPTION	DATE
1	BY	SPACER PLUG ADDED OUTER HEAD BOLTING ADDED BOLTS TO BOTTOM OF CASE	8-8-91
2	BY	REVISED BOTTOM END IN BOWL FUEL BASKET OUTER CLOSURE HEAD BOLTS REPAIRED FUEL BASKET SPACER PLUG FUEL BASKET FUEL BASKET FUEL BASKET	11-11-91
3	BY	ADDED THE DOWN LOCK & LOCK TIGHTENING REVISED FUEL BASKET	11-11-91
4	BY	REVISED FUEL BASKET FUEL BASKET FUEL BASKET	11-11-91

REV	DATE	NAME	SPC	DWG NO	DESCRIPTION
1	8/8/91	W. J. W.			
2	11/11/91	W. J. W.			
3	11/11/91	W. J. W.			
4	11/11/91	W. J. W.			

NATIONAL LEAD COMPANY
NUCLEAR DIVISION
WRANGEL PLANT

GENERAL ARRANGEMENT
10/24 RAILCAR

CORE NO. 29932
PROJ. NO. A-5525
SCALE
SHEET 1 OF 1

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Valved Quick Disconnect Coupling (See Note 2 (cont.))

PRESSURE GAUGE
See Note 2 (cont.)

GLIDE VALVE
See Note 2 (cont.)

Valved Quick Disconnect Coupling
See Note 4 (cont.)

DUST CAP
& LAMPARD

CLIPPING HAND
Eye Bulb (1/4\"/>

CAVITY EXPANSION TANK
(359 Cu In.)

SECTION 'E-E'
Scale 1/2

Thermowell
(See Section F-F)

Valved Quick Disconnect Coupling
with Dust Cap & Lampard
See Note 2 (cont.)

GLIDE VALVE
See Note 2 (cont.)

VIEW 'D-D'
Scale 1/2

LIFTING TERMINUS
2 Paces (100')
13 3/4\"/>

4\"/>

FILL POINT

Access Cover

SECTION 'F-F'
Scale 1/4

Thermocouple Head
(Water Tight)
2 Paces 100' Apart

TYPICAL 2 PLACES
SECTION 'J-J'
Scale 1/4

REV	BY	DATE	DESCRIPTION
1	WJ	11/12/61	10810E
2	WJ	11/12/61	10810E
3	WJ	11/12/61	10810E
4	WJ	11/12/61	10810E
5	WJ	11/12/61	10810E
6	WJ	11/12/61	10810E
7	WJ	11/12/61	10810E
8	WJ	11/12/61	10810E
9	WJ	11/12/61	10810E
10	WJ	11/12/61	10810E
11	WJ	11/12/61	10810E
12	WJ	11/12/61	10810E
13	WJ	11/12/61	10810E
14	WJ	11/12/61	10810E
15	WJ	11/12/61	10810E
16	WJ	11/12/61	10810E
17	WJ	11/12/61	10810E
18	WJ	11/12/61	10810E
19	WJ	11/12/61	10810E
20	WJ	11/12/61	10810E
21	WJ	11/12/61	10810E
22	WJ	11/12/61	10810E
23	WJ	11/12/61	10810E
24	WJ	11/12/61	10810E
25	WJ	11/12/61	10810E
26	WJ	11/12/61	10810E
27	WJ	11/12/61	10810E
28	WJ	11/12/61	10810E
29	WJ	11/12/61	10810E
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66	WJ	11/12/61	10810E
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73	WJ	11/12/61	10810E
74	WJ	11/12/61	10810E
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76	WJ	11/12/61	10810E
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89	WJ	11/12/61	10810E
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94	WJ	11/12/61	10810E
95	WJ	11/12/61	10810E
96	WJ	11/12/61	10810E
97	WJ	11/12/61	10810E
98	WJ	11/12/61	10810E
99	WJ	11/12/61	10810E
100	WJ	11/12/61	10810E

NATIONAL LEAD COMPANY
NUCLEAR DIVISION
WINSTON-SALEM, N.C.

NLI 1/2 SPENT FUEL CASK
DETAILS

CODE 20932
SCALE 1/4 & 1/2
SHEET 2 OF 4

TABLE 1

ITEM	DESCRIPTION	QTY	UNIT
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SECTION A-A

SECTION B-B

SECTION C-C

SECTION D-D

SECTION E-E

SECTION F-F

SECTION G-G

Appendix C
NLI-1/2 and NAC-1 Annual Procedures

NLI-1/2

NLI INDUSTRIES, INC. - NUCLEAR DIVISION - WILMINGTON, DELAWARE - MANUFACTURING & QUALITY CONTROL PROCEDURE

Rev. 0 Date 1 Date 2 Date 3 Date 4 Date 5 Date 6 Date

JOB	UNIT	DRAWING	ENG: <i>EPH</i>	10/11/78	226	5/15/79											PG #
		72000F	QC: <i>MO</i>	10/26/78	<i>MD</i>	5/16/79											1
			PROD: <i>NB</i>														

Date: 10/17/78	Material:	Next Assy.	Rev.	Sht. 1
Originator: Williams	Description: Annual Compliance Tests for LWT 1/2 Cask System			of 6

Oper. No.	Description of Operation	Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks
1	Check material conformance to Bill of Material. Q.C. survey personnel barrier & trailer for radiation. Record hubodometer reading.						
2	Remove personnel barrier and repair any broken welds per NLI Proc. GWP-84.						
3	Q.C. inspect welds per NLI Proc. 316.						
4	Q.C. survey cask surface for radiation.						
5	Remove cask from trailer and place in vertical position. Remove outer head and inner head. Q.C. to survey for radiation during disassembly.						
6	Inspect and repair as necessary trailer weldment and cask tie downs per maintenance inspection schedule results to be recorded on "Maintenance Inspection of Tie Downs and Trailer Weldment" Rev. 1. (Copy Attached). Weld repairs to be done using weld procedures identified on Dr. 72022F.						
7	Trailer to be sent out for annual inspection per "F" Inspection List (copy attached).						

NL INDUSTRIES, INC. – NUCLEAR DIVISION – WILMINGTON, DELAWARE – MANUFACTURING & QUALITY CONTROL PROCEDURE

Rev. 0		Date 1		Date 2		Date 3		Date 4		Date 5		Date 6		Date			
JOB	UNIT	DRAWING	ENG: <i>EEH</i>	<i>10-18-78</i>	<i>EEH</i>	<i>5/10/79</i>									PG #		
		72000F	QC: <i>MD</i>	<i>10-20-78</i>	<i>MD</i>	<i>5/10/79</i>									2		
Date: 10/17/78		Material:										Next Assy.		Rev.		Sht. 2	
Originator: Williams		Description: Annual Compliance Tests for LWT 1/2 Cask System														of 6	

Oper. No.	Description of Operation	Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks
8	Check material conformance to Bill of Material. Inspect cask and closure head (inner and outer) seal surfaces and seals. Clean surfaces and replace any damaged seals.						
9	Install BWR basket. Take basket from can located in Delaware Valley area. Also install BWR drain line assembly. Reference Drawing 72006F.						
10	Helium Leak Test - Inner closure head seal and primary valves V-1 and V-2 see Sketch No. 1 attached. Install inner closure head with metal "O" ring seal in place. Torque closure head bolts to 300 FT-LBS, in pairs 180° apart in 4 steps. Remove valved nipple from V-2 valve arrangement. Install V-2 valve cap with metal "O" ring seal only, in place. Torque valve cap bolts to 250 IN-LBS. Connect vacuum pump to valved nipple in V-1 valve arrangement or valved nipple can be removed and vacuum pump connection can be threaded into base plate of V-1 valve arrangement. Evacuate cask cavity to 1 inch Hg. Pressurize cask cavity to 10 PSIG using clean dry helium. Using a sniffer probe connected to a mass spectrometer, scan the joint between the closure head and cask flange and the V-2 valve cap and base, moving at a rate not to exceed 15 inches per minute. A leak rate greater than 1×10^{-6} STP CC/SEC will be cause for rejection. Repeat						

NL INDUSTRIES, INC. - NUCLEAR DIVISION - WILMINGTON, DELAWARE - MANUFACTURING & QUALITY CONTROL PROCEDURE

Rev. 0		Date 1		Date 2		Date 3		Date 4		Date 5		Date 6		Date	
JOB	UNIT	DRAWING	ENG: <i>CEH</i>	10/10/78	<i>CEH</i>	5/10/79									PG #
		72000F	QC: <i>MD</i>	10/10/78	<i>MD</i>	5/10/79									3
Date: 10/17/78			Material:										Next Assy.	Rev.	Sht. 3
Originator: Williams			Description: Annual Compliance Tests for LWT 1/2 Cask System												of 6
Oper. No.	Description of Operation					Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks				
11	<p>Check material conformance to Bill of Material.</p> <p>the test with V-1 valve cap and metal "O" ring seal bolted in place and pressurize cask thru V-2 valve arrangement. Only V-1 valve cap needs to be scanned.</p> <p>Helium Leak Test - Outer closure head seal and closure head cavity drain valve cap seals V-3 and V-4. Install outer closure head with "O" ring seal in place. Torque closure head bolts to 150 FT-LBS. in pairs 180° apart in 3 steps. Remove valved nipple from V-3 valve arrangement. Install V-3 valve cap with "O" ring seals in place. Torque valve cap bolts to 75 IN-LBS. Connect vacuum pump to V-4 valve arrangement. Perform helium leak test as described in Oper. No. 10. Scan joint between closure head and cask and V-3 valve cap and base. Repeat the test with V-4 valve cap and "O" rings bolted in place and pressurize closure head cavity thru V-3 valve arrangement. Only V-4 valve cap needs to be scanned.</p>														
12	<p>Hydrostatic Test Inner Closure Head Seal. Install inner closure head with metal "O" ring seal in place. Torque closure head bolts to 300 FT-LBS, in pairs 180° apart in 4 steps. Connect water supply line to valved nipple in V-2 valve arrangement. Connect vent line, having a pressure gauge and shut off valve, to valved nipple in V-1 valve arrangement. XXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXX pressurize cask cavity to 220 PSIG. Hold</p>														

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Rev. 0		Date 1		Date 2		Date 3		Date 4		Date 5		Date 6		Date	
JOB	UNIT	DRAWING	ENG: <i>EEH</i>	<i>10/17/78</i>	<i>EEH</i>	<i>5/11/77</i>									PG #
		72000F	QC: <i>MD</i>	<i>10/20/78</i>	<i>MD</i>	<i>5/11/77</i>									4
Date: 10/17/78			Material:										Next Assy.	Rev.	Sht. 4
Originator: Williams			Description: Annual Compliance Tests for LWT 1/2 Cask System												of 6
Oper. No.	Description of Operation					Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks				
13	<p>Check material conformance to Bill of Material.</p> <p>pressure for 30 minutes. Visually inspect closure head seal area. Any drop in pressure or leakage will be cause for rejection.</p> <p>Hydrotest Outer Closure Head Seal. Install outer closure head with "O" ring seal in place. Torque closure bolts to 150 FT-LBS. in pairs 180° apart in 3 steps. Connect water supply line to either V-3 or V-4 valve arrangement. Connect vent line, having a pressure gauge and shut off valve to the valve arrangement (V-3 or V-4) not being used as the water supply connection. Pressurize the closure head cavity to 45 PSIG. Hold pressure for 30 minutes. Visually inspect closure head seal area. Any drop in pressure or leakage will be cause for rejection.</p>														
14	Drain all water from internal cavities.														
15	Hydrostatic Test Water Jacket and Expansion Tank - Cask in vertical position. Remove water jacket relief valve and replace with calibrated pressure gauge and vent valve. Remove vent plug from expansion tank. Connect pump and supply of water/antifreeze mix to quick disconnect at water jacket drain valve, V-7. Fill water jacket and expansion tank until overflow occurs at vent valve and vent plug. Close vent valve and vent plug and pressurize														

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Rev. 0		Date 1		Date 2		Date 3		Date 4		Date 5		Date 6		Date			
JOB	UNIT	DRAWING	ENG:	10/10/78	10/24/78	5/11/79									PG #		
		72000F	QC:												5		
			PROD:	NA													
Date: 10/17/78		Material:										Next Assy.		Rev.		Sht. 5	
Originator: Williams		Description: Annual Compliance Tests for LWT 1/2 Cask System														of 6	
Oper. No.	Description of Operation					Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks						
	<p>Check material conformance to Bill of Material.</p> <p>system to 405 PSIG. Hold pressure for 30 minutes. Visually inspect all joints. Any drop in pressure or leakage will be cause for rejection.</p>																
16	<p>Water Jacket Relief Valve. Relief valve to be bench tested to verify cracking and reseating pressures. Allowable variation is +5%, - 12% of nominal cracking pressure - 200 PSIG.</p>																
17	<p>Perform hydrometer test of neutron shield fluid. Test for minimum -40°F condition.</p>																
18	<p>Reassemble cask per Dr. 72001F</p> <p>BWR Basket & Drain Line - Item 4</p> <p>Drain Line Gasket - Item 25</p> <p>Check all gaskets in place.</p> <p>Check all fasteners in place and torque.</p> <p>Item 12 - 300 FT-LBS.</p> <p>Item 22 - Dr. 72009F - 250 IN-LBS.</p> <p>Item 30 - 150 FT-LBS.</p> <p>Item 35 - 75 IN-LBS.</p> <p>Item 21 - 75 IN-LBS.</p>																

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Rev. 0 Date 1 Date 2 Date 3 Date 4 Date 5 Date 6 Date

JOB	UNIT	DRAWING	ENG: <i>EFH</i>	<i>10/16/78</i>	<i>EFH</i>	<i>5/18/79</i>											PG #
		72000F	QC: <i>WJD</i>	<i>10/16/78</i>	<i>WJD</i>	<i>5/14/79</i>											6
			PROD: <i>NA</i>														

Date: 10/17/78	Material:	Next Assy.	Rev.	Sht. 6
Originator: Williams	Description: Annual Compliance Tests for LWT 1/2 Cask System			of 6

Oper. No.	Description of Operation	Work Center	Comp. No.	Docu. Rev.	QC. Cust. Govt. A.I.	Date	Remarks
19	Check material conformance to Bill of Material.						
20	Inspect impact structures for damage and repair per NLI Proc. GWP-84.						
	Assemble cask, top and bottom impact structures and personnel barrier to trailer per drawing 72000F.						

NLI 1/2 Spent Fuel Cask
Schematic Diagram
Alternate Configuration
Cask and Expansion Tanks

SKETCH # 1

Rev. I
12/76

NAC-1/NFS-4

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3.0 GENERAL INSPECTION

3.1 Exterior

- 3.1.1 Inspect entire cask (including bottom and upper impact limiter) and polish out any nicks or gouges found.
- 3.1.2 Inspect trunnions and surrounding areas for rust (ferric contamination) from yoke or trailer and remove with naval jelly.
- 3.1.3 Beadblast any polished (shiny) surfaces with .012" - .017" diameter glass beads. This does not include cask lid which has a polished finish.
- 3.1.4 Inspect upper impact limiter gasket.

3.2 Valve Ports (5) - Repair or replace as required.

- 3.2.1 Remove port covers, if necessary; inspect covers for damage (threads, O-ring, and O-ring groove).
- 3.2.2 Inspect threads in valve port cavity.
- 3.2.3 Inspect male "Snap-Tite" for physical damage.

NOTE: This work can be done while performing hydro pressure check on cask. DO NOT place covers back in position. This will be done after hydro test.

3.3 Cask Lid (Removed from Cask)

- 3.3.1 Attach spider and lift lid with 1/2 ton crane, inspect lid for nicks and gouges.
 - 3.3.1.1 File and polish as needed.
 - 3.3.1.2 Take special note around edges that could affect sealing.
- 3.3.2 O-Rings and O-Ring Grooves
 - 3.3.2.1 Remove O-rings and inspect for damage (nicks, etc.); replace if needed.
 - 3.3.2.2 Inspect grooves for nicks or other damage and repair as needed.
 - 3.3.2.3 Place O-rings back into grooves being sure the grooves and rings are cleaned. Hold in place using vacuum grease.

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3.4 Cask Sealing Surface for Lid (With Lid Removed)

- 3.4.1 Inspect sealing surface in general for nicks and gouges. File and polish as needed.

3.5 Lid Bolts

- 3.5.1 Inspect bolts for excessive wear or damage - repair or replace as needed.
- 3.5.2 Coat threads with Molydisulfide or "Molykote".

4.0 REBUILDING OF BALL VALVES AND CAVITY RELIEF VALVE.

- 4.1 Four Ball Valves require rebuilding, or replacement: the vent, gasket check, and two drain valves.

Note: When rebuilding a drain valve, flush through the vent line with demineralized water and drain through the drain valve to be repaired, to a suitable drain. When changing gasket check valve, flushing is not necessary. All hose connections to cask require valved female "Snap-Tite" fitting. Use care in handling residual water as it may be contaminated.

- 4.1.1 Remove the two 1/4-20 bolts that tie the pipe down near the opening of the port and the four 5/16" cap screws that hold the pipe end to the body of the valve. Remove this piece from the cavity and place on clean surface.

CAUTION: Be sure to monitor the valve cavity and any pieces removed in case any "hot spots" are uncovered.

- 4.1.2 Using the valve installation tool, turn out the remaining portion of the ball valve.
- 4.1.3 Check the pieces of the valve closely for a possible radiation hazard to extremities.

CAUTION: Take care in noting the relation of the pipe end with the welded short nipple and the stop on the valve body. It is important that these pieces be reassembled in the same order to maintain a conventional open-close position among the valves on the cask.

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- 4.1.4 Disassemble the rest of the valve and rebuild according to Figure 1 with Rebuild Kit.

NOTE: Be sure all internal surfaces are free from dirt and grit, especially the Teflon seats.

- 4.1.5 Inspect ball for scratches or blemishes that might cause leakage past Teflon seat. Replace ball if needed.

- 4.1.6 When inserting the ball, be sure the vent hole is pointed toward the pipe end with the welded nipple (hole is toward cask when installed) and turn the handle counterclockwise to the open position (this will prevent the ball from falling out).

NOTE: If the valve has sustained damage or wear that cannot be remedied by use of the rebuilding kit, replace entire valve assembly with new valve.

- 4.1.7 Assemble valve body and back flange. Coat the threads on the nipple with "Led-Plate" and replace the valve in the valve cavity. It can first be turned in by hand and then tightened using the valve installation tool.

- 4.1.8 Ensure that the valve handle in on "Top" of the valve. Also, check that when closing the valve, the vent hole points toward the cask (be careful not to close valve completely or the ball may fall out). If the valve is assembled incorrectly, remove valve and reassemble.

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TO REPLACE SEATS AND SEALS ON ADJUSTABLE STEM VALVES

1. PLACE VALVE IN OPEN POSITION. REMOVE FOUR BODY NUTS AND BOLTS, REMOVE CENTER SECTION FROM BETWEEN PIPE ENDS.
2. WITH STEM IN CLOSED POSITION, REMOVE OLD SEATS, BODY SEALS, AND BALL.
3. REMOVE HANDLE NUT, HANDLE, AND STOP FROM STEM.
4. USING A WRENCH TO PREVENT STEM FROM TURNING, REMOVE ADJUSTING NUT FROM STEM. REMOVE STEM THROUGH BODY CAVITY.
5. REMOVE FOLLOWER AND STEM SEAL. CHECK AND CLEAN ALL SEALING SURFACES, IF NECESSARY.
6. PLACE THRUST BEARING ON STEM AND INSERT THROUGH BODY CAVITY.
7. PLACE STEM SEAL, STEM SEAL FOLLOWER, AND BELLEVILLE WASHERS IN POSITION. (STEM SEAL IS THICKER THAN THRUST BEARING.)

FOR STEMS WITH ELASTOMER 'O' RING SEALS:

THESE ARE NO LONGER AVAILABLE AND ARE REPLACED BY THE ABOVE SEAL PACKAGE. ASSEMBLE AS DIRECTED ABOVE.

ASSEMBLE ADJUSTING NUT FAR ENOUGH SO THE WRENCH MAY BE PLACED ON TOP OF STEM. TIGHTEN ADJUSTING NUT TO MAKE THE STEM SNUG AND FIRM. EXCESSIVE TIGHTENING ONLY CAUSES HIGHER TORQUE AND SHORTER SEAL LIFE.

8. REPLACE STOP, HANDLE, AND HANDLE NUT ON STEM. WITH STEM IN CLOSED POSITION, REPLACE BALL AND SEATS. WITH STEM IN OPENED POSITION, INSERT BODY SEALS AND PLACE CENTER SECTION BETWEEN PIPE ENDS.

NOTE: WHEN REPLACING OPTIONAL STAINLESS STEEL 'S' GASKET BODY SEAL, THE WIDE FLANGE IS PLACED AGAINST BODY OF THE VALVE. SEE VIEW A-A.

REPLACE BODY BOLTS AND NUTS AND TIGHTEN.

Figure 1

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- 4.1.9 Take the valve end with the long pipe and male "Snap-Tite", and center the body seal and the Teflon seat against the ball.

Note: The body seal and Teflon sent may be held in place usig vacuum grease. Take care not to get dirt on any parts.

- 4.1.10 Reassemble this portion to the portion already in the valve cavity using 4-5/16" cap screws. Then refasten the 1/2" pipe down with the 1/4-20 screws.

- 4.1.11 If an annual is being performed, continue with the procedure, completing required documentation. If the ball valves are being rebuilt on an exception basis, then pressure test the cask cavity to 100 + 5 psig and check for leaks using the pressure gage. Hold the pressure for 10 minutes. No pressure drop is permitted. Complete the required documentation.

NOTE: If air is used to pressurize the cask, then a suitable leak detector such as SNOOP must be used (no foaming is permitted) along with the pressure gage reading.

- 4.2 Rebuilding or replacement of the cavity relief valve.

- 4.2.1 Pull poppet ring to release any pressure that might be between the relief valve and 300 psig rupture disk.

- 4.2.2 Remove relief valve from cavity, using an open end wrench.

NOTE: If a new relief valve is to be installed, verify the valve operates as described beginning in step 4.2.7 below. Record the serial number of the replacement valve.

- 4.2.3 Remove override ring and rod and "break" body joint by using 13/16" wrench.

NOTE: DO NOT use pipe wrenches.

- 4.2.4 Remove upper portion of the body and turn out the poppet after checking that all inner surfaces are clean. If unable to repair, replace relief valve.

- 4.2.5 Remove sealing poppet and replace with a new poppet after checking that all inner surfaces are clean. (If unable to repair, replace relief valve.)

- 4.2.6 Turn in the adjusting spring to the approximate pressure that it was originally and replace the upper valve body (not tight).

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- 4.2.7 Attach this part of the valve to the pressure test assembly and apply pressure to the valve using the high pressure hand pump.
- 4.2.8 If the relief valve releases before 200 psig, turn in the adjusting spring. If it does not release at 200 psig, turn the adjusting spring out until it does. Cracking pressure is 200 ± 10 psig and reseal pressure 170 ± 10 psig per manufacturer's specification for this type valve.
- 4.2.9 Once adjusted to 200 psig, hold the adjusting spring in position and tighten the upper portion of the body. Replace override ring and rod.
- 4.2.10 Apply pressure again and pull override to verify operation.
- 4.2.11 Remove the relief valve from the test assembly and reinstall.
- 4.2.12 If an annual is being performed, continue with the procedure. If the relief valve is being replaced or rebuilt on an exception basis, then pressure test the cask cavity to 100 ± 5 psig and check for leaks using the pressure gage. Hold the pressure for 10 minutes. No pressure drop is permitted.

NOTE: If air is used to pressurize the cask, then a suitable leak detector such as SNOOP must be used (no foaming is permitted) along with the pressure guage reading.

5.0 REPLACEMENT OF THE CAVITY RUPTURE DISK

NOTE: Replacement of the cavity rupture disk should be done concurrently with the relief valve rebuilding or replacement.

- 5.1 Using the 1-1/4" deep well socket, remove the entire assembly from the cask.
- 5.2 Remove the outer body of the assembly from the inner body (see Figure 2) being careful not to damage the threads.
- 5.6 Remove the seating spacer and old rupture disk being careful not to damage the seat on the spacer.
- 5.7 Clean all surfaces, especially seats and threads, and check for rough edges on the seating surfaces. Polish rough spots with crocus cloth.

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Figure 2

- 5.8 Place new disk in the inner body followed by the seating spacer. Be sure the dome of the disk is up.
- 5.9 Apply small amount of "Led-Plate" to threads of outer body and the inner face between the outer body and seating spacer. Reassemble and tighten snug.
- 5.10 Apply "Led-Plate" to the 1/8" NPT of the assembly and replace the assembly in the relief cavity. Tighten snug.
- 5.11 If an annual is being performed, continue with the procedure. If the cavity rupture disk is being replaced on an exception basis, then pressure test the cask cavity to 100 ± 5 psig and check for leaks using the pressure gage.

NOTE: If air is used to pressurize the cask, then a suitable leak detector such as SNOOP must be used (no foaming is permitted) along with the pressure gage reading.

6.0 REPLACEMENT OF THE NEUTRON SHIELD TANK RUPTURE DISKS

- 6.1 On the surge tank at the upper end of the cask, remove the 3/4" vent plug.
- 6.2 Remove the 3/4" drain plug, being prepared to catch any water that might drain out.

NOTE: No water should be present in any tank. Presence of water indicates a leak that must be repaired.

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- 6.3 Remove the rupture disk distribution head and the large assembly nut (see Figure 3) with a wrench while holding the outlet connection so it does not turn.

CAUTION: When handling this assembly, be careful not to damage the seats of the assembly or to get dust or dirt on them.

Neutron Shield Tank
Rupture Disk Assembly

Figure 3

- 6.4 Remove assembly and clean the dirt and grease from all surfaces (especially threads) and place on clean surface.
- 6.5 Remove rupture disk and vacuum support and place on clean surface.
- 6.6 Inspect seat of inner connection for damage and dirt. If seating surface is not smooth, polish with crocus cloth.
- CAUTION: Be sure seating surfaces are free from any dirt and grit.
- 6.7 Clean grease and dirt from all threads (male and female).
- 6.8 Inspect vacuum support for any damage that might affect rupture disk.

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- 6.9 Inspect new disk for any apparent defects (holes, extreme wrinkles, etc.).

CAUTION: Do not touch curved portion of disk. Handle with care.

- 6.10 Apply thin film of vacuum grease to seating surfaces of vacuum support and rupture disk and seat.

CAUTION: Be sure there is vacuum grease on all seating surfaces including the inlet and outlet connections.

- 6.11 Place rupture disk assembly on the inlet fitting with curved surface out.

- 6.12 Put assembly nut over outlet connection and place in position in the cavity. Hold the outlet connection out away from the rupture disk and tighten the large assembly nut with fingers while holding the outlet connection from turning (assembly nut threads are to have a thin layer of "Led-Plate" wiped on).

- 6.13 Use a wrench to tighten the assembly nut snug while preventing the outlet connection from turning. Torque to 10 ft-lb (+5,-0).

- 6.14 Replace distribution head after coating threads with "Led-Plate".

NOTE: The neutron shield tanks are normally empty but they must be leak tight to prevent in-leakage of pool water during handling.

- 6.15 With the neutron shield tanks empty, attach the pressure test assembly to the 3/4" pipe plug (vent) on the surge tank at the top of the cask. Using utility air, apply an 80 psig pressure to the neutron shield tank. Shut off valve on test assembly and let stand for 10 minutes.

NOTE: This is done on each of the four neutron shield tanks.

- 6.16 Check the rupture disks, pipe plugs, and seams for leaks using "SNOOP." There should be no bubbles or foaming.

- 6.17 If pressure has not dropped after 10 minutes, open test assembly valve to relieve the pressure. Remove the assembly and replace the pipe plug (coat the pipe plugs with "Led-Plate").

- 6.18 If pressure does drop, relieve the pressure in the tank and check the assembly for leaks. If leak is in test assembly, repair and re-do static check.

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7.0 PRESSURE TEST OF THE GASKETS (Static Check at 100 + 5 psig)

- 7.1 Place lid in position on top of cask (aligning mark on lid with mark on cask).
- 7.2 Using the new bolts, torque each to 300 (+50, -0) ft lb using a 1, 4, 2, 5, 3, 6 pattern; then, with the same sequence, torque each bolt to 650 (+100, -0) ft lb.
- 7.3 Using the high pressure check assembly, attach assembly to male "Snap-Tite" in the gasket check valve cavity.
- 7.4 Attach high pressure hand pump and demineralized water to test assembly.
- 7.5 Open ball valve, located in cavity, with valve hook and apply 100 + 5, psig to the double O-ring seal.
- 7.6 Close ball valve on pressure check assembly and shut off demineralized water. Wait for 10 minutes.

Note: If air is used to pressurize the cask, then a suitable leak detector such as SNOOP must be used (no foaming is permitted) along with the pressure gauge reading).
- 7.7 If zero pressure drop, disconnect the high pressure hand pump and bleed pressure off through assembly ball valve. Close cavity ball valve and disconnect assembly. Place valve port cover back in position.
- 7.8 If pressure drop is noted, disconnect the the high pressure hand pump and bleed pressure off through assembly ball valve. Remove the test assembly and repressurize it to 100 psig to see if leak is in assembly. If in assembly, repair leak and recheck lid gaskets. If not in assembly, first check "Snap-Tite" fittings and valves for leakage, then if necessary replace lid gaskets and recheck.

8.0 PRESSURE TEST OF THE CASK CAVITY (Static Check and Visual Inspection at 100 psig)

- 8.1 Attach high pressure test assembly to the cask's vent valve.
- 8.2 Using the hand pump and demineralized water or air, pressurize the cask cavity to 100 + 5 psig. Close the ball valve on the test assembly and disconnect (or bleed off) demineralized water line pressure.

CAUTION: Do not stand in front of any of the valve ports while pressurizing the cask. It could be possible for contaminated water to spray out if gross leaks are present.

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- 8.3 While waiting 10 minutes for the static pressure check, visually inspect the drain valve ports, cavity relief valve port and the vent valve port (where test fixture is connected) for leaks.

CAUTION: Do not leave cask unattended while filled with water. Temperature rise of water a few degrees will overpressurize the cask and burst primary cavity rupture disk.

Note: If air pressure is used, a suitable leak detector such as SNOOP must be used (no foaming permitted), in conjunction with pressure readings.

- 8.4 Since the male "Snap-Tites" connected to the drain and vent ball valves are the valved type, it is necessary to open the "Snap-Tite" valved fitting using a valved female fitting to check for leakage past the ball valves when closed. The special drain hose used during cask unloading can be used for this purpose or the plunger on the fitting can be depressed to open.
- 8.5 Since the cask cavity has a high pressure (300 psig) rupture disk followed by a 200 psig relief valve, to ensure there are no leaks in the rupture disk, it is necessary to open the relief valve. Pull the poppet ring to vent the relief valve. If any pressure or water is noted when checking relief valve, replace 300 psig rupture disk.
- 8.6 If no static pressure loss noted on the test fixture, open valve on test assembly to relieve cavity pressure. Attach drain line and open drain valve.
- 8.7 Sample water from cask cavity for activity.
- 8.8 After the water has been drained from the cask cavity, close the vent valve and pressurize it to 100 ± 5 psig with demineralized water. Close ball valve on the test assembly and disconnect (or bleed off) demineralized water pressure. If no static pressure loss is noted after 10 minutes, open valve on test assembly to relieve pressure and remove assembly from cask.
- 8.9 Remove drain hoses.
- 8.10 Be sure all valves are closed and replace port covers.
- 9.0 PNEUMATIC PRESSURE CHECKS OF THE IMPACT LIMITERS
- 9.1 Impact Limiters (static test for leakage at 5 (+2, -0) psig.
- 9.2 Remove the pipe plug from the balsa wood compartment.

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- 9.3 Insert a pipe coupler with male "Snap-Tite" fitting in impact limiter port.
- 9.4 Using the low pressure check assembly, attach assembly to the male "Snap-Tite" on the impact limiter port.
- 9.5 Attach a pressure regulator on the air supply line.
- 9.6 Adjust regulator to give 5 (+2, -0) psig air supply for test.
- 9.7 Connect regulated air supply to low pressure check assembly and apply 5 psig to the impact limiter compartment.
- 9.8 Allow air pressure to stabilize for 1 hour, readjust to 5 psig if required, then hold for 30 minutes for static pressure check.
- 9.9 While waiting 30 minutes, check for leaks around welds using SNOOP. Criteria for test acceptance is no foaming of SNOOP.
- 9.10 If no leakage is noted, open valve assembly to relieve pressure.
- 9.11 Remove test apparatus and coupler, then coast the threads on the pipe plug and replace the lug in the impact limiter port.

NOTE: This is done on each of the two impact limiter compartments on the cask.

Appendix D

Containment Verification Operations

NAC-1/NFS-4

SECTION: ESD	DOCUMENT NO. 520	PAGE 22 OF 46
TITLE: INER CASK HANDLING AND LOADING PROCEDURE (FMP)	REVISION NO. 12	DATE:
PREPARED BY: F. L. Danese		March 1987

5.5.3.10 Using the overhead crane, remove the transfer basket cable removal platform from the loading structure.

5.6 Cask Preparation for Shipment (Note: Complete Attachment 1 While Performing This Section)

5.6.1 Install lid bolts finger-tight.

5.6.2 Torque the lid bolts to 300 ft.-lbs. (+50, -0) using a 1, 4, 2, 5, 3, 6 sequence. Then, torque the lid bolts to 650 ft.-lbs. (+100, -0) using the same sequence.

5.6.3 Attach pressure test fixture to the O-ring annulus vent valve. Open the valve and O-ring annulus vent, pressurize the annulus between the double O-ring seals to 30 (+5, -0) psig with air, then isolate and hold for 10 minutes. There may be a small pressure transient while temperature equalizes. Check for zero pressure leak.

NOTE: Replace O-rings if leakage is found. This can be accomplished by replacing the carriage onto the structure, re-attaching the lid lifting adapter, and removing the lid in a manner similar to the normal loading sequence. Unless one O-ring is found to have an obvious defect, both O-rings should be replaced. The O-ring annulus vent valve is to the left when facing the cask pressure relief valve [center].

Again using the pressure test fixture, close the drain and vent valves and pressurize the cask cavity, with air, to 30 psig (+5, -0) through the cavity vent valve, isolate and hold for 10 minutes. Visually inspect the cask, closure lid, and valves (4) for leakage. To check the valves for through-the-valve leakage, a female Snap-Tite fitting must be used to open the Snap-Tite fitting check valve. After the pressure test, disconnect the pressure source and vent pressure off of the cask cavity.

NOTE: Any leakage observed must be remedied prior to shipment of the cask. It is not normally necessary to unload the cask to correct minor leaks. Notify NAC immediately if assistance is required. These tests are a requirement of the cask's Certificate of Compliance. Successful performance of the tests must be documented.

5.6.4 Commence decontamination of all exposed cask surfaces. Rinse and wipe exposed cask surfaces dry. (See Section 6 for decontamination recommendations.)

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5.6.5 Connect station (pressurized) air to the cask vent valve and open one drain valve. Force air through the cask for five minutes after visual indications of residual water disappear from the discharge. Repeat this operation for the second drain valve.

NOTE: Both drain valves may be used simultaneously if fitting and lines are available. Air, helium, nitrogen or argon may be used to force water out and dry the cavity. Vent the cask to atmospheric pressure.

5.6.6 Shut all valves. Lock the valve handles in the closed position. Disconnect all lines. Replace the valve port covers finger-tight and lockwire in place. Also, lockwire and seal all six (6) lid bolts. Lift the cask. Decontaminate the bottom of the cask.

NOTE: The relief valve port cover is unique. Care must be taken to ensure the correct cover is used.

5.6.7 Complete surface decontamination. Tape the neutron shield tank rupture disk ports to reduce road dirt entry to these ports in transit.

NOTE: The cask should meet site surface contamination limits **BEFORE** it is placed in the shipping container. Major decontamination efforts conducted after the cask is loaded in the container normally result in the container becoming contaminated, complicating the shipping effort.

5.6.8 Prior to lifting the cask, verify that the yoke arms are fully and correctly engaged with the cask trunnions. Lift the cask and move it to the container loading area.

5.7 Loading The Cask Into The Container (Note: Complete Attachment 1 While Performing This Section)

5.7.1 Rotate the cask into its proper orientation for loading. Lower the cask carefully, placing lower trunnions into the tie-downs on the container. (Note that the lower trunnions are not on a cask center line and the cask can be put on the tie-downs upside down. Correct orientation is with cask nameplate on "top" of the cask when the cask is in horizontal position.)

5.7.2 Place tie-downs around lower trunnions and secure bolts finger-tight. Lower cask to horizontal position, while keeping crane cables vertical.

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5.1.19 Using a mirror, survey cask internals, visually inspect cask cavity for foreign material, damage, etc. Note any discrepancy on shipping document and checklist.

5.2 Cask Loading

- 5.2.1 Fill cask cavity with demineralized water to level of inner container flange (estimated volume 56 gallons).
- 5.2.2 Install yoke guide brackets on each leg of the yoke.
- 5.2.3 Make certain that the cask sealing surface for the inner head is free of all foreign matter.
- 5.2.4 Attach hydraulic lines to lifting yoke. Operate hydraulic unit to assure system is operating correctly. Engage lifting yoke to cask trunnions and pick up cask.
- 5.2.5 Lift cask from the cask washdown pit.
- 5.2.6 Move cask over laydown area of the Spent Fuel Pool and slowly lower cask to bottom of pool.
- 5.2.7 After seating the cask on the bottom of the pool, disengage lifting yoke from cask using hydraulic system.
- 5.2.8 Lift hook and lifting yoke clear of pool. Wash down all components as they come out of pool.
- 5.2.9 Using the Spent Fuel Handling Machine, grapple and lift the fuel assembly to be shipped from storage position and place into the cavity of the cask and lower the fuel assembly until seated on the bottom of the cask cavity. Use the underwater TV camera as required to observe this operation. Inspect the inner "O" ring sealing surface of the cask to insure that it is free of all foreign material.
- 5.2.10 Attach the two Quick Disconnect attachments for head valves (T-1) to the two valved quick disconnect nipples (V-1 and V-2) on the Inner Closure Head. This is necessary to open these line to expanding water once the head is in place.
- 5.2.11 Attach two inner closure head slings to Inner Closure Head and to attachment points provided on cask lifting yoke as described in Step 5.1.16.
- 5.2.12 Move yoke and head to pool area and lower to cask. Lower the yoke and inner closure lid until the pin slot is aligned with longer alignment pin. Continue to lower the

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yoke and inner closure head until the underside of the head is just below the top of the longer pin--but is still above the shorter pin. TV helps here.

CAUTION

Use extreme caution in preventing the top of a guide pin from coming in contact with the metal "O" ring on the underside of the inner head.

- 5.2.13 Move the head horizontally toward the pin until pin and slot are engaged.
- 5.2.14 Lower head until shorter pin enters its head alignment slot.
- 5.2.15 Lower head onto cask and observe carefully to ascertain that no binding or cocking has precluded proper seating.
- 5.2.16 Verify that the arms are disengaged position by actuating the master cylinder.
- 5.2.17 Lower lift rig down on to cask until alignment brackets are aligned with the trunnion and rest on top of the cask. Move lift arms to engaged position by actuating the master cylinder or air valve.

CAUTION

Be certain the lifting arms have cleared the end plates of all trunnions and are totally engaged. This should be verified by both the operator and one other person viewing from different angles before lifting cask. A third person must verify that the other two are in the proper location for accurate viewing and the third person should concur in their observations before the lift is started.

- 5.2.18 Raise lift rig slowly 2 inches to 3 inches until lift rig is supporting the weight of the cask. Verify that the lifting rig has engaged the trunnions properly.
- 5.2.19 Raise cask from pool, washing down all components as they emerge from the pool. Flush pool water from head cavity, replacing it with clean water.
- 5.2.20 When the cask head is at a convenient proximity to the bridge, stop the lift, install and hand tighten all inner head bolts using flex-socket speed wrench.

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5.2.21 The cask should be sprayed with D.I. water as it is raised from the pool. All open parts should be also sprayed to rinse out any puddles of pool water.

5.3 Cask Preparation for Shipment

- 5.3.1 Move cask to the cask washdown pit.
- 5.3.2 Move cask into cask washdown pit, keeping it wet, if practical to do so, until decon is completed. The head cavity should be kept full of water.
- 5.3.3 Decontamination of the cask surfaces may begin after the cask has been transferred to the cask wash down area.
- 5.3.4 Detach slings from inner head lugs.
- 5.3.5 Disengage lifting yoke and remove from cask.
- 5.3.6 Check both cavity drain valves, V-3 and V-4, to be certain they are closed.
- 5.3.7 Replace long guide pins with the two shorter ones. Tighten the 12 inner head bolts to 300 ± 10 ft. lbs. torque each. Do this in three or more cycles using the bolt selection shown below. (Every fifth bolt.) The starting position may be selected at random. On the last complete cycle, no bolt shall move in response to 300 ft. lbs. torque.

- 5.3.8 If necessary, refill the head cavity with demineralized water.

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NOTE

When instruction specify connections to a given numbered valve, the connections will be made to the valve's corresponding Quick Disconnect Attachment (T-1). V-1 is color coded yellow; V-2 is plain.

- 5.3.9 Connect Pressure/Vacuum Gauge Assembly (T-3) to inner Cavity Bottom Access Valve (V-2) and connect Drain Hose (T-12) to valve on T-3, which is fitted with a Snap-Tite Quick Disconnect fitting.
- 5.3.10 Connect demineralized water line to the Inner Cavity Upper Access Valve (V-1).
- 5.3.11 With the drain hose from V-2 in the measuring bucket, open demineralized water supply valve fully and determine the flow rate (gpm).
- 5.3.12 Obtain a sample of this water for activity analysis, then close water supply valve.
- 5.3.13 Place discharge end of drain hose in Spent Fuel Pool.
- 5.3.14 Open water supply valve and flush cask, replacing volume approximately twice (85 gallons, total). Obtain a sample of flush water, just prior to end of flush, for activity analysis.
- 5.3.15 When flushing is complete, close water supply valve and disconnect water line from V-1. Close drain line valve on T-3 (Pressure Gauge Assembly).
- 5.3.16 Attach air supply line regulated to 20 psig air pressure to V-1.
- 5.3.17 Remove drain hose from pool and place in bucket which can hold at least seven gallons or place into cask washdown pit drain.
- 5.3.18 Open drain hose valve in T-3.
- 5.3.19 Open air supply line to force out about five gallons of water from the cask inner cavity.
- 5.3.20 Close drain hose valve.
- 5.3.21 Pressurize cask cavity to 15 psig.
- 5.3.22 Close air line valve.

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- 5.3.23 Crack the Pressure/Vacuum Release Valve on Attachment T-3 until cask pressure bleeds down to 10 psig. Close Pressure/Vacuum Release Valve on Attachment T-3.
- 5.3.24 Observe the water contained in the head cavity for any bubbles coming from inner cavity seal. If a leak is detected within 10 minutes it must be corrected before continuing with step 5.3.25.
 - 5.3.24.1 If the inner head seal is leaking, first check torque on bolts. If torque is okay, return cask to Unit 1 Spent Fuel Pool, remove head and check seal ring per procedure III-B of Reference 2.2
 - 5.3.24.2 If seal ring appears okay, remove fuel from cask and return cask to pool surface to inspect seal surface.
 - 5.3.24.3 When corrective action necessitates reverting to an earlier step in the procedure, all steps following must again be executed.

NOTE

If return to Spent Fuel Pool is required, notify Shift Engineer before proceeding.

- 5.3.25 Open air supply valve and allow air to force out remaining water. Take appropriate precautions for handling contaminated effluent water and the pressurized air which will be emitted following water displacement. Purge cask cavity for 5 minutes after the last visible sign of water flow has stopped.
- 5.3.26 Shut off air supply and disconnect air line.
- 5.3.27 Detach drain hose from V-2. Close drain valve.
- 5.3.28 Attach helium line to quick disconnect nipple on T-2. Open valve on helium supply line and allow helium to flow into cask until pressure vacuum gauge on T-3 indicates cask cavity is slightly above atmospheric pressure. Close valve on helium supply line.
- 5.3.29 Remove helium line from attachment T-2. Allow excess helium to escape from cask. Immediately remove T-1 fitting from V-1 to close valved nipple on Inner Closure Head.

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- 5.3.30 Remove Attachment T-1 from nipple V-2. The cask inner cavity is now confined with a helium atmosphere at atmospheric pressure.
- 5.3.31 Attach Drain Hose (T-12) to one of Closure Head Cavity Drain Valves (V-3 or V-4), place loose end of hose in cask washdown pit and drain water from Closure Head Cavity.
- 5.3.32 When first Closure Head Cavity Drain line is drained, transfer T-12 to other Closure Head Cavity Drain Valve (V-3 or V-4) and drain residual water from it.

CAUTION

Removal of this water will allow increased streaming of radiation from the top of the cask. Avoid placing any part of the body other than hands in this area until the outer head is in place.

- 5.3.33 Using a clean, lint-free cloth, blot up all readily accessible water standing on the inner head surface and adjacent areas.
- 5.3.34 Retrieve the two valve caps and coat the threads of each valve cap bolt with Neolube.
- 5.3.35 Bolt each cap into place using torque of 21 ± 2 foot lbs.
- 5.3.36 Attach Seal Ring Test Attachment (T-10) to fitting on valve cap for V-1 and attach air supply line to opposite end of T-10. Open air supply line valve and valve on T-10 and apply 5 psig to space between two seal rings. Close both air line supply valve and valve on T-10 and disconnect air supply line from T-10.

NOTE

Observe pressure gauge for 5 minutes. Any discernable drop in pressure will indicate a leaking seal which will require correction and retesting. Remove Attachment T-10 from fitting on cap.

- 5.3.37 Repeat Step 5.3.36 on valve cap for V-2.
- 5.3.38 Attach the two-legged sling to the outer closure head and to the auxiliary crane hook.
- 5.3.39 Coat the threaded portion of the head bolts with Neolube.

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- 5.3.40 Position the head about 1/2" above the cask and manipulate the head until two or more of the head bolts drop into the threaded holes of the cask body. Engage two bolts to serve as guides, then lower the head into place.
- 5.3.41 Torque head bolts to 75 + 5 ft. lbs. each in several incremental steps using the bolt selection pattern shown (every 5th bolt). Position 1 is selected at random. The last cycle should result in no movement of any bolt when subjected to 75 lbs. torque. Insert security seal through two adjacent bolts.

- 5.3.42 Connect pressure gauge attachment (T-3) to V-3. Close both valves on attachment.
- 5.3.43 Attach vacuum pump hose attachment (T-2) to V-4 and connect air supply line regulated to 20 psig to T-2.
- 5.3.44 Open air supply valve and valve on T-2. Pressurize outer cavity to 15 psig. Close valve on Attachment T-2 and disconnect air supply line.
- 5.3.45 Crack valve on Attachment T-2 and slowly bleed off air until gauge on Attachment T-3 reads 10 psig. Close valve. Hold for 10 minutes. If any detectible drop in pressure is observed, check the seal ring for damage.

NOTE

If it is necessary to return to any preceding step, all subsequent steps from that point must be repeated in sequence. Notify SNFM.

- 5.3.46 Open valve on T-2 fitting and bleed off excess air from closure head cavity.

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- 5.3.47 Remove attachment T-2 and T-3 from valves V-3 and V-4.
- 5.3.48 Retrieve valve caps and bolts for valves V-3 and V-4 and coat threads of bolts with Neolube.
- 5.3.49 Install valve caps on each of the inner closure head cavity drain valves. Torque each bolt to 7 ± 1 ft. lbs.
- 5.3.50 Attach Seal Ring Test Attachment (T-10) to fitting on cover plate for V-3 and attach air or helium supply line to opposite end of Attachment (T-10). Open air supply line valve and valve on T-10 and apply 5 psig to space between seal rings.

Close both air line supply valve and valve on Attachment T-10 and disconnect air supply line from T-10. Observe pressure gauge for 5 minutes. Any discernible loss of pressure will indicate a leaking seal which will require correction and retesting. Remove Attachment T-10 from fitting on cap.
- 5.3.51 Repeat Step 5.3.50 for cover plate on V-4.
- 5.3.52 Complete decontamination of exterior surfaces of cask until surface contamination is acceptable for release.

NOTE

Decontamination can proceed throughout the cask sealing and testing procedure to whatever extent is convenient.

5.4 Loading Transportation

- 5.4.1 Check water jacket drain valve cover for secure attachment.
- 5.4.2 Remove alignment brackets from lift yoke.
- 5.4.3 Verify that trailer is level, side to side.
- 5.4.4 Attach cask lifting yoke to cask and lift about 3 feet.
- 5.4.5 Remove wooden shield disc and decon cask bottom if necessary.
- 5.4.6 Move cask over trailer location. Position cask to engage cutouts in bottom end of cask with rear tie-down. Lower cask to rest on front tie-down saddle, moving cask/trailer, as required, to keep crane cables vertical. With slight

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tension on crane cables, verify that front tie-down bolts can be started into their respective holes. Disengage cask lifting yoke from cask trunnions and store yoke.

- 5.4.7 Survey cask closure head area and valve boxes for surface contamination in accordance with DOT Regulations 173.393 (a). Record final values on shipping document.
- 5.4.8 Coat threads of front tie-down bolts (two (2) 1-3/8" Socket Head Cap Screws) with Neolube, install and torque to 200 ft. lbs. Install lock wire on each bolt. Install top and bottom impact structures with four (4) 3/4" Hex Head Bolts each and torque to 50 ft. lbs. Lockwire adjacent bolts. Insert security seal, connecting front impactor bolt head with cask lug.
- 5.4.9 Attach personnel barrier via sling to auxiliary hook. Lift and move personnel barrier over trailer, observing front-rear orientation. Install personnel barrier on trailer and bolt in place with four (4) 4/8" Hex Head Bolts. Note positioning marks. Do not secure center clamps on either side.
- 5.4.10 Install personnel barrier access panel, if removed.
- 5.4.11 Move trailer/cask out of Auxiliary Building.

NOTE

At least two people in addition to the driver will observe the attachment of the trailer to the tractor to assure that the fifth wheel safety latch is all the way open before hookup and completely closed after hookup, and that no damage has occurred due to hookup forces.

- 5.4.12 Check trailer and cask for proper DOT labeling and placarding.
- 5.4.13 Make final Rad-Con survey of truck system.
- 5.4.14 Return all service equipment to normal storage.
- 5.4.15 Tech Staff review shipping documents for completeness and accuracy.
- 5.4.16 Give a bill of lading and other documentation for cask and fuel to the truck driver.
- 5.4.17 NLI tooling and equipment has been decontaminated to levels suitable for transfer to the next location.

Appendix E

Cask Tie Down Arrangements

NAC-1/NFS-4

NAC-1/NFS-4 Cask Tiedown Arrangement

PLAN VIEW

FRONT VIEW

SIDE VIEW

NAC-1/NFS-4 Cask Tiedown Arrangement

FRONT VIEW SIDE VIEW

NAC-1/NFS-4 Cask Tiedown Arrangement

NLI-1/2

NLI-1/2 Cask Tiedown Arrangement

NLI-1/2 Cask Tiedown Arrangement

NLI-10/24

NLI-10/24 Cask Tiedown Arrangement

NLI-10/24 Cask Tiedown Arrangement

Appendix F

Selected Federal Regulations

- **10CFR71.45**
- **10CFR73.27**
- **10CFR73.37**
- **10CFR73, Appendix D**
- **10CFR71, Subpart H**

PART 71 • PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

(b) For a Fissile Class II package, the allowable number of packages which may be transported in the same vehicle in accordance with § 71.59; and

(c) For a Fissile Class III shipment, any proposed special controls and precautions for transport, loading, unloading, and handling, and any proposed special controls in the event of accident or delay.

§ 71.37 Quality assurance.

(a) The applicant shall describe the quality assurance program (see Subpart H of this part) for the design, fabrication, assembly, testing, maintenance, repair, modification, and use of the proposed package.

(b) The applicant shall identify any established codes and standards proposed for use in package design, fabrication, assembly, testing, maintenance, and use. In the absence of any codes and standards, the applicant shall describe the basis and rationale used to formulate the package quality assurance program.

(c) The applicant shall identify any specific provisions of the quality assurance program which are applicable to the particular package design under consideration, including a description of the leak testing procedures.

§ 71.39 Requirement for additional information.

The Commission may at any time require additional information in order to enable it to determine whether a license, certificate of compliance, or other approval should be granted, denied, modified, suspended, or revoked.

Subpart E—Package Approval Standards

§ 71.41 Demonstration of compliance.

(a) The effects on a package of the tests specified in § 71.71 (Normal Conditions of Transport) and the tests specified in § 71.73 (Hypothetical Accident Conditions) must be evaluated by subjecting a sample package or scale model to test, or by other method of demonstration acceptable to the Commission, as appropriate for the particular feature being considered.

(b) Taking into account the type of vehicle, the method of securing or attaching the package, and the controls to be exercised by the shipper, the Commission may permit the shipment to be evaluated together with the transporting vehicle.

(c) Environmental and test conditions different from those specified in § 71.71 and § 71.73 may be approved by the Commission if the controls proposed to be exercised by the shipper are demonstrated to be adequate to assure the safety of the shipment.

§ 71.43 General standards for all packages.

(a) The smallest overall dimension of a package must not be less than 10 cm (four in.).

(b) The outside of a package must incorporate a feature, such as a seal, which is not readily breakable, and which, while intact, would be evidence that the package has not been opened by unauthorized persons.

(c) Each package must include a containment system securely closed by a positive fastening device which cannot be opened unintentionally.

(d) A package must be of materials and construction which assure that there will be no significant chemical, galvanic, or other reaction among the packaging components or between the packaging components and the package contents, including possible reaction resulting from leakage of water to the maximum credible extent.

(e) A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operation and, except for a pressure relief device, must be provided with an enclosure to retain any leakage.

(f) A package must be designed, constructed, and prepared for shipment so that under the tests specified in § 71.71 (Normal Conditions of Transport) there would be no loss or dispersal of radioactive contents, no significant increase in external radiation levels, and no substantial reduction in the effectiveness of the packaging.

(g) A package must be designed, constructed, and prepared for transport so that in still air at 38°C (100°F) and in the shade, no accessible surface of a package would have a temperature exceeding 50°C (122°F) in a non-exclusive use shipment or 82°C (180°F) in an exclusive use shipment.

(h) A package must not incorporate a feature which is intended to allow continuous venting during transport.

§ 71.45 Lifting and tie-down standards for all packages.

(a) Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

(b) Tie-down devices:

(1) If there is a system of tie-down devices which is a structural part of the package, the system must be capable of withstanding, without generating stress in any material of the package in excess of its yield strength, a static force applied to the center of gravity of the package having a vertical component of two times the weight of the package with its contents, a horizontal component along the direction in which the vehicle travels of 10 times the weight of the package with its contents, and a horizontal component in the transverse direction of five times the weight of the package with its contents.

(2) Any other structural part of the package which could be used to tie down the package must be capable of being rendered inoperable for tying down the package during transport, or must be designed with strength equivalent to that required for tie-down devices.

(3) Each tie-down device which is a structural part of a package must be designed so that failure of the device under excessive load would not impair the ability of the package to meet other requirements of this part.

§ 71.47 External radiation standards for all packages.

A package must be designed and prepared for shipment so that the radiation level does not exceed 200 millirem per hour at any point on the external surface of the package and the transport index does not exceed 10 (See § 71.4 "Definitions"). For a package transported as exclusive use by rail, highway, or water, radiation levels external to the package may exceed those limits, but must not exceed any of the following:

(a) 200 millirem/hour on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour:

(1) The shipment is made in a closed transport vehicle;

(2) Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation; and

(3) There are no loading or unloading operations between the beginning and end of the transportation;

(b) 200 millirem/hour at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle;

(c) 10 millirem/hour at any point two

PART 73 • PHYSICAL PROTECTION OF PLANTS AND MATERIALS

(6) Procedures shall be established to assure that no unauthorized persons or material are on the aircraft before strategic special nuclear material is loaded on board.

(7) Arrangements shall be made at all domestic airports to assure that the seven required armed escorts or other armed personnel are available and that the required security measures will be taken upon landing.

(8) Arrangements shall be made at the foreign terminal at which the shipment is to be unloaded to assure that security measures will be taken on arrival.

(k) Shipment by Rail.

(1) A shipment by rail shall be escorted by seven armed escorts in the shipment car or an escort car next to the shipment car of the train. At least three escorts shall keep the shipment car under continuous visual surveillance. Escorts shall detain at stops when practicable and time permits to maintain the shipment cars under continuous visual surveillance and to check car or container locks and seals.

(2) Procedures shall be established to assure that no unauthorized persons or materials are on the shipment or escort car before strategic special nuclear material is loaded on board.

(3) Only containers weighing 5,000 lbs or more shall be shipped on open rail cars.

(4) A voice communication capability between the escorts and the movement control center shall be maintained. A redundant means of continuous communication also shall be available. Calls to the movement control center shall be made at least every half hour to convey the status and position of the shipment. In the event no call is received in accordance with these requirements, the licensee or his agent shall immediately notify the law enforcement authorities and the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of this part and initiate their contingency plan.

(5) Transfer to and from other modes of transportation shall be in accordance with paragraph (f) of this section.

(l) *Shipment by sea.* (1) Shipments shall be made only on container-ships. The strategic special nuclear material container(s) shall be loaded into exclusive use cargo containers conforming to American National Standards Institute (ANSI) Standard MH5.1—"Basic Requirements for Cargo Containers" (1971) or International Standards Organization (ISO) 1498, "General Cargo Containers" (1978). Locks and seals shall be inspected by the escorts whenever access is possible.

(2) All shipments shall be accompanied by two armed escorts who

shall be able to converse in a common language with the captain of the ship.

(3) Minimum domestic ports of call shall be scheduled and there shall be no scheduled transfer to other vessels after the shipment leaves the last port in the United States. Transfer to and from other modes of transportation shall be in accordance with paragraph (f) of this section.

(4) At all ports of call the escorts shall ensure that the shipment is not removed. At least two armed escorts or other armed personnel shall maintain continuous visual surveillance of the cargo area where the container is stored up to the time the ship departs.

(5) Export shipments shall be accompanied by two armed escorts from the last port in the United States until the shipment is unloaded at a foreign terminal and prime responsibility for physical protection is assumed by agents of the consignee. While on foreign soil, the escorts may surrender their weapons to legally constituted local authorities.

(6) Import shipments shall be accompanied by two armed escorts at all times within the geographical limits of the United States. These escorts shall provide physical protection for the shipment until relieved by verified agents of the U.S. consignee.

(7) Ship-to-shore communications shall be available, and a ship-to-shore contact shall be made every six hours to relay position information, and the status of the shipment.

(8) Arrangements shall be made at the foreign terminals at which the shipment is to be unloaded to assure that security measures will be taken upon arrival.

§ 73.27 Notification requirements.

(a)(1) A licensee who delivers formula quantities of strategic special nuclear material to a carrier for transport shall immediately notify the consignee by telephone, telegraph, or teletype, of the time of departure of the shipment, and shall notify or confirm with the consignee the method of transportation, including the names of carriers, and the estimated time of arrival of the shipment at its destination. (2) In the case of a shipment (f.o.b.) the point where it is delivered to a carrier for transport, a licensee shall, before the shipment is delivered to the carrier, obtain written certification from the licensee who is to take delivery of the shipment at the f.o.b. point that the physical protection arrangements required by §§ 73.25 and 73.26 for licensed shipments have been made. When a contractor exempt from the requirements for a Commission license is the consignee of a shipment, the licensee shall, before the shipment is delivered to the carrier, obtain written certification from the contractor who is to take delivery of the shipment at the f.o.b. point that the physical protection arrangements required by the United

States Department of Energy Order Nos. 5832.1 or 5832.2, as appropriate, have been made. (3) A licensee who delivers formula quantities of strategic special nuclear material to a carrier for transport or releases such special nuclear material f.o.b. at the point where it is delivered to a carrier for transport shall also make arrangements with the consignee to be notified immediately by telephone and telegraph, teletype, or cable, of the arrival of the shipment at its destination or of any such shipment that is lost or unaccounted for after the estimated time of arrival at its destination.

(b) Each licensee who receives a shipment of formula quantities of strategic special nuclear material shall immediately notify by telephone and telegraph or teletype, the person who delivered the material to a carrier for transport and the Administrator of the appropriate Nuclear Regulatory Commission

Regional Office listed in Appendix A of the arrival of the shipment at its destination. When a United States Department of Energy license-exempt contractor is the consignee, the licensee who is the consignor shall notify by telephone and telegraph, or teletype, the Administrator of the appropriate Nuclear Regulatory Commission

Regional Office listed in Appendix A of the arrival of the shipment at its destination immediately upon being notified of the receipt of the shipment by the license-exempt contractor as arranged pursuant to paragraph (a)(3) of this section. In the event such a shipment fails to arrive at its destination at the estimated time, or in the case of an export shipment, the licensee who exported the shipment, shall immediately notify by telephone and telegraph or teletype, the Administrator of the appropriate Nuclear Regulatory Commission

Regional Office listed in Appendix A of this part, and the licensee or other person who delivered the material to a carrier for transport. The licensee who made the physical protection arrangements shall also immediately notify by telephone and telegraph, or teletype, the Administrator of the appropriate Nuclear Regulatory Commission

Regional Office listed in Appendix A of the action being taken to trace the shipment.

(c) Each licensee who makes arrangements for physical protection of a shipment of formula quantities of strategic special nuclear material as required by §§ 73.25 and 73.26 shall immediately conduct a trace investigation of any shipment that is lost or unaccounted for after the estimated arrival time and file a report with the Commission as specified in § 73.71.

PART 73 • PHYSICAL PROTECTION OF PLANTS AND MATERIALS

§ 73.37 Requirements for physical protection of irradiated reactor fuel in transit.

(a) *Performance objectives.* (1) Each licensee who transports, or delivers to a carrier for transport, in a single shipment, a quantity of irradiated reactor fuel in excess of 100 grams in net weight of irradiated fuel, exclusive of cladding or other structural or packaging material, which has a total external radiation dose rate in excess of 100 rem per hour at a distance of 3 feet from any accessible surface without intervening shielding, shall establish and maintain, or make arrangements for, and assure the proper implementation of, a physical protection system for shipments of such material that will achieve the following objectives:

(i) Minimize the possibilities for radiological sabotage of spent fuel shipments, especially within heavily populated areas; and

(ii) Facilitate the location and recovery of spent fuel shipments that may have come under the control of unauthorized persons.

(2) To achieve these objectives, the physical protection shall:

(i) Provide for early detection and assessment of attempts to gain unauthorized access to, or control over, spent fuel shipments;

(ii) Provide for notification to the appropriate response forces of any spent fuel shipment sabotage attempts; and

(iii) Impede attempts at radiological sabotage or spent fuel shipments within heavily populated areas, or attempts to illicitly move such shipments into heavily populated areas, until response forces arrive.

(b) *General requirements.* To achieve the performance objectives of paragraph (a) of this section, a physical protection system established and maintained, or arranged for, by the licensee shall:

(1) Provide for notification of the Nuclear Regulatory Commission in advance of each shipment, in accordance with § 73.72 of this part.

(2) Include procedures for coping with circumstances that threaten deliberate damage to a spent fuel shipment and with other safeguards emergencies.

(3) Include instructions for each escort that, upon detection of the abnormal presence of unauthorized persons, vehicles or vessels in the vicinity of a spent fuel shipment, or upon detection of a deliberately induced situation that has the potential for damaging a spent fuel shipment, the escort will:

(i) Determine whether or not a threat exists;

(ii) Assess the extent of the threat, if any;

(iii) Inform local law enforcement agencies of the threat and request assistance; and

(iv) Implement the procedures developed in accordance with paragraph (b)(2) of this section.

(4) Include a communications center at a designated location, which will be staffed continuously by at least one individual who will monitor the progress of the spent fuel shipment and will notify the appropriate agencies in the event a safeguards emergency should arise.

(5) Provide for maintenance of a written log by the escorts and communications center personnel, for each spent fuel shipment, which will include information describing the shipment and significant events that occur during the shipment, and will be available for review by authorized NRC personnel for a period of at least 1 year following completion of the shipment.

(6) Provide that arrangements have been made with local law enforcement agencies along the routes of road and rail shipments, and at U.S. ports where vessels carrying spent fuel shipments are docked, for their response to an emergency or a call for assistance.

(7) Provide for advance approval by the NRC of the routes used for road and rail shipments of spent fuel, and of any U.S. ports where vessels carrying spent fuel shipments are scheduled to stop.

(8) Provide that shipments are planned so that scheduled intermediate stops are avoided to the extent practicable.

(9) Provide that at least one escort maintains visual surveillance of the shipment during periods when the shipment vehicle is stopped, or the shipment vessel is docked.

(10) Provide that escorts (other than members of local law enforcement agencies, or ship's officers serving as unarmed escorts) have successfully completed the training required by Appendix D of this part.

(11) Provide that shipment escorts make calls to the communications center at least every 2 hours to advise of the status of the shipment for road and rail shipments, and for sea shipments while shipment vessels are docked at U.S. ports.

(c) *Shipments by road.* In addition to the provisions of paragraph (b), the physical protection system for any portion of a spent fuel shipment that is by road shall provide that:

(1) A transport vehicle within a heavily populated area is:

(i) Occupied by at least two individuals, one of whom serves as escort, and escorted by an armed member of the local law enforcement agency in a mobile unit of such agency; or

(ii) Led by a separate vehicle occupied by at least one armed escort, and trailed

by a third vehicle occupied by at least one armed escort.

(2) A transport vehicle not within any heavily populated area is:

(i) Occupied by at least one driver and one other individual who serves as escort; or

(ii) Occupied by a driver and escorted by a separate vehicle occupied by at least two escorts; or

(iii) Escorted as set forth in paragraph (c)(1) of this section.

(3) Escorts have the capability of communicating with the communications center, local law enforcement agencies, and one another, through the use of:

(i) A citizens band (CB) radio available in the transport vehicle and in each escort vehicle;

(ii) A radiotelephone or other NRC-approved equivalent means of two-way voice communications available in the transport vehicle or in an escort vehicle committed to travel the entire route; and

(iii) Citizens band (CB) radio and normal local law enforcement agency radio communications in any local law enforcement agency mobile units used for escort purposes.

(4) The transport is equipped with NRC-approved features that permit immobilization of the cab or cargo-carrying portion of the vehicle.

(5) The transport vehicle driver has been familiarized with, and is capable of implementing, transport vehicle immobilization, communications, and other security procedures.

(d) *Shipments by rail.* In addition to the provisions of paragraph (b), the physical protection system for any portion of a spent fuel shipment that is by rail shall provide that:

(1) A shipment car within a heavily populated area is accompanied by two armed escorts (who may be members of a local law enforcement agency), at least one of whom is stationed at a location on the train that will permit observation of the shipment car while in motion.

(2) A shipment car not within any heavily populated area is accompanied by at least one escort stationed at a location on the train that will permit observation of the shipment car while in motion.

(3) Escorts have the capability of communicating with the communications center and local law enforcement agencies through the use of a radiotelephone, or other NRC-approved equivalent means of two-way voice communications, which shall be available on the train.

(e) *Shipments by sea.* In addition to the provisions of paragraph (b), the physical protection system for any portion of a spent fuel shipment that is

by sea shall provide that:

(1) A shipment vessel, while docked at a U.S. port within a heavily populated area, is protected by:

(i) Two armed escorts stationed on board the shipment vessel, or stationed on the dock at a location that will permit observation of the shipment vessel; or

(ii) A member of a local law enforcement agency, equipped with normal LLEA radio communications, who is stationed on board the shipment vessel, or on the dock at a location that will permit observation of the shipment vessel.

(2) A shipment vessel, while within U.S. territorial waters, or while docked at a U.S. port not within a heavily populated area, is accompanied by an escort, who may be an officer of the shipment vessel's crew, who will assure that the shipment is unloaded only as authorized by the licensee.

(3) Escorts have the capability of communicating with the communications center and local law enforcement agencies through the use of a radiotelephone, or other NRC-approved equivalent means of two-way voice communications.

(f) Prior to the transport of spent fuel within or through a state a licensee subject to this section shall notify the governor or the governor's designee. The licensee shall comply with the following criteria in regard to a notification: (1) The notification must be in writing and sent to the office of each appropriate governor or the governor's designee. A notification delivered by mail must be postmarked at least 7 days before transport of a shipment within or through the state. A notification delivered by messenger must reach the office of the governor or the governor's designee at least 4 days before transport of a shipment within or through the state. A list of the mailing addresses of governors and governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

(2) The notification must include the following information:

(i) The name, address, and telephone number of the shipper, carrier and receiver.

(ii) A description of the shipment as specified by the Department of Transportation in 49 CFR § 172.202 and § 172.203(d).

(iii) A listing of the routes to be used within the state.

(iv) A statement that the information described below in § 73.37(f)(3) is required by NRC regulations to be protected in accordance with the requirements of § 73.21.

(3) The licensee shall provide the following information on a separate enclosure to the written notification:

(i) The estimated date and time of departure from the point of origin of the shipment.

(ii) The estimated date and time of entry into the governor's state.

(iii) For the case of a single shipment whose schedule is not related to the schedule of any subsequent shipment, a statement that schedule information must be protected in accordance with the provisions of § 73.21 until at least 10 days after the shipment has entered or originated within the state.

(iv) For the case of a shipment in a series of shipments whose schedules are related, a statement that schedule information must be protected in accordance with the provisions of § 73.21 until 10 days after the last shipment in the series has entered or originated within the state and an estimate of the date on which the last shipment in the series will enter or originate within the state.

(4) A licensee shall notify by telephone or other means a responsible individual in the office of the governor or in the office of the governor's designee of any schedule change that differs by more than 6 hours from the schedule information previously furnished in accordance with § 73.37(f)(3), and shall inform that individual of the number of hours of advance or delay relative to the written schedule information previously furnished.

(g) State officials, state employees, and other individuals, whether or not licensees of the Commission, who receive schedule information of the kind specified in § 73.37(f)(3) shall protect that information against unauthorized disclosure as specified in § 73.21.

Use of off-duty employees.

Site security jurisdictional boundaries.

f. Administrative and Logistical Considerations—Descriptions of licensee practices that may have an influence on the response to safeguards contingency events. The considerations shall include a description of the procedures that will be used for ensuring that all equipment needed to effect a successful response to a safeguards contingency will be easily accessible, in good working order, and in sufficient supply to provide redundancy in case of equipment failure.

4. **Responsibility Matrix.** This category of information consists of detailed identification of the organizational entities responsible for each decision and action associated with specific responses to safeguards contingencies. For each initiating event, a tabulation shall be made for each response entity depicting the assignment of responsibilities for all decisions and actions to be taken in response to the initiating event. (Not all entities will have assigned responsibilities for any given initiating event.) The tabulations in the Responsibility Matrix shall provide an overall picture of the response actions and their interrelationships. Safeguards responsibilities shall be assigned in a manner that precludes conflict in duties or responsibilities that would prevent the execution of the plan in any safeguards contingency.

5. **Procedures.** In order to aid execution of the detailed plan as developed in the Responsibility Matrix, this category of information shall detail the actions to be taken and decisions to be made by each member or unit of the organization as planned in the Responsibility Matrix.

APPENDIX D—PHYSICAL PROTECTION OF IRRADIATED REACTOR FUEL IN TRANSIT, TRAINING PROGRAM SUBJECT SCHEDULE.

Pursuant to the provision of § 73.37 of 10 CFR Part 73, each licensee who transports or delivers to a carrier for transport irradiated reactor fuel is required to assure that individuals used as shipment escorts have completed a training program. The subjects that are to be included in this training program are as follows:

Security Enroute

- Route planning and selection
- Vehicle operation
- Procedures at stops
- Detours and use of alternate routes

Communications

- Equipment operation
- Status reporting
- Contacts with law enforcement units
- Communications discipline
- Procedures for reporting incidents

Radiological Considerations

- Description of the radioactive cargo
- Function and characteristics of the shipping casks
- Radiation hazards
- Federal, State and local ordinances relative to the shipment of radioactive materials
- Responsible agencies

Response to Contingencies

- Accidents
- Severe weather conditions
- Vehicle breakdown
- Communications problems
- Radioactive "spills"
- Use of special equipment (flares, emergency lighting, etc.)

Response to Threats

- Reporting
- Calling for assistance
- Use of immobilization features
- Hostage situations
- Avoiding suspicious situations

The licensee is also required to assure that armed individuals serving as shipment escorts, other than members of local law enforcement agencies, have completed a weapons training and qualifications program equivalent to that required of guards, as described in III and IV of Appendix B of this part, to assure that each such individual is fully qualified to use weapons assigned him.

Appendix E—Levels of Physical Protection To Be Applied in International Transport of Nuclear Material¹

(Verbatim from Annex I to the Convention on the Physical Protection of Nuclear Material)

(a) Levels of physical protection for nuclear material during storage incidental to international nuclear transport include:

- (1) For Category III materials, storage within an area to which access is controlled;
- (2) For Category II materials, storage within an area under constant surveillance by guards or electronic devices, surrounded by a physical barrier with a limited number of points of entry under appropriate control or any area with an equivalent level of physical protection;

(3) For Category I material, storage within a protected area as defined for Category II, to which, in addition, access is restricted to persons whose trustworthiness has been determined, and which is under surveillance by guards who are in close communication with appropriate response forces. Specific measures taken in this context should have as their objective the detection and prevention of any assault, unauthorized access, or unauthorized removal of material.

(b) Levels of physical protection for nuclear material during international transport include:

(1) For Category II and III materials, transportation shall take place under special precautions including prior arrangements among sender, receiver, and carrier, and prior agreement between natural or legal persons subject to the jurisdiction and regulation of exporting and importing States, specifying time, place and procedures for transferring transport responsibility;

(2) For Category I materials, transportation shall take place under special precautions identified for transportation of Category II and III materials, and in addition, under constant surveillance by escorts and under

¹ See Appendix C to Part 110 of this chapter from the physical description of the categories of nuclear material as set forth in Annex I to the Convention. For the purposes of this part, the following categories of nuclear material are synonymous:

Category I is a formula quantity of strategic special nuclear material;

Category II is special nuclear material of moderate strategic significance or irradiated fuel; and

Category III is special nuclear material of low strategic significance.

conditions which assure close communication with appropriate response forces:

(3) For natural uranium other than in the form of ore or ore residue, transportation protection for quantities exceeding 500 kilograms U shall include advance notification of shipment specifying mode of transport, expected time of arrival and [shall provide for] confirmation of receipt of shipment.

APPENDIX F—NATIONS THAT ARE PARTIES TO THE CONVENTION ON THE PHYSICAL PROTECTION OF NUCLEAR MATERIAL¹

Nation	Date of deposit of instrument of ratification with the IAEA
Brazil	Oct. 17, 1985.
Bulgaria	May 2, 1984.
Canada	Mar. 21, 1986.
Czechoslovakia	Apr. 23, 1982.
German Democratic Republic (E. Germany)	Feb. 5, 1981.
Guatemala	Apr. 23, 1985.
Hungary	May 4, 1984.
Indonesia	Nov. 5, 1986.
Korea, Republic of	Apr. 7, 1982.
Liechtenstein	Nov. 25, 1986.
Mongolia	May 28, 1986.
Norway	Aug. 15, 1985.
Paraguay	Feb. 6, 1985.
Philippines	Sept. 22, 1981.
Poland	Oct. 5, 1983.
Sweden	Aug. 1, 1980.
Switzerland	Jan. 9, 1987.
Turkey	Feb. 27, 1985.
Yugoslavia	May 14, 1986.
Union of Soviet Socialist Republic	May 25, 1983.
United States of America	Dec. 13, 1982.

¹ An update list of party nations will appear annually in the Department of State's publication, *Treaties in Force*. Appendix F will be amended as required to maintain its currency.

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made in writing to the office of each appropriate governor or governor's designee and to the Director of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of Part 73 of this chapter.

(2) A notification delivered by mail must be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(3) A notification delivered by messenger must reach the office of the governor or of the governor's designee at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

(i) A list of the names and mailing addresses of the governors' designees receiving advance notification of transportation of nuclear waste was published in the Federal Register on June 30, 1983 (48 FR 30221).

(ii) The list will be published annually in the Federal Register on or about June 30 to reflect any changes in information.

(iii) A list of the names and mailing addresses of the governors' designees is available upon request from the Director, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

(4) The licensee shall retain a copy of the notification as a record for one year.

(d) *Information to be furnished in advance notification of shipment.* Each advance notification of shipment of nuclear waste must contain the following information:

(1) The name, address, and telephone number of the shipper, carrier, and receiver of the nuclear waste shipment;

(2) A description of the nuclear waste contained in the shipment, as required by the regulations of DOT in 49 CFR 172.202 and 172.203(d);

(3) The point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

(4) The seven-day period during which arrival of the shipment at state boundaries is estimated to occur;

(5) The destination of the shipment, and the seven-day period during which arrival of the shipment is estimated to occur; and

(6) A point of contact with a telephone number for current shipment information.

(e) *Revision notice.* A licensee who finds that schedule information previously furnished to a governor or governor's designee in accordance with this section will not be met, shall telephone a responsible individual in the office of the governor of the state or of

the governor's designee and inform that individual of the extent of the delay beyond the schedule originally reported. The licensee shall maintain a record of the name of the individual contacted for one year.

(f) *Cancellation notice.* (1) Each licensee who cancels a nuclear waste shipment for which advance notification has been sent, shall send a cancellation notice to the governor of each state or the governor's designee previously notified and to the Director of the appropriate Nuclear Regulatory Commission Regional Office listed in Appendix A of Part 73 of this chapter.

(2) The licensee shall state in the notice that it is a cancellation and shall identify the advance notification which is being cancelled. The licensee shall retain a copy of the notice as a record for one year.

§71.99 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Atomic Energy Act of 1954, as amended, (the Act) or Title II of the Energy Reorganization Act of 1974, as amended, or any regulation or order issued under the Acts. A court order may be obtained for the payment of a civil penalty imposed under section 234 of the Act for violation of sections 53, 57, 62, 63, 61, 82, 101, 103, 104, 107, or 109 of the Act, or section 208 of the Energy Reorganization Act of 1974, as amended; or any rule, regulation, or order issued under the Acts, or any term, condition, or limitation of any license issued under the Acts, or for any violation for which a license may be revoked under section 186 of the Act. Any person who willfully violates any provision of the Act or any regulation or order issued under the Acts may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

Subpart H—Quality Assurance

§71.101 Quality assurance requirements.

(a) *Purpose.* This subpart describes quality assurance requirements applying to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of components of packaging which are important to safety. As used in this subpart, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality

assurance actions related to control of the physical characteristics and quality of the material or component to predetermined requirements.

(b) *Establishment of program.* Each licensee shall establish, maintain, and execute a quality assurance program satisfying each of the applicable criteria of this subpart, and satisfying any specific provisions which are applicable to the licensee's activities including procurement of packaging. The licensee shall apply the applicable criteria in a graded approach, and to an extent that is consistent with their importance to safety.

(c) *Approval of program.* Prior to the use of any package for the shipment of licensed material subject to this subpart, each licensee shall obtain Commission approval of its quality assurance program. Each licensee shall file a description of its quality assurance program, including a discussion of which requirements of this subpart are applicable and how they will be satisfied, with the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

(d) *Existing package designs.* The provisions of this paragraph deal with packages which have been approved for use in accordance with this part prior to January 1, 1979, and which have been designed in accordance with the provisions of this part in effect at the time of application for package approval. Those packages will be accepted as having been designed in accordance with a quality assurance program which satisfies the provisions of paragraph (b) of this section.

(e) *Existing packages.* The provisions of this paragraph deal with packages which have been approved for use in accordance with this part prior to January 1, 1979, have been at least partially fabricated prior to that date, and for which the fabrication is in accordance with the provisions of this part in effect at the time of application for approval of package design. These packages will be accepted as having been fabricated and assembled in accordance with a quality assurance program which satisfies the provisions of paragraph (b) of this section.

(f) *Previously approved programs.* A Commission-approved quality assurance program which satisfies the applicable criteria of Appendix B of Part 50 of this chapter and which is established, maintained, and executed with regard to transport packages will be accepted as satisfying the requirements of paragraph (b) of this section. Prior to first use, the licensee shall notify the Director, Office of Nuclear Material Safety and

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Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, of its intent to apply its previously approved Appendix B program to transportation activities. The licensee shall identify the program by date of submittal to the Commission, Docket Number, and date of Commission approval.

§ 71.103 Quality assurance organization.

The licensee³ shall be responsible for the establishment and execution of the quality assurance program. The licensee may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the quality assurance program, or any part of the quality assurance program, but shall retain responsibility for the program. The licensee shall clearly establish and delineate in writing the authority and duties of persons and organizations performing activities affecting the safety-related functions of structures, systems and components. These activities include performing the functions associated with attaining quality objectives and the quality assurance functions. The quality assurance functions are (a) assuring that an appropriate quality assurance program is established and effectively executed and (b) verifying, by procedures such as checking, auditing, and inspection, that activities affecting the safety-related functions have been correctly performed. The persons and organizations performing quality assurance functions must have sufficient authority and organizational freedom to identify quality problems; to initiate, recommend, or provide solutions; and to verify implementation of solutions. The persons and organizations performing quality assurance functions shall report to a management level which assures that the required authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations, are provided. Because of the many variables involved, such as the number of personnel, the type of activity being performed, and the location or locations where activities are performed, the organizational structure for executing the quality assurance program may take various forms provided that the persons and organizations assigned the quality assurance functions have the required

³ While the term "licensee" is used in these criteria, the requirements are applicable to whatever design, fabrication, assembly, and testing of the package is accomplished with respect to a package prior to the time a package approval is issued.

authority and organizational freedom. Irrespective of the organizational structure, the individual(s) assigned the responsibility for assuring effective execution of any portion of the quality assurance program at any location where activities subject to this section are being performed must have direct access to the levels of management necessary to perform this function.

§ 71.105 Quality assurance program.

(a) The licensee shall establish, at the earliest practicable time consistent with the schedule for accomplishing the activities, a quality assurance program which complies with the requirements of this section. The licensee shall document the quality assurance program by written procedures or instructions and shall carry out the program in accordance with those procedures throughout the period during which packaging is used. The licensee shall identify the material and components to be covered by the quality assurance program, the major organizations participating in the program, and the designated functions of these organizations.

(b) The licensee, through its quality assurance program, shall provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to assure conformance to the approved design of each individual package used for the shipment of radioactive material. The licensee shall assure that activities affecting quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and assurance that all prerequisites for the given activity have been satisfied. The licensee shall take into account the need for special controls, processes, test equipment, tools and skills to attain the required quality, and the need for verification of quality by inspection and test.

(c) The licensee shall base the requirements and procedures of its quality assurance program on the following considerations concerning the complexity and proposed use of the package and its components:

- (1) The impact of malfunction or failure of the item to safety;
- (2) The design and fabrication complexity or uniqueness of the item;
- (3) The need for special controls and surveillance over processes and equipment;

(4) The degree to which functional compliance can be demonstrated by inspection or test; and

(5) The quality history and degree of standardization of the item.

(d) The licensee shall provide for indoctrination and training of personnel performing activities affecting quality as necessary to assure that suitable proficiency is achieved and maintained. The licensee shall review the status and adequacy of the quality assurance program at established intervals. Management of other organizations participating in the quality assurance program shall regularly review the status and adequacy of that part of the quality assurance program which they are executing.

§ 71.107 Package design control.

(a) The licensee shall establish measures to assure that applicable regulatory requirements and the package design, as specified in the license for those materials and components to which this section applies, are correctly translated into specifications, drawings, procedures, and instructions. These measures must include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from standards are controlled. Measures must be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the materials, parts, and components of the packaging.

(b) The licensee shall establish measures for the identification and control of design interfaces and for coordination among participating design organizations. These measures must include the establishment of written procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces. The design control measures must provide for verifying or checking the adequacy of design, by methods such as design reviews, alternate or simplified calculational methods, or by a suitable testing program. For the verifying or checking process, the licensee shall designate individuals or groups other than those who were responsible for the original design, but who may be from the same organization. Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, the licensee shall include suitable qualification testing of a prototype or sample unit under the most adverse design conditions. The licensee shall

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48 FR 38449
apply design control measures to items such as the following: criticality physics, radiation shielding, stress, thermal, hydraulic, and accident analyses; compatibility of materials; accessibility for inservice inspection, maintenance, and repair; features to facilitate decontamination; and delineation of acceptance criteria for inspections tests.

(c) The licensee shall subject design changes, including field changes, to design control measures commensurate with those applied to the original design. Changes in the conditions specified in the package approval require NRC approval.

§ 71.109 Procurement document control.

The licensee shall establish measures to assure adequate quality is required in the documents for procurement of material, equipment, and services, whether purchased by the licensee or by its contractors or subcontractors. To the extent necessary, the licensee shall require contractors or subcontractors to provide a quality assurance program consistent with the applicable provisions of this part.

§ 71.111 Instructions, procedures, and drawings.

48 FR 35600
The licensee shall prescribe activities affecting quality by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall require that these instructions, procedures, and drawings be followed. The instructions, procedures, and drawings must include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished.

§ 71.113 Document control.

The licensee shall establish measures to control the issuance of documents such as instructions, procedures, and drawings, including changes, which prescribe all activities affecting quality. These measures must assure that documents, including changes, are reviewed for adequacy, approved for release by authorized personnel, and distributed and used at the location where the prescribed activity is performed. These measures must assure that changes to documents are reviewed and approved.

§ 71.115 Control of purchased material, equipment, and services.

(a) The licensee shall establish measures to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These

measures must include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products upon delivery.

(b) The licensee shall have available documentary evidence that material and equipment conform to the procurement specifications prior to installation or use of the material and equipment. The licensee shall retain or have available this documentary evidence for the life of the package to which it applies. The licensee shall assure that the evidence is sufficient to identify the specific requirements met by the purchased material and equipment.

(c) The licensee or designee shall assess the effectiveness of the control of quality by contractors and subcontractors at intervals consistent with the importance, complexity, and quantity of the product or services.

§ 71.117 Identification and control of materials, parts, and components.

48 FR 35600
The licensee shall establish measures for the identification and control of materials, parts, and components. These measures must assure that identification of the item is maintained by heat number, part number, or other appropriate means, either on the item or on records traceable to the item, as required throughout fabrication, installation, and use of the item. These identification and control measures must be designed to prevent the use of incorrect or defective materials, parts, and components.

§ 71.119 Control of special processes.

The licensee shall establish measures to assure that special processes, including welding, heat treating, and nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

§ 71.121 Internal inspection.

The licensee shall establish and execute a program for inspection of activities affecting quality by or for the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity. The inspection must be performed by individuals other than those who performed the activity being inspected. Examination, measurements, or tests of material or products processed must be performed for each work operation where necessary to

assure quality. If direct inspection of processed material or products is not carried out, indirect control by monitoring processing methods, equipment, and personnel must be provided. Both inspection and process monitoring must be provided when quality control is inadequate without both. If mandatory inspection hold points, which require witnessing or inspecting by the licensee's designated representative and beyond which work should not proceed without the consent of its designated representative, are required, the specific hold points must be indicated in appropriate documents.

§ 71.123 Test control.

48 FR 35600
The licensee shall establish a test program to assure that all testing required to demonstrate that the packaging components will perform satisfactorily in service is identified and performed in accordance with written test procedures which incorporate the requirements of this part and the requirements and acceptance limits contained in the package approval. The test procedures must include provisions for assuring that all prerequisites for the given test are met, that adequate test instrumentation is available and used, and that the test is performed under suitable environmental conditions. The licensee shall document and evaluate the test results to assure that test requirements have been satisfied.

§ 71.125 Control of measuring and test equipment.

The licensee shall establish measures to assure that tools, gages, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified times to maintain accuracy within necessary limits.

§ 71.127 Handling, storage, and shipping control.

The licensee shall establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels must be specified and provided.

§ 71.129 Inspection, test, and operating status.

(a) The licensee shall establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests

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performed upon individual items of the packaging. These measures must provide for the identification of items which have satisfactorily passed required inspections and tests where necessary to preclude inadvertent bypassing of the inspections and tests.

(b) The licensee shall establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

§ 71.131 Nonconforming materials, parts, or components.

The licensee shall establish measures to control materials, parts, or components which do not conform to the licensee's requirements in order to prevent their inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items must be reviewed and accepted, rejected, repaired, or reworked in accordance with documented procedures.

§ 71.133 Corrective action.

The licensee shall establish measures to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected. In the case of a significant condition adverse to quality, the measures must assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

§ 71.135 Quality assurance records.

(a) The licensee shall maintain sufficient written records to furnish evidence of activities affecting quality. The records must include the following: design records, records of use and the results of reviews, inspections, tests, audits, monitoring of work performance, and materials analyses. The records must include closely related data such as qualifications of personnel, procedures, and equipment. Inspection and test records must, at a minimum, identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. Records must be identifiable and retrievable. Records pertaining to the fabrication of the package must be

retained for the life of the package to which they apply. Records pertaining to the use of the package for shipment of radioactive material must be retained for a period of two years after the shipment.

(b) The licensee shall establish a records retention program which is consistent with the applicable regulations, designating factors such as duration, location, and assigned responsibility.

§ 71.137 Audits.

The licensee shall carry out a comprehensive system of planned and periodic audits to verify compliance with all aspects of the quality assurance program and to determine the effectiveness of the program. The audits must be performed in accordance with written procedures or checklists by appropriately trained personnel not having direct responsibilities in the areas being audited. Audited results must be documented and reviewed by management having responsibility in the area audited. Follow-up action, including re-audit of deficient areas, must be taken where indicated.

Appendix A—Determination of A_1 and A_2

I. Single radionuclides.

(1) For a single radionuclide of known identity, the values of A_1 and A_2 are taken from Table A-1 if listed there. The values A_1 and A_2 in Table A-1 are also applicable for radionuclides contained in (α, n) or (γ, n) neutron sources.

(2) For any single radionuclide whose identity is known but which is not listed in Table A-1, the values of A_1 and A_2 are determined according to the following procedure:

(a) If the radionuclide emits only one type of radiation, A_1 is determined according to the rules in paragraphs (i), (ii), (iii) and (iv) of this paragraph. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 Ci. If a parent nuclide decays into a shorter lived daughter with a half-life not greater than 10 days, A_1 is calculated for both the parent and the daughter, and the more limiting of the two values is assigned to the parent nuclide.

(i) For gamma emitters, A_1 is determined by the expression:

$$A_1 = \frac{S}{\Gamma} \text{ curies}$$

where Γ is the gamma-ray constant, corresponding to the dose in R/h at 1 m per Ci; the number S results from the choice of 1 rem/h at a distance of 3 m as the reference dose-equivalent rate.

(ii) For X-ray emitters, A_1 is determined by the atomic number of the nuclide:

for $Z < 55$ — $A_1 = 1000$ Ci

for $Z > 55$ — $A_1 = 200$ Ci

where Z is the atomic number of the nuclide.

(iii) For beta emitters, A_1 is determined by the maximum beta energy ($E_{\max}$) according to Table A-2.

(iv) For alpha emitters, A_1 is determined by the expression:

$A_1 = 1000 A_2$

where A_2 is the value listed in Table A-3:

(b) A_2 is the more restrictive of the following two values:

(i) The corresponding A_1 ; and

(ii) The value A_2 obtained from Table A-3.

(3) For any single radionuclide whose identity is unknown, the value of A_1 is taken to be 200 Ci and the value of A_2 is taken to be 0.002 Ci. However, if the atomic number of the radionuclide is known to be less than 82, the value of A_1 is taken to be 10 Ci and the value of A_2 is taken to be 0.4 Ci.

II. Mixtures of radionuclides, including radioactive decay chains.

(1) For mixed fission products the following activity limits may be assumed if a detailed analysis of the mixture is not carried out:

$A_1 = 10$ Ci

$A_2 = 0.4$ Ci

(2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring proportions and no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value from Table A-1 to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be considered. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.

(3) In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide are known, the permissible activity of each radionuclide $R_1, R_2, \dots, R_n$ is such that $F_1 + F_2 + \dots + F_n$ is not greater than unity, where

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_2(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_n(R_n)}$$

Appendix G

Personnel Barrier Configurations

NLI-1/2

NLI-1/2 Cask Personnel Barrier Configuration

NLI-1/2 Cask Personnel Barrier Configuration

NLI-1/2 Cask Personnel Barrier Configuration

NAC-1/NFS-4

NAC-1/NFS-4 Personnel Barrier Configuration

NLI-10/24

NLI-10/24 Rail Cask Personnel Barrier Configuration

NLI-10/24 Rail Cask Personnel Barrier Configuration

CLEARANCE FOR OPENING PERSONNEL BARRIER
and
REMOVING NLI 10/24 RAIL CASK

Appendix H

Typical Survey Documents

- **NLI-1/2**
- **NAC-1/NFS-4**

NLI-1/2

ATTACHMENT C (cont'd.)
CASK DEPARTURE SURVEY

Departure Date and Time:
Survey Date and Time:
Surveyed by:
Instruments:
Calibration Date:

Contamination Survey

dpm/100cm²

		β - γ	α
1.	Front Face Left		
2.	Front Face Middle		
3.	Front Face Right		
4.	Front Cask Left		
5.	Front Cask Top Left		
6.	Front Cask Top Right		
7.	Front Cask Right		
8.	Front Cask Bottom		
9.	Front Trunnion - Left		
10.	Front Trunnion - Right		
11.	Cask Left		
12.	Cask Top		
13.	Cask Right		
14.	Cask Bottom		
15.	Cask Left		
16.	Cask Top		
17.	Cask Right		
18.	Cask Bottom		
19.	Cask Left		
20.	Cask Top		
21.	Cask Right		
22.	Cask Bottom		
23.	Cask Left		
24.	Cask Top		
25.	Cask Right		
26.	Cask Bottom		
27.	Rear Trunnion - Left		
28.	Rear Trunnion - Right		
29.	Rear Cask Left		
30.	Rear Cask Top Left		
31.	Rear Cask Top Right		
32.	Rear Cask Right		
33.	Rear Cask Bottom		
34.	Rear Face Left		
35.	Rear Face Middle		
36.	Rear Face Right		

CASK DEPARTURE SURVEY

TOP VIEW OF CASK ON TRAILER

FRONT

ATTACHMENT A (cont'd.)
TRAILER SURVEY

Arrival/Departure Date and Time:
Survey Date and Time:
Surveyed by:
Instruments:
Calibration Date:

Contamination Survey

dpm/100cm²

	β - γ	α
1. Cab		
2. Tarpaulin Frame		
3. Front Deck Right		
4. Front Deck Left		
5. Rear Deck Right		
6. Rear Deck Left		
7. Trailer Beam Right		
8. Trailer Beam Left		
9. Front Trunnion Support Left		
10. Front Trunnion Support Right		
11. Rear Trunnion Support Left		
12. Rear Trunnion Support Right		
13. Tire Surface		

Radiation Survey (All readings in mRem/hr - neutron and gamma)

Location	Contact	@ 2 Meters
Front of Trailer		
Left Side of Trailer		
Right Side of Trailer		
Rear of Trailer		
Cab		N/A

NAC-1/NFS-4

CONTAMINATION:			RADIATION:					
LOC. NO.	Dpm/100 Cm ²		Mrem/hr			Mrem/Hr		
	B	R	BETA - GAMMA			NEUTRON		
			@0'	@3'	@6'	@0'	@3'	@6'
1	0		250	35	5			
2	0							
3	20							
4	0							
5	140							
6	0							
7	0							
8	150							
9	0							
10	0							
11	0							
12	0							
13	0							
14	0							
15	0							
16	0							
17	0							
18	0							
19	0							
20	0							
21	0							
22	0							
23	0							
24	0							
25	0							
26	1120							
27	60							
28	0							
29	0							
30	0

REMARKS:

CPSK AFTER DECON.

CONTAMINATION:

LOC. NO.	Dpm/100 Cm ²
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RADIATION:

Mrem/hr

Mrem/Hr

BETA - GAMMA

NEUTRON

୧୦୧

03'

46'

60'

03'

Q6'

LINEAR SURVEY OF BOTTOM OF CASK

CONTAMINATION:			RADIATION:						FRONT OF TRAILER	
LOC. NO.	Dpm/100 Cm ²		BETA - GAMMA			NEUTRON			1	2
	B _r	α	@0'	@3'	@6'	@0'	@3'	@6'		
1	1920	-	0.7	0.5	.15	BG				
2	1800	-	0.7	0.5	.15	BG				
3	4610	-	0.4	.1<	.1<	BG				
4	210	-	0.3	.1<	.1<	BG				
5	100	-	0.5	.1<	.<	BG				
6	620	-	0.2	.1<	.1<	BG				
7	350	-	0.3	.1<	.1<	BG				
8	0	-	0.2	.1<	.1<	BG				
9	100	-	0.2	.1<	.1<	BG				
10	830	-	0.2	.1<	.1<	BG				
11	330	-	0.1	.1<	.1<	BG				
12	420	-	0.1	.1<	.1<	BG				
13	140	-	0.3	.1<	.1<	BG				
14	460	-	0.5	.1<	.1<	BG				
15	-									
16										
17										
18										
19										

REAR OF TRAILER

RECEIVED (✓)

SHIPPED ()

REMARKS:

Appendix I
Outline of Operating Procedures

NLI-1/2

NLI-1/2 Cask

Procedure Outline for Cask Handling

1. Arrival at site.
2. Health Physics Survey.
3. Washdown for removal of road dirt.
4. Remove personnel barrier and store.
5. Remove impact limiters and store.
6. Remove tie down bolts.
7. Attach lifting yoke to upper trunnions.
8. Upright cask and remove from trailer.
9. Move cask to decontamination area.
10. Remove outer closure head and store.
11. Remove inner closure head (and spacer plug) and store.
12. Remove appropriate valve box covers.
13. Prefill cask with water.
14. Move cask to loading position in spent fuel pool.
15. Disengage lifting yoke from cask.
16. Load fuel into basket in cask.
17. Replace spacer plug and inner closure head.
18. Re-engage lifting yoke to cask.
19. Raise cask to surface of pool.
20. Rinse off cables, hook, lifting yoke, and cask as they emerge from pool.
21. Hand tighten all inner closure head bolts.

22. Flush cask and discharge water to pool.
23. Move cask to decontamination area.
24. Start decontamination procedures.
25. Attach air hose to upper access valve and apply pressure to force approximately seven gallons of water from cask.
26. Close drain valve and apply air pressure. Bubble test cask seal and upper and lower access valves.
27. Force out remaining water in cask cavity.
28. Dry cask cavity by vacuum.
29. Back fill cask cavity with helium.
30. Replace outer closure head.
31. Pressure test outer closure head with air pressure.
32. Dry outer closure head cavity by vacuum.
33. Recharge outer closure head cavity with air.
34. When cask is properly decontaminated re-engage lifting rig and replace cask back onto truck.
35. Replace impact limiters.
36. Replace personnel barrier.
37. Health Physics Survey.
38. Complete paper work.
39. Ship

If the cask should be used with the inner container, an additional step would be required between steps 29 and 30 in which a suction pump is used to draw water out of the annulus between the inner container and the inner wall of the cask cavity.

NAC-1/NFS-4

NAC-1/NFS-4 Cask

Procedure Outline for Cask Handling (Unloading)

1. Receive cask and trailer at handling area and place wheel chocks under trailer wheels.
2. Perform radiation survey on cask and transporter in accordance with Station Health Physics procedures.
3. Unbolt and remove front and rear cask tie-downs.
4. Unbolt front impact limiter from cask and slide it forward on carriage built into the trailer.
5. Using an overhead crane (minimum 30 tons), attach the lifting yoke to upper trunnions on cask.
6. Rotate shipping cask to the vertical position on the trailer, keeping the crane cable as vertical as practicable.
7. Lift the cask from the trailer and move it to the decontamination pad or planned work area. Set the cask down on a plywood pad.
8. Check external cask temperature at midpoint using hand held pyrometer and record cask temperature on check-off sheet.
9. Remove lock wire seals from the head bolts and valve port covers. Remove all port covers (five) with special spanner wrench.
10. Attach the pressure check assembly to the cavity vent valve. Open cask vent and read pressure.
11. Connect station D.I. service water to one of the cask drain valves. Connect a drain line to the cask vent valve. Verify that the cask vent valve is open. Open the cask drain valve. Flood the cask cavity with water. Continue flushing the cask for one hour.
12. Shut off the D.I. water source. Close the drain valve and remove the D.I. water line from the drain valve.
13. Attach a drain line to the cask vent valve and open the vent valve.

14. Remove the closure lid hold-down bolts.
15. Remove the vent line. Attach a female Snap-Tite to the vent valve.
16. Verify that the two drain valves (bottom) are closed and that the cavity vent valve (top) is open.
17. Lower the cask to the floor of the cask loading area.
18. Attach the closure lid lifting gear to a suitable hoist. Slowly raise the closure lid.
19. Remove fuel assembly(ies) from cask and transfer the fuel assembly to the appropriate fuel storage location.
20. Retrieve the closure lid. Align mark on the lid with mark on the cask. Lower the closure lid onto its seat.
21. Reposition the crane over the cask. Reattach the hook to the yoke or the yoke to the cask, if removed. Ensure and verify full engagement of hook to yoke and yoke arms to trunnions. Begin raising the cask.
22. Raise the cask to a convenient elevation and install at least two of the six lid bolts finger-tight.
23. Move the cask to the decontamination area.
24. Using an auxiliary hoist, raise the lid and inspect the O-rings and sealing surface for damage.
25. Torque the closure head bolts to 650 ft. lbs.
26. Attach the pressure test fixture to the O-ring annulus vent valve. Open the O-ring annulus vent valve, pressurize the annulus between the double O-ring seals to 30, (+5,-0) psig (water), and then close the annulus valve. Hold this pressure for 10 minutes. There should be no pressure drop.
27. Using the pressure test fixture, pressurize the cask cavity, with water, to 30 (+5,-0) psig through the cavity vent valve, isolate, and hold for 10 minutes. Visually inspect the cask, closure lid, and valves (four) for leakage.
28. Attach a drain line to the drain valve. Open the valve to allow water from the cask cavity to drain out.
29. Connect station (pressurized) air to the cask vent valve. Connect a drain line to one drain valve. Force air through the cask for five minutes after visual indications of liquid water disappear from the discharge. Repeat this operation for the second drain valve.

30. Shut all valves. Lock the valve handles in the closed position. Disconnect all lines. Replace the valve port covers finger-tight and lock-wire in place.
31. Complete surface decontamination.
32. Prior to lifting the cask, verify that the yoke arms are fully and correctly engaged with the cask trunnions. Lift the cask and move it to the trailer loading area.
33. Rotate the cask into its proper orientation for loading. Lower the cask carefully, placing lower trunnions into the tie-downs at the back end of the transporter.
34. Place tie-downs around lower trunnions and secure bolts finger-tight. Lower cask to horizontal position, while keeping crane cables as vertical as practicable.
35. Remove the yoke from the cask by removing the ball-loc pin or other locking device and tie-down upper trunnions.
36. Tighten the front two and rear two trunnion tie-downs, torquing tie-down bolts to 30 ft-lbs.
37. Install closure lid impact limiter and torque the four bolts to 50 ft-lbs.
38. Remove wheel chocks.

NLI-10/24

PROCEDURE OUTLINE FOR NUCLEAR POWER PLANT

1. Arrival - Health Physics Survey - Inspection.
2. Open Personnel Barrier.
3. Health Physics survey of cask and car surfaces.
4. Wash down for removal of road dirt.
5. Remove lifting yoke or yokes, if on board.
6. Disconnect neutron shield water jacket expansion tank line from water jacket.
7. Using jack supplied, raise rear (bottom) end of cask off cradles, remove locking pin.
8. Remove rear impact limiter and store.
9. Slide turning support structure forward from travel position to turning position and bolt in place. Install trunnion bearings.
10. Slide trunnion sockets inward and lower trunnions into trunnion sockets.
11. Using jack supplied, raise front impact limiter off cradle and remove locking pin.
12. Remove front impact limiter and store.
13. Position car for removal of cask.
14. Engage lifting yoke with upper trunnions.
15. Raise cask to vertical position.
16. Raise cask off car and move it to Decontamination Area. Set cask down and remove yoke. Remove trunnion bearings.

17. Clean cask, if necessary, to remove road dirt.
18. Remove outer closure head and place on supports.
19. Remove inner closure head and spacer plug and place on supports furnished by NL, preferably in pool area.
20. Prefill cask cavity with water.
21. Connect neutron shield water jacket to temporary expansion tank.
22. Install anti-contamination barrier.
23. Re-engage lifting yoke and move cask to specified location in pool.
24. Disengage yoke from cask and move it away.
25. Fill anti-contamination barrier as cask is lowered into pool.
26. Load fuel.
27. Replace spacer plug and inner closure head.
28. Raise cask to surface of pool. Spray all elements of system with demineralized water as they emerge from pool water to remove as much contamination as possible.
29. Open bottom plug on anti-contamination barrier.
30. At top of pool, install (hand tight) some or all of inner closure head nuts.
31. Flush cask with approximately 900 gallons of demineralized water. Discharge to pool.
32. Move cask to Decontamination Area.

33. Connect supply of demineralized water to auxiliary cooling inlet and circulate at rate sufficient to balance decay heat load. Outlet may be routed to suitable drain or spent fuel pool load. If water is in short supply, the recirculating system on the rail car may be used. Utility will furnish the piping. If pressure drop over system exceeds a head of eighty (80) feet, a booster pump will be required (See Note #1).
34. Start Decontamination procedures.
35. Tighten inner closure head nuts to required torque level.
36. Force out enough water (about 20-25 gallons) using helium pressure to expose seal. Apply helium pressure to test seal and valves.
37. Force balance of water out with helium pressure.
38. Dry cavity by vacuum pump and recharge cask cavity with helium.
39. Drain water from closure head cavity.
40. Place outer closure head in place and tighten bolts to required torque levels.
41. Pressure test the outer closure head seals and valve using compressed air (10 psig).
42. Dry closure head cavity by evacuation and recharge with air.
43. When cask is satisfactorily decontaminated, stop flow of secondary cooling water, disconnect water supply and drain hose.

44. Install trunnion bearings.
45. Disconnect temporary expansion tank from neutron shield water jacket.
46. Attach lifting yoke and return cask to car.
47. By reversing steps 8 through 13, attach cask to car and re-install impact limiters.
48. Connect neutron shield water jacket to expansion tank on rail car.
49. Drain demineralized water from auxiliary cooling channels in cask.
50. Connect auxiliary cooling system inlet and outlet to corresponding fittings on cask and start auxiliary cooling system.
51. Final health physics survey.
52. Replace personnel barrier.
53. Final car inspection.
54. Complete paper work and placarding.
55. Ship.

Yokes need not be returned to car unless they will be required at point of delivery.

NOTE 1: When the cask is loaded with spent fuel, the decay heat from the fuel assemblies begins to raise the water temperature in the cask. Installation of the inner closure head will limit the flow of water or steam to the vent valve, which must remain open until some of the water is removed from the cask. The flushing operation (Step 31) will remove at least some of the decay heat, but, as soon as this operation is concluded, the circulation of cooling water in the auxiliary cooling channels may be necessary depending upon the amount of heat generated by the spent fuel.

Should there be a significant delay between the flushing operation and the beginning of circulation in the auxiliary cooling channels, the utility should be prepared to pass the effluent steam through a filter to remove particulate matter or to collect the steam and lead it to an off gas system.

Appendix J
Summary of PATRAM Paper
Describing a Fuel Oxidation
Occurring in Transport

EXPERIMENTAL INVESTIGATION OF RELEASE MECHANISMS RESPONSIBLE
FOR AIRBORNE CONTAMINATION SEEN DURING POST-TRANSPORT
UNDERWATER UNLOADING OF A FAILED PWR
SPENT FUEL ASSEMBLY

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INTRODUCTION

In May 1980 a spent PWR fuel assembly containing several severely failed rods was shipped from the Connecticut Yankee, Haddam Neck Reactor to the Battelle Columbus Hot Cell Laboratory. Nuclear Assurance Corporation's spent fuel shipping cask NAC-1E was used for the shipment. This cask, when loaded, is a sealed unit licensed for transport of uncanned failed rods or assemblies. The assembly was, therefore, carried in the cask without being placed in a failed fuel can. Also, the shipment was made dry; cask cavity environment was normal atmospheric air.

No unusual events occurred during transport. Arrival condition of the cask at its destination was normal. As the first step in unloading, water was slowly pumped into the cask until the internal cavity was filled. Upon sampling, the cooling water was found to contain contamination levels much higher than usual.

During subsequent underwater unloading of the cask excessive contamination was released into the pool water followed by airborne contamination which spread throughout the high-bay cask handling area. Effective operating procedures minimized personnel exposure and contained the contamination to the confines of the high-bay work area. The contamination signature was identified as being that of high burnup spent fuel.

From this event, two basic questions arise:

- What caused the release of airborne spent fuel contamination during underwater unloading of a failed spent fuel assembly?
- What are the implications of this effect to spent fuel handling, transportation, and storage?

An investigative research program was initiated to provide data helpful in answering these questions. This paper discusses that research program and its results to date.

RESEARCH PROGRAM

Source terms responsible for contamination release are of particular interest to assessments of spent fuel transportation scenarios. Very little published data exist, particularly data from experimental investigations of source term generation.

This event provides a valuable opportunity to experimentally study the effect of handling and shipping on a failed spent fuel assembly. In particular, the

mechanisms leading to the generation of a contamination release source term can be examined. An investigative research program was initiated for just that purpose.

Fuel Assembly Characteristics

The fuel assembly considered in this study is a 14 x 14 PWR assembly with stainless steel clad fuel rods. It has undergone three consecutive reactor operating cycles achieving an end-of-life burnup of approximately 36,000 MWD/MTU. It was discharged from the reactor in January, 1979 and was stored in the spent fuel pool until April, 1980. At that time it was shipped to the hot cell laboratory for postirradiation examination.

During operation, this assembly experienced failure of several individual fuel rods. Post-discharge optical examination in the storage pool revealed visible failures in seven individual rods. These failures consisted of longitudinal splits in the cladding which had opened exposing the interior fuel material. The splits varied in length from a few centimeters to as much as a meter with gaps of up to one centimeter.

Experimental Investigation

Upon loading the fuel assembly for shipment, the cask cavity contained unpressurized, normal atmospheric air. A sample of the cask cavity atmosphere taken upon arrival at its destination showed it to be still unpressurized but essentially depleted of oxygen.

The fuel assembly had been sealed in the cask for a period of six days prior to its unloading at the hot cell site. Heat content of the assembly was calculated to be approximately 3 KW. Maximum fuel rod cladding surface temperatures reached during shipment were estimated to be approximately 220 C (430 F) for peripheral rods and 300 C (570 F) for center rods. If the heat content of the assembly had been 2.5 KW, it is estimated that these temperatures would have been approximately 200 C (390 F) and 270 C (520 F), respectively. In either case, the maximum temperatures are comparable to reactor operating temperatures and no cladding degradation should be expected. However, these temperatures are sufficient to promote oxidation of the UO_2 fuel material.

Extensive analyses were made of the pool water as well as the cask flush water. These analyses identify the various contaminating isotopes as to solubility. Analysis of pool water surface layers and airborne samples identify those isotopes which were carried to the surface without wetting.

Samples were taken of the fuel material at the exposed regions of the failed rods and from unfailed rods. These samples were examined metallographically, chemically, and by electron microscopy techniques to determine the characteristics of the fuel and to determine if any physical or chemical changes had taken place.

Porosity and density measurements of the fuel material help to determine the susceptibility for generation of particulate or aerosol source terms. Characterizations are made of the oxidation mechanisms and the resulting release mechanism.

FINDINGS

Although still in progress, the experimental investigation suggests that, during transit, the exposed fuel oxidized generating a contamination release source term. Data have been obtained which characterize this source term. Chemical and physical characteristics of the fuel material have been determined. Changes in fuel condition due to the heat load and cask cavity environment experienced during shipping are identified.

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