MILLSTONE STEAM GENERATOR PACKAGING, SHIPMENT, AND DISPOSAL

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ABSTRACT

During the fourth quarter of 1992 Northeast Utilities and their subcontractor Chem-Nuclear Systems Inc. completed the first commercial large radioactive shipment utilizing ocean travel. This achievement was the culmination of eighteen months of work which included licensing a steam generator as a Type A transportation package, completing a comprehensive operational plan, and shipping two steam generators for disposal.

INTRODUCTION

What is radioactive?, weighs four hundred and eighty tons?, is one hundred and forty feet long and twenty feet wide?, stands twenty two feet tall?, has one hundred and sixty eight tires? and can move over land and sea? No, this is not a joke! Its a steam generator from Northeast Utilities Millstone Unit #2 on a heavy haul transporter. On November 30 1992, the second of two steam generators safely arrived at Chem-Nuclear's Barnwell Disposal Facility culminating three years of work and two individual shipments between Waterford, Connecticut and Barnwell, South Carolina.

This technical achievement is unique for several reasons including:

- A large component licensed by the NRC as a Type A, LSA transport package.
- First commercial radioactive shipment to be placed on an open waterway.

Several large components have been transported in the past utilizing rail (Pathfinder Reactor) and barge (Shippingport Reactor). However neither of these shipments required NRC licensing of the package on an open waterway. This effort required the integration, cooperation, and support of the U.S. Coast Guard, National Cargo Bureau, Northeast Utilities, Chem-Nuclear, Chem-Nuclear subcontractors (see Attachment #1), and the Nuclear Regulator Commission (NRC). This team strived for one goal, "licensing to ensure the safe, reliable, and technically achievable transport of the Millstone steam generators."

Licensing

Implicit in the transport of each steam generator was the task of qualifying the steam generator as a waste package that meets the regulatory requirements of 10CFR71 and is capable of being shipped. Subsequently, to license the steam generator required the development of a Safety Analysis Report (SAR). This report entailed addressing numerous technical issues including: encapsulating the contaminates, selection of transport medium, and route. Also addressed were 10CFR71 transport requirements and lifting and tie-down standards. These efforts resulted in the issuance of a Certificate of Compliance by the NRC for the Millstone steam generator subassembly (SGSA).

During the development, review, and approval of the SAR, several requirements were incorporated that enhanced the safe, reliable, transport of the steam generators. These requirements included the use of an escort tug, third-party review of all tie-down equipment, injection of low density cellular concrete (LDCC) into the SGSA, design and fabrication of a complex tie-down system, and development of an extensive operational and emergency plan. These additions were implemented to ensure the necessary "checks and balances" existed to ensure the safety and reliability of each shipment.

Three major technical issues were necessary to overcome. These were classification, tie-downs, and containment.

Classification

Proper characterization was imperative in determining the extensiveness and need for an SAR. Utilizing recent dose rate measurements and smear samples, it was determined that the SGSA with the highest activity contained 1403 curies. Approximately 600 curies consisted of Co^{60} which exceeded the Type A quantities given in 10CFR71. Subsequently, an NRC certification of the transport package was necessary.

Integral in this classification were discussions with the regulator to address concerns associated with the uniform distribution of the activity within package contents. Following these discussions, it was decided to inject LDCC into the primary and secondary sides of the SGSA. Utilizing the total activity, the specific activity (total activity/weight of LDCC) was calculated and determined to be below the LSA limits. Therefore, the packages were classified as NRC-approved Type A LSA.

Tie-Downs

During development, review, and approval of the SAR, the tie-down design basis were formulated to satisfy the requirements of 10CFR71. The design basis involved several technical restrictions such as:

1. The tie-downs were not to be a structural part of the package.
2. The acceleration standards of ANSI N14.24 "American National Standard for Highway Route Controlled Quantities of Radioactive Materials - Domestic Barge Transport" were to be used which included a higher factor of safety for tie-down cables based on American Institute of Steel Construction.
3. A mutually agreeable, third party review, inspection, and approval of the design and implementation of the tie-down system.

Each of the identified limitations were developed and agreed to following an assessment of NU and NRC objectives.

Containment

An assessment of the containment system was necessary to meet the Normal Conditions of Transport for LSA Material in 10CFR71. To ensure no loss or dispersal of radioactive contents and the effectiveness of the packaging, three mechanisms were utilized.

1. Tight adhesion of the contaminants to the inside surfaces of the tubes in the SGSA's.
2. Encapsulation of the contaminants by the low density cellular concrete.
3. The welded-shut barrier provided by the package itself.

The welded shut barrier required the development of a top-hat closure. This closure was necessary because the steam drum for each generator was reused. This top-hat provided a closure head that provided both containment and shielding.

TRANSPORT

In preparation for transport the steam generators were injected with LDCC, shielded (as necessary), and painted. This work was performed by Northeast Utilities in their preparation facility to address NRC, 10CFR71, and surface contamination issues, respectively. Injection of LDCC consisted of pumping in LDCC into the primary and secondary sides of the steam generator. Also, an external coating, the use of a tarp, and completing the transportation cradle cable system was necessary.

A transportation plan was developed to provide comprehensive management, coordination, and emergency response procedures during transit of each SGSA between Waterford, Connecticut and Barnwell, South Carolina. This plan encompassed the movement of the SGSA from the preparation facility at the plant to the disposal site including the phases described below: 1) Millstone Land Transit, 2) Ocean Transit, 3) SRS and SC Land Transit.

MILLSTONE LAND TRANSIT

This transit included a haul route load test, the use of two transporters, a jacking tower and transition beams to support various transitions. To maximize the transporter safety margin and the allowable tolerance within the suspension, a fourteen line three-file trailer was utilized for the transport along South Carolina roadways. As this wide transporter was not compatible with the loading configuration at the existing preparation facility, a fourteen line two-file trailer was utilized to move the SGSA from the preparation facility to the barge slip. At the barge slip, jacking towers were utilized to transfer the SGSA onto the fourteen line three-file trailer. Then the three-file trailer was driven onto the barge over fifty foot transition beams. Once on the barge the transporter and SGSA were secured in accordance with the approved tie-down design.

Following the completion of the tie-down system, various plant and regulatory agencies inspected the barge, tugs, transporter, and SGSA. These agencies included: Millstone Radwaste Shipping, U.S. Coast Guard, Marine Surveyor (American Management Systems), and National Cargo Bureau. These agencies ensured that the necessary safety systems existed on the barge and tugs, that all equipment was operational, and that the barge, transporter, and SGSA were prepared in accordance with the approved calculations and drawings.

Ocean Transit

Ocean transit was performed utilizing the "Lockwood No. 1" barge and the tugs "Antares" and "Miss Jennifer". This barge is a deck barge with roll on and roll off capabilities. Transit proceeded from the Millstone barge slip around Block Island and down the East Coast of the United States. At the Chesapeake Bay in Virginia the barge entered the intracoastal waterway to Morehead City, North Carolina to the Savannah River.

Prior to entering the Savannah River the barge was transferred to two river tugs with a shallow draft. These tugs moved the barge one hundred and fifty seven miles up the river to the Savannah River Site boat ramp.

SRS AND SC LAND TRANSIT

This phase was comprised of improving the SRS boat ramp in preparation for offloading the SGSA, disassembly of the tie-down system, transiting thirty-three miles of roadway, spanning three bridges, and laying plate across three culverts and two water lines. This coupled with numerous overhead obstructions and several traffic control issues required extensive preplanning. The communication between SRS Electrical and Traffic Divisions, State Highway Patrol, Edisto Electric, Lockwood Brothers and Chem-Nuclear insured a safe transit.

The excavation at the boat ramp was required to facilitate the docking of the barge and to minimize the grade change while driving off the barge. The transition from barge to land was complicated by a ninety degree right-hand turn as the transporter came off the barge.

Spanning of bridges were required because the capacity of the existing bridges was inadequate. Spanning the bridges consisted of laying transition beams across the length of the bridge. Oak cribbing and wedges were utilized to make a ramp between the existing roadway and the transition beams.

Disposal

Prior to disposal numerous preparatory activities were required including: obtaining a variety of approvals from the Department of Health and Environmental Control (DHEC) of South Carolina, grading the slope into the trench to accommodate the transporter, grading a roadway to the trench, installing a 50 ft. rear access gate, oak cribbing to off-load the SGSA, and design, build and test transfer beams. Once the transporter was on the Barnwell Waste Management Facility, it was backed into the trench. Once in the trench, the transport package was off-loaded onto the transfer beams and the transporter was driven out of the trench. Then the SGSA was lowered into its final burial position utilizing a hydraulic jacking system.

CONCLUSION

Whether it be overland or by sea, the technical capability exists to ship large radioactive packages. This project was successful because of the close relationship maintained between customer, contractor, subcontractors, and regulators. Each group developed a team of professionals committed to the safe and responsible disposal of the Millstone SGSA's.

The following technical and financial considerations should be made when assessing heavy haul of radioactive shipments:

Technical

1. Accessibility of disposal sites.
2. Capability of new regional disposal sites to accept large unprocessed heavy components.
3. Technical hazards and logistical complexities associated with segmentation.
4. Licensing of long-term on-site storage.
5. Personnel exposure limits and requirements will become more restrictive.

Financial

1. Future cost of segmentation and radioactive waste disposal.
2. Cost of on-site storage and monitoring.
3. Liability associated with on-site storage.

ATTACHMENT 1

CUSTOMERS	SUBCONTRACTORS	REGULATORS
Northeast Utilities - Quality Assurance - Radioactive - Transportation - Engineering - Site Services - Health Physics - Security	Riteway National Cargo Bureau Marine Surveyor Werts Excavation Edisto Electric Thunderbolt Marine Higgins Erectors & Haulers Bragg Heavy Haul Transport Marino Crane Scott Crane	Corp. of Engineers, State of South Carolina Corp. of Engineers, State of Georgia Water Resource Commission, Stateof South Carolina Department of Health & Environmental Control
Savannah River Site - Wackenhut - Westinghouse - Environmental - Project Manager - NEPA		Nuclear Regulatory Commission US Coast Guard
Department of Energy - Enironmental - Project Manager - Roads Management - Transportation Dept. - Electrical Dept.		State of SC Permitting Office State of SC Department of Transportation
	US Soil and Conservationist	Barnwell - City Council - Mayor
	Tie-Down Fabricators - Oehler Industries - Craft Industries - RECO - Kent Fabricators - Structural Mechanics	Director Radiation Control, Dept. of Env. Protection, State of Connecticut Div. of Occupational & Radiological Health, State of Rhode Island NY State Health Dept. Dept. of Environmental Protection, State of New Jersey Program Admin., Div. of Public Health Plan Review, Permitting & Enforcement, State of Delaware Maryland Dept. of the Environment

ATTACHMENT 1, CONT'D

CUSTOMERS	SUBCONTRACTORS	REGULATORS
		Dir., Bureau of Radiological Control, State of Virginia Deputy Dir., Dept. of Environment, Health & Natural Resources, State of North Carolina Director, Div. of Radioactive Materials Licensing & Compliance, Dept. of Health and Environmental Control, State of South Carolina Manager, Radioactive Materials Program, Dept. of Natural Resources, State of Georgia South Carolina - Beaufort County - Jasper County - Hampton County - Allendale County Georgia - City of Savannah - Chatham County - Effingham County - Scriven County