NAC INTERNATIONAL NUCLEAR MATERIAL TRANSPORTATION TECHNOLOGY AND EXPERIENCE - KEY SUCCESS FACTORS TO SUPPORT MODERN NUCLEAR DEVELOPMENT

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ABSTRACT

Radioactive and nuclear material transportation has increasingly become a subject of interest to many, partially promoted by ongoing developments in the nuclear industry. New power plant projects; nuclear fuel post irradiation examinations; international collaboration in nuclear research projects; large decommissioning and disposal activities of older facilities; international non-proliferation programs; spent fuel recycling or disposition projects and other nuclear-related activities are creating an increased demand for transport technology and services to relocate a variety of nuclear materials throughout the world.

In the ongoing effort to improve the nuclear industry's public image it is beneficial to publicize the stellar long-term track record of companies like NAC International and others in association with governmental agencies for safely transporting spent fuel and other nuclear materials throughout the world. In this paper, NAC offers information about its cask technology and nuclear transportation experience over the past three decades. In addition, important success factors, including maintaining a safe and efficient spent fuel transportation program, are identified.

1. Introduction

This paper provides an overview of NAC's spent fuel transport experience and shares important lessons learned in transportation safety, operational experience and security. In particular, NAC indentifies key success factors to every transportation campaign covering all means of transportation (roads, rail, marine and air) and dealing with all issues associated with safety, security, public and regulatory scrutiny. It is projected that further expansion of nuclear industry programs will drive a growing demand for nuclear material transport technology and services. In order to support this trend, it is important to apply key success factors to safely and securely perform future shipments. NAC has performed more than 3,700 spent fuel shipments and almost 7 million miles in transit. The experience gathered over the years developing cask technology and providing services, creditably allows NAC to contribute valuable information required to achieve success in nuclear material transportation.

1.1 NAC International Background

NAC was founded in 1968 as a nuclear services company and today is a leading spent fuel transportation provider and cask designer. With headquarters in Atlanta, Georgia and strategic offices in the United Kingdom, Moscow and Japan, NAC offers a wide range of services to key customers around the world. In the area of spent fuel transportation, NAC has shipped a wide range of radioactive materials including research and commercial spent fuel in the United States and abroad. In particular, NAC has provided spent fuel transportation services for the U.S Department of Energy (DOE) in its Foreign Research Reactor Fuel Repatriation Program (FRR). The FRR program (to return U.S. origin research reactor fuel to the United States) began in 1996 and it partially relies on NAC's fleet of NAC-LWT transportation casks. NAC operates a fleet of eight spent fuel and high level waste transportation casks, multiple dry transfer systems (DTS) and ancillary equipment to support its transportation projects.

1.2 Cask Technology and Dry Transfer Equipment

The foundation of NAC's transportation program is the NAC Legal Weight Truck (NAC-LWT) truck cask. The NAC-LWT is licensed by the NRC under 10 CFR 71 with Certificate of Compliance - COC USA / 92225 Rev. 48 and is currently certified as B(U)F-96. Validation of the NAC-LWT has been issued in many countries including Denmark, Brazil, Portugal, Romania, Hungary, Slovenia, Argentina, Indonesia, Australia, Sweden, Italy, United Kingdom, Canada and others. NAC's casks are licensed for various contents including Light-Water Reactor (LWR) fuel assemblies, high-burn-up fuel rods, irradiate hardware and waste. The LWT cask is also certified for a variety of research reactor fuels including plate-type MTR, TRIGA, DIDO, MOATA, HIFAR, damaged fuel, and fuel debris with high decay heat, short cool times, varying enrichments (natural to 94% U-235) and other special particularities. NAC's casks have been operated in more than 60 nuclear facilities. With its fleet of casks, NAC has logged approximately 3,700 shipments travelling more than 7 million miles. Furthermore, these spent fuel shipments have been performed by multi-modal means of transportation including air, ocean freighter, barge, rail and of course, on the road.

1.3 NAC-LWT Cask Parameters

An illustration of the NAC-LWT cask with its key component parts is shown as Figure I. A photograph of the NAC-LWT is shown in Figure II. Key cask parameters are summarized in Table I. The most important aspect of the NAC-LWT is its adaptability to accommodate a variety of fuel types and configurations. Furthermore, the NAC-LWT cask has been provided with a complete set of auxiliary loading equipment to work with very restrictive facility infrastructure characteristics, including limited crane load capacity and lift height, tight access doors, low floor loading capability and limited pool storage.

A key component of NAC's auxiliary equipment is the Dry Transfer System (DTS), which is used for moving the irradiated fuel from the pool into the cask (Figure III). The DTS is used to ensure facility adaptability with the NAC-LWT which has been a key success factor to implementing spent fuel transportation campaigns at many research reactor facilities. The system has been used for more than 10 years to handle more than 3,000 spent fuel assemblies.

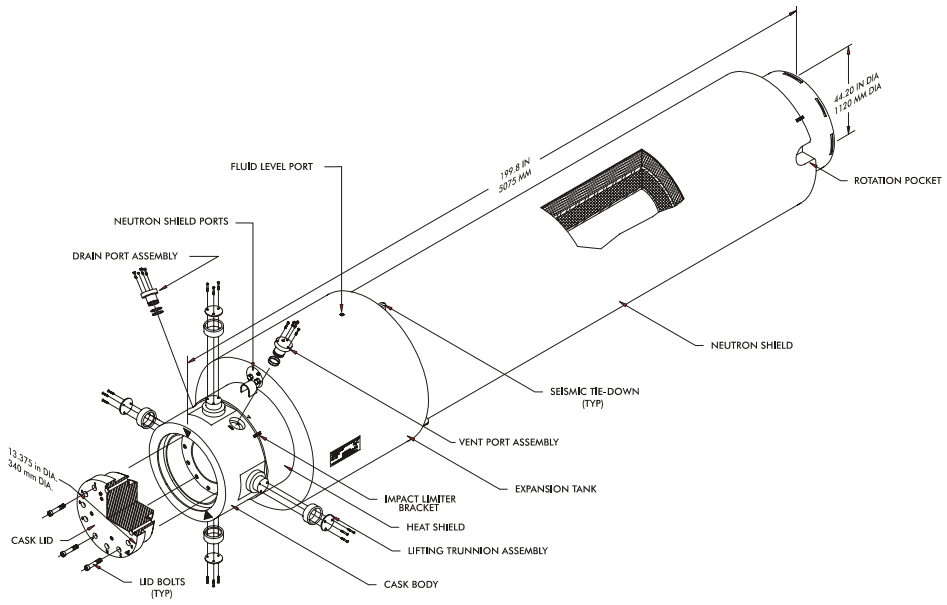

Figure I – NAC LWT Cask Illustration

Figure II – NAC-LWT Cask being placed into its ISO container

Table I – NAC LWT Cask Parameters

Dimensions	***inches***	***mm***
Overall length	*199.80*	*5075*
Overall diameter	*44.20*	*1120*
Cavity length	*180.90*	*4600*
Cavity diameter	*13.37*	*340*

Weight	***tons***	***metric tons***
Loaded	*25.6*	*24*
Empty	*24*	*22.4*

Figure III – Dry Transfer System (DTS Cask and Adapter)

1.4 NAC-LWT Spent Fuel Shipments

NAC uses the NAC-LWT cask fleet to package and transport fuel and highly radioactive waste items from facilities around the world. In particular, NAC routinely performs shipments for research and commercial nuclear power reactors supporting post-irradiation examinations (PIE) of fuel to various hot cell facilities around the world. In this regard, the NAC-LWT supports nuclear fuel research and development programs. Programs where the NAC-LWT cask has been used or contracted to support transport irradiated materials are:

- DOE MOX program (Oak Ridge National Laboratory)
- U.S. non-proliferation programs (Savannah River National Lab., Idaho National Lab.)
- University reactor shipments (Various, FRR, RERTR, GTRI)
- DOE Research and Development Experiments (Sandia National Lab., Pacific Northwest Lab., etc.)
- Shipments to Hot Cell facilities (GE Vallecitos, Studvick, Chalk River, Oakridge, and others)
- Commercial Shipments (various)

Figure IV identifies all the U.S. facilities where NAC casks have shipped or received spent fuel or radioactive materials. Figure V illustrates countries where the NAC-LWT has received validation or approvals in support of spent fuel or radioactive material shipments.

Figure IV – U.S. Facilities that have used the NAC casks or transfer equipment

Figure V – International Shipments using NAC-LWT Cask (FRR and NP Programs)

The combined experience in performing the domestic and international shipments has led NAC to identify key success factors that must be implemented in every spent fuel transportation campaign. The following section of this paper describes some of these factors and recommends actions to ensure their rightful consideration in future shipments.

2. Success Factors in NAC Spent Fuel Transportation

Over the past 30 years NAC has been involved in the safe transportation of more than 3,700 shipments of nuclear materials including spent fuel. A large number of these shipments have been unique and complex requiring the coordination of multiple parameters, stakeholders, regulatory jurisdictions and transport scenarios. The lessons learned are applied from one shipment to the next until key success factors become quite apparent. The following logistical aspects of spent fuel transport projects form the foundation of a successful shipping campaign:

2.1 Shipping Program Organization

Program organization and program management form the foundation of a successful shipping campaign. NAC has maintained a dedicated spent fuel transportation team staffed by individuals specializing in the regulatory, operational, transportation, security and procedural needs of the shipment. NAC's field personnel have a thorough knowledge of cask operation procedures and constantly update these procedures as lessons-learned are acquired. The NAC engineering organization provides the licensing, engineering and design support to promptly address any issue affecting the NAC-LWT usage, including design and approval of unique fuel basket configurations, certificate amendments or changes related to facility interface issues. NAC's quality assurance organization works hand-in-hand with other organizations to maintain and ensure accuracy and control of quality records affecting the equipment. Other important aspects of the shipping organization include safeguards and security personnel, assuring security compliance and escort coverage. Spent fuel shipments are inherently complex, involving a multitude of organizations.

Well-developed project plans, schedules with ample time allowances and contingency, and well developed interface definition by the project manager are absolute essentials. Overall, the shipping program organization must be well defined and must adhere to detailed quality procedures, project plans, divisional procedures and explicit task oriented procedures all of which are governed by the corporate Quality Assurance program and adheres to the U.S. NRC, U.S. DOT and international regulatory requirements.

2.2 Operation and Maintenance

Safety and operational efficiency of a shipping program is highly dependent on the equipment, personnel, and operation and maintenance procedures. These not only include equipment or procedures that are directly related to handling the transportation cask, but also related to the facility interface aspects of the shipping program. This includes the Dry Cask Transfer system and related ancillary equipment that NAC typically uses in facilities with crane handling or other interface limitations. NAC subscribes to the “Keep it Simple” philosophy, a necessity for many of the remote projects performed by NAC, but also proven in service as a means to improve shipment performance.

Automation is used only where necessary, and directly visible indicators (such as tape on cables and radiation measurement verification of grapple movement) are used wherever possible. NAC’s maintenance program has a number of mandatory and operational considerations, with regulatory compliance being paramount. In order to maintain NAC’s fleet of spent fuel shipping casks, they must undergo an annual maintenance program. This program is implemented per the applicable casks Safety Analysis Report (SAR), the latest revision to the Certificate of Compliance, 10 CFR 71 and NRC Regulatory Guide 7.9. With this goal in mind, NAC’s equipment maintenance program is governed by NAC’s procedures and cask maintenance program supported by the corporate quality assurance program. In addition, there are operational, cost and scheduling considerations in implementing an efficient maintenance program. NAC maintains a dedicated cask support facility so that regulatory and pre-shipment maintenance of casks and support equipment supports NAC and customer needs.

2.3 Facility Interface

NAC recognized in early shipments that facility interface issues were one of the primary factors delaying spent fuel shipments. Accordingly, NAC has developed a Dry Transfer System (DTS), a Intermediate Transfer System (ITS) and specialized tooling to address facility compatibility issues such as, crane handling limitations, insufficient cask handling space and other interface aspects related to a variety of reactor configurations. NAC realized that resolving potential interface requirement conflicts in advance of delivering the shipping equipment to the site was essential to avoiding costly shipment delays. NAC’s in-house engineering and design capabilities have been instrumental in resolving facility interface issues.

2.4 Communications

Communication among the multitude of line, regulatory, public and oversight organizations having a role in spent fuel transportation is complicated yet critical to success. Indications of a good team rapport are evident when personnel involved in the shipment clearly understand their responsibilities and the interfaces between all parties involved in the spent fuel shipment. Furthermore, clear communication is key to the resolution of in-transit issues where the jurisdiction of the spent fuel shipment may change as a result of the shipment moving from country to country or changing mode of transportation (i.e., barge to rail to truck, etc.). Finally, good communications is an integral part of safeguards and security for the shipment.

2.5 Documentation

An important aspect of the spent fuel transportation campaigns has been compliance with the substantial volume of regulatory-related documentation. Assuring completion of all paperwork required of all agencies involved is one key for success. For example, most shipments have required the reliance on multi-modal means of transportation through trans-national routes. Each shipment has required a number of certifications, validations, permits and approvals that met the standards of a local jurisdiction where the cask is in transit, as well as other requirements set forth by the international nuclear community including NRC and IAEA requirements.

2.6 Considerations for Future Shipments

Advanced planning, established relationships, and experience are vital aspects of a successful transportation campaign. Too often, transportation is an afterthought, with program planners underestimating the time and uniqueness of 10CFR71 and IAEA TS-R-1 compliance. There is no substitute for an early start. A new transportation campaign almost always involves a certain amount of public and political controversy. Conduct of an early “demonstration” shipment can flush out these issues so that the mainstream shipments are less affected. In all of NAC’s campaigns, we have seen a significant reduction in public concern after the first shipment is completed successfully. A “demonstration” or early shipment also serves to cement working relationships among the various organizations having responsibilities for highway route controlled shipments of nuclear material. In the United States, NAC has years of experience working with law enforcement and emergency preparedness personnel from the various states as well as regional planning groups. The relationships that have been forged over the years build trust, facilitate communications, and prevent problems that might otherwise occur. There is no substitute for experience whether it is in handling casks or facilitating transportation of spent fuel. No evolution is without some new challenges and it is only through years of experience that they are recognized and resolved. Methodical, deliberate operations and consistent problem resolution secures the safety and success of this work. Utilizing experienced field personnel, with the backing of the NAC corporate organization, has helped to assure that the critical aspects of each operation proceed safely to completion.

3. Conclusion

Nuclear spent fuel and radioactive material transportation is a mature industry. Over the past 40 years there has been significant lessons learned that can be applied to a nuclear material transportation program for moving these materials among multiple nuclear sites worldwide. Increased international collaboration in research projects; large decommissioning and disposal activities; international non-proliferation campaigns; spent fuel recycling or disposition projects and other nuclear developments are fuelling an increased demand for transport technology and services. Many of these programs or projects involve shipments to and from hot cell facilities. Each radioactive and nuclear material transportation campaign is unique, complex and multifaceted as its coordination requires multiple technical disciplines and the involvement of various stakeholders. Furthermore, the nuclear renaissance will certainly promote the expansion of nuclear material transportation programs covering a wide range of transportation packages, contents, modes of transportation and multiple in-transit jurisdictions (local, regional, national and international).

This paper has identified a number of the key success factors that require special attention to ensure successful implementation of a shipping program. These include a well-defined shipping organization with outlined responsibilities (corporate, federal and state); building

relationships among the parties; advanced planning, a well-defined maintenance program; and creativity in resolving facilities interface issues using appropriate handling equipment and procedures.

NAC's experience proves that this effort can be achieved safely and successfully, even in large-scale complex transportation campaigns. In fact, there has not been any release of radioactive material nor major issues associated with spent fuel transportation using NAC technology over the past three decades. Furthermore, the efficacy and low risks attributed to transporting spent fuel or nuclear materials are highlighted by the operational performance experienced so far. As the prospect for a nuclear expansion becomes a reality, governments and international organizations should build on the successful experience of organizations such as NAC and others, which have dealt with the myriad issues associated with operations, safety, security, public and regulatory scrutiny. This in turn will go a long way toward assuring the logistical availability of a viable international transportation program and the safety of its execution. Consequently, the nuclear material transportation industry will be making its rightful contribution to the nuclear renaissance.