IRRADIATED FUEL TRANSPORT - TWO DECADES OF EUROPEAN EXPERIENCE

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ABSTRACT

The transport of irradiated nuclear fuel is an essential and integral component of the nuclear fuel cycle.

Nuclear Transport Limited (NTL) has been in the forefront of the transport of irradiated fuel for two decades and has safely and successfully completed over 2500 shipments containing more than 5000 tones of uranium to the reprocessing plants of COGEMA at Cap La Hague in France and British Nuclear Fuels, Sellafield, in England.

During the two decades, there have been significant changes in fuel parameters, flask designs, regulations and public perception, all of which have impacted on the management of the irradiated fuel transport business.

This paper briefly describes NTL experience in meeting these challenges, the design and development of new flasks to meet future requirements of high burn-up fuels to 55 GWD/TeU and the flasks for the return of highly active vitrified waste.

INTRODUCTION

The international transport of irradiated nuclear fuel from European power reactors to the reprocessing plants at Cap La Hague and Sellafield has been safely and successfully carried out for more than thirty years. These transport operations were performed during the 1960's by three different companies, Transnucleaire Paris, Transnuklear Hanau and BNFL. Since the early 1970's, these transport operations have been performed by an international company, Nuclear Transport Limited (NTL), which was formed in 1972 with equal French, German and United Kingdom shareholding. During the last two decades, NTL has performed more than 2500 shipments of irradiated power reactor fuel, containing more than 5,000 tones of uranium to the reprocessing plants of COGEMA at Cap La Hague and BNFL at Sellafield.

Since its formation in 1972 NTL has developed into three companies, namely: Nuclear Transport Limited (NTL), a company registered in the UK, Société Nucléaire pour les Transports Lourds (NTL SA), a company registered in France and Nukleare Transportleistungen GmbH (NTL GmbH) registered in Germany. Each of the companies has exactly the same shareholders (33⅓% BNFL, 33⅓% Transnucleaire Paris, RSB Germany 20%, GNS Germany 13⅓%). The NTL group has five offices, one at Risley in the United Kingdom, three in France (Paris, Cap La Hague and Dunkirk) and one in Germany (Hanau).

NTL owns a pool of 18 transport flasks together with railway wagons and road trailers to cover the road, rail and sea modes of trans-European network. The flasks are type B packages and comply with the Regulations of the International Atomic Energy Agency (IAEA). They weigh between 30 and 110 tones with the capacity to carry up to 12 PWR or 32 BWR fuel elements. With the exception of some of the lighter flasks which travel by road all the transport is by rail. In most cases the flask is loaded on to a purpose built railwagon at the reactor site for delivery direct by rail either to Sellafield or to COGEMA's rail transfer facility at Valognes near La Hague. In certain cases, where there are no rail facilities within the reactor site, the flasks are transported by road to the nearest rail terminal. In addition to its own flasks, NTL operate flasks owned by COGEMA for transports to La Hague and Gesellschaft fur Nuklear Service mbH (GNS) for transports to Sellafield.

Over twenty years NTL's business has grown from an initial level of about 80 tones per annum to the present level of about 400 tones per annum. Over this period there have been significant changes in fuel parameters, flask designs, regulations and public perception, all of which have impacted on the management of the irradiated fuel transport business.

TRANSPORT MANAGEMENT

NTL has developed a management system to ensure that all transport operations are executed with safety as the primary objective. The 1985 edition of the IAEA Transport Regulations introduced Quality Assurance requirements for all aspects of package design, manufacture, operation and maintenance. Competent Authorities were given the additional responsibility of Compliance Assurance. This change meant that NTL had to demonstrate to competent authorities that all its transport activities were covered by a Quality Assurance system. The NTL QA Manual was first issued in 1983 based on the IAEA Safety Series 50-C-QA and reviewed in 1987 to take account of the standard ISO 9001. Since then NTL have been subjected to compliance audits from competent authorities. In 1991 NTL decided to apply for formal registration of the Quality Management system and, following a successful audit by Lloyds Register in England, certificates were issued enabling NTL to join the United Kingdom Register of Quality Assessed Companies. The QA system is applied to individual shipments with a documentation system called a Quality Plan. Each Quality Plan identifies the activities and responsibilities of all the organizations involved in the transport. The Quality Plan controls:

- Transport Administration
- Despatch arrangements at the reprocessor
- Reactor site operations
- Despatch arrangements at the reactor

All the activities have supporting documentation which is referenced in the Quality Plan. For example, fuel loading is controlled by flask operating instructions and fuel identification procedures.

INITIAL REACTOR TRANSPORTS

There is much work to be done before the initial transports from a reactor site commence. The first stage is flask allocation and this depends on:

- The requirements of the reprocessor
- Physical limitations at the reactor
- The fuel characteristics
- Any limitation on the transport route

Site surveys are essential to confirm adequate cranage and space for handling. Fuel pre and post irradiation data is analyzed for criticality safety, decay heat and radiation source strength in conjunction with the nominated flask types. With fuel compatibility confirmed, the nominated flask types are subjected to a handling route study at the reactor to identify all necessary equipment such as lifting beams and special tooling. The proposed transport route is examined for any restrictions and the necessary transportation equipment is also identified.

TRANSPORT PLANNING

A typical shipment may involve transport through four different countries. Competent authority approval is sought independently from each country via the most appropriate NTL office.

Applications are made well in advance of proposed transports. A transport program is established taking into account:

- Flask utilization
- Reactor shutdown periods
- Reprocessor fuel receipt program
- Flask maintenance periodicity

More detailed planning takes place when the actual fuel elements to be shipped are identified. Variations in fuel types or minor modifications to fuel elements must be covered by an appropriate competent authority approval before transport. With about 1500 fuel elements to be transported each year, NTL has established a computerized network of fuel element databases. Each reactor fuel type is identified with approximately 100 characteristics and entered into the database. NTL flask and equipment details are entered with data on the competent authority approvals. The NTL database network contains the details of more than 40,000 individual fuel elements and it is a valuable tool to both NTL operations and the reprocessors. Proposed fuel transports can be quickly checked on the NTL database for equipment compatibility and corresponding approvals before preparing a detailed loading plan for each shipment. The loading plan identifies the individual fuel elements for a specific shipment and is an essential document to ensure the transport is in compliance with regulations.

TRANSPORT OPERATIONS

Notification telexes detailing the transport programs are sent to all those involved before, during, and on completion of the particular transport cycle. The transport operations utilizes normal scheduled rail freight services.

A typical transport cycle for transports to La Hague would take approximately two weeks and includes preparation and despatch of the empty flask, fuel loading at the reactor, return and unloading of the flask at La Hague. This is because of the relatively short land distances to the reactor sites taking at the most three days transport in each direction. A typical transport cycle for transport to Sellafield would take approximately four weeks, that is allowing one week to travel by rail to the reactor, one week for fuel loading, one week for return travel and one week for unloading and flask preparation for despatch. Departure dates within the four week cycle are timed to ensure that flasks travel during week days since no rail freight services are available at the weekends. Most of the transport is by rail from reactor sites well inside the European mainland. To reach the United Kingdom the flasks travel between Dunkirk and Dover by a rail ferry link operated by the French national railways (SNCF). This is a regular service shuttling both road and rail freight between the United Kingdom and France on a vessel specially designed for the transport of dangerous goods. The crossing takes approximately 2 hours and the railwagons are loaded directly onto the ship with a RO/RO system.

This ferry service is provided three times daily.

FLASK TYPES

Flasks are always loaded under water but for transport there are two options; "Wet" flasks have water in direct contact with the fuel during transport and "Dry" flasks travel with a gas filled cavity. Since its inception, NTL has used both types with wet flask technology developed by BNFL and dry flask technology from Transnucleaire SA (TNP). Most of the transports to COGEMA utilize the TNP dry flask designs including the TN12, TN13, and TN17 flask types. These weigh between 75 and 110 tones and are all fabricated from forged steel with a solid wall, monolithic construction.

Shipments to Sellafield use wet type flasks and to date most shipments have been carried out using BNFL and NTL designed Excellox flasks.

The Excellox flasks are of a composite construction comprising of an outer carbon steel body, with an inner lead liner insert for gamma shielding.

The most recent flask introduced for shipments to Sellafield is the CASTOR S1 flask developed by GNS and utilizing spheroidal graphite iron to form a monolithic flask by a special casting process. The CASTOR S1 is the first flask using this design technology to be licensed and operated for the transport of spent fuel for reprocessing. This technology has been pioneered by GNS to develop a wide range of flasks for spent fuel transport/storage and for waste packaging. The CASTOR S1 is a wet type flask weighing 80 tones with a shorter version, the CASTOR S2 weighing 76 tones. It is planned to introduce more CASTOR flasks into this business.

NEW FLASKS

Since the 1970's there have been significant changes in the fuel to be transported. These changes have occurred both in fuel size and other parameters including enrichment, power rating and burn-up, and in recent years the picture has been further complicated with the introduction of the so-called mixed oxide fuels.

With the development of the fuel database information, NTL was ideally placed to consider the long term future of its flask fleet and initiate the development of new flasks to meet the upward trend in the reactor operation.

Jointly with BNFL, NTL has designed and developed a new monolithic design of flask. Two variants of this design have been developed, the Excellox 6 which is designed for

European operation to carry 5 meters long PWR fuels and the Excellox 7 which will cater for the Japanese reactor fuel requirements to BNFL. The Excellox 7 flask could also meet requirements for BWR and PWR reactors in Europe.

An initial order has been placed by BNFL for three Excellox 6 flasks to be operated by NTL, for service early in 1994 to carry PWR spent fuel from Germany to Sellafield. These new flasks will meet NTL future requirements of transporting highly irradiated fuels up to burn-ups of 55 GWD/TeU.

BNFL has a commitment to return residues arising from its fuel reprocessing operation to its overseas base load customers. NTL was awarded the contract to design and detail a new flask capable of transporting 21 vitrified packages whilst satisfying the stringent shielding requirements within the overall UK weight and size limitations. Tenders for the first flasks have now been invited and contracts are expected to be placed in 1993.

GREEN ISSUES

For most of its 20 years of operation NTL has transported fuel by road, rail and sea over millions of miles without raising the concerns of the public. In the late 1980's, spent fuel transport became the focus for opposition to reprocessing operations and on some occasions transports have been and are being delayed by demonstrations. NTL have responded to this new climate with an open door policy fully supported by BNFL and COGEMA and a number of campaigns to heighten public awareness were organized. NTL supported by the reprocessors have given presentations to Green organizations, local government representatives and attended public meetings to debate transport safety. Exhibitions have been staged at strategic points on the transport route to promote the safety of the industry. NTL have adapted to this public relations role with characteristic enthusiasm. 20 years of spent fuel transport without a single incident resulting in the release of radioactivity from a flask proves the reliability of an industry which puts safety first.