Spent Fuel Shipment—An Example of Compliance Assurance in Italy

A. Orsini and M. Paganelli

ENEA, Rome, Italy

Introduction

In 1982 ENEL, the Italian electricity utility, asked the Competent Authority to start the decommissioning procedure for the Garigliano nuclear power station for economic reasons. The first stage of decommissioning consisted of the removal of the 322 fuel elements left in the vessel and in the pond to proceed towards a progressive declassification of the nuclear plant and reduce the number of personnel required for its future management. For interim storage of the fuel elements it was decided to use the pond belonging to the former Avogadro reactor at Saluggia in Turin Province, the only one in Italy, authorised for the purpose by the Ministry of Industry, which can take up to 550 fuel elements with a total thermal power of under 500 kW. Transport was by road, using the AGN1 container of the type B(M) designed specifically to transport up to 7 fuel elements from the Trino and Garigliano power stations (Pochini et al. 1986). As transport contractor, ENEL chose a private Italian company from among those authorised under the law by the Ministery of Industry and the Ministry of Transport to transport fresh and irradiated fuel in Italy. This authorisation ensures a good level of technical and radiological protection knowledge and preparation, checked every two years or so by ENEA-DISP inspectors, and also knowledge of security regulations. For authorisation of the transport operation, as provided for under IAEA Regulations (para 716), the carrier prepared a safety report in conformity with Italian regulations and the requirements imposed by ENEA-DISP for this exceptional series of shipments made in a climate of public opinion unfavourable to the use of nuclear energy.

Safety report on transport from Garigliano to Saluggia

The safety report also examined the possibility of using the railway, but because of the lack of a railway link to either source or destination plant and the difficulties encountered with staff over the transport of radioactive materials, it was determined that the only possible mode of transport was by road. The safety report not only met all the requirements of the Regulations, it also covered the following points.

1 - The four alternative routes chosen, which varied in length from 850 km to 1050 km (Table I), followed motorways for 95% of their length and avoided large towns. The time of departure was set so that the Rome Ring Road was used only at night. Stops for fuelling the vehicle and changes of personnel were also predetermined and no other stops were permitted.

Table I - Map of Italy with 4 highway itineraries from Garigliano to Saluggia

2 - The transport vehicle was escorted for the whole route by a spare tractor unit and a van fitted up for mechanical maintenance work.

3 - The police, who escorted the convoy for the whole distance, decided what route to follow at the start of each journey in accordance with the instructions given by the Competent Authority for nuclear security. The police were also in radio contact with the local authorities responsible for initial responses to any emergency.

4 - The carrier appointed an "engineer in charge of shipment" with responsibility for managing all aspects of the transport operation in normal conditions and for organising technical support to local authorities in accident and incident conditions.

5 - The "engineer in charge of shipment" was required to report any anomaly encountered and the exact location of the convoy to his company head office and to ENEA-DISP from the mobile radiological protection laboratory escorting the convoy.

6 - The radiological protection laboratory was equipped with an electrical generating set and powerful lamps and was therefore able to carry out any kind of measurement anywhere, for example the following:
a) level of gamma, beta and alpha radiation
b) surface contamination by special probe and smear test
c) contamination in liquid matrix, with calibrated containers, by scintillator connected to a computer.
d) contamination in air, with aspirator, filters and then measurement of emission spectra of radionuclides present.
The mobile laboratory also contained overalls, gloves, masks and personal threshold dosimeters for intervention in radiation fields or in the presence of contamination.

7 - An analysis of accidental releases not covered by the tests envisaged for type B packages was developed on the basis of the real characteristics of the fuel elements at the time of transport. Because of the long period of pond storage, these had a maximum power of about 160 Watts, much less than the 3 kW/element assumed in the design of the AGN1 container.

8 - The mobile laboratory was equipped with a computer and appropriate software to evaluate the release of contaminants in the event of an accident.

Modifications to the Garigliano plant

ENEL modified and improved the system of moving and handling in loading the AGN1 packaging for this transport operation.

- The lifting system at the Garigliano plant was given a general overhaul and constraints were imposed on some movements to reduce the possibility of accidents, taking account of the fact that the plant was in the decommissioning phase. After the general overhaul, the crane manoeuvred the empty container many times in order to train the personnel and reveal faults typical of new equipment.

- All the fuel elements were inserted into dry stainless steel containers to facilitate their final storage, thus also adding an additional barrier to the package seal, though this was not evaluated quantitatively and not taken into account in approval of the package.

- It was decided to use a plastic sleeve to cover the packaging before positioning it in the loading pond, so as to decrease external surface contamination. Decontamination was carried out using a dismountable station. This comprised a plastic clad metal structure within which a high pressure water spray rotated.

Approval of transport by ENEA-DISP

Approval of the transport operation by ENEA-DISP, the government technical control organisation for all nuclear activities, was based on an overall checking of the transport operation and dosimetric estimates for fuel movement, including handling within the source and destination plants. The following specific points proved important.

- The cask tie-down system was checked as forming an integral part of the cask and therefore able to withstand a static force 10, 5 and 2 times the weight of the package in the longitudinal, transverse and vertical directions. The approval of the tie-down system carried out by ENEA-DISP facilitated acceptance testing of the vehicle for transport of irradiated fuel by the Ministry of Transport.

- Estimation of the collective dose envisaged for the whole fuel transport operation is shown in Table II. The maximum value of 0.22 Sv.man is undoubtedly conservative.

- Procedures for alerting the local authorities affected by the shipment and providing them with help in the event of an accident were tested with some authorities and judged satisfactory.

Itinerary / Hypothesis / Main input data	A 1	A 2	B
Distance per shipment (km)	850	850	1050
Transport index	3	5	3
Fraction of travel in:			
rural p. zone (20 p/km2)	0.95	0.25	0.95
suburban p. zone (150 p/km2)	0.04	0.70	0.04
urban p. zone (500 p/km2)	0.01	0.05	0.01
Velocity (km/h)	25	25	25
Traffic count passing a:			
spec. point-rural zone	1000	700	1000
spec. point-suburban zone	1500	1400	1500
spec. point-urban zone	2500	9500	2500
Suburban shielding ratio	0.5	0.5	0.5
Urban shielding ratio	0.95	0.95	0.95
Output data			
Dose per shipment (man*mSv)			
to crew	0.23	0.38	0.28
to handlers	0.60	1	0.60
to surrounding popul.	0.01	0.05	0.013
to people travelling	1.60	4.19	1.97
to surr. pop. while stopped	0.07	0.45	0.08
to total population	1.68	4.69	2.06
Maximum population dose (man*Sv) for 46 shipments: 0.22			

Table II - Assessment by INTERTRAN of collective equivalent dose for the transport of fuel elements from Garigliano to Saluggia

In view of the importance of this transport operation, all the procedures and analyses performed were discussed with the Technical Commission, which is the highest interministerial consultative body in Italy in the field of nuclear installations. The Technical Commission was informed of the system for real time reporting of the position and condition of the vehicle during transport through the ENEA-DISP location service, the aim being to respond to any alarming information such as is sometimes given out about such transport operations (Table III). Following approval of the transport operation by ENEA-DISP, the Ministry of Transport issued its final approval certificate, as required under Italian regulations for large sources of radioactive material.

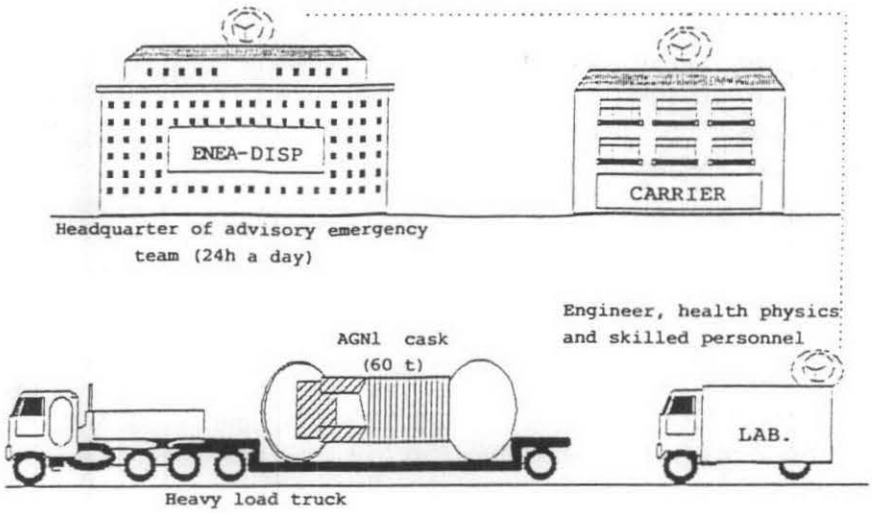

Table III - Schema of communication system for the transport of Garigliano spent fuel

Audits carried out by ENEA-DISP

More than 30 audits were performed by ENEA-DISP inspectors and officials in the course of the 46 shipments. These took place over a period of two and a half years and excluded the period of the summer traffic peak, when movement of many dangerous loads is forbidden. These audits started with insertion of the fuel elements into the steel containers and ended with unloading into the Avogadro plant. The points that emerged were as follows.

- The procedures laid down for loading, transport and unloading were correctly applied and no difficulties were encountered in satisfying the levels for external contamination of the container and for seal provided for in the certificate of approval and in the IAEA Regulations.

- The maximum levels of radiation both in contact with the surface and at one metre from the cask were respectively 230 microSv/h and 45 microSv/h, while the mean transport index for the 46 shipments was 1.6. The highest values were always measured at the top of the cask in horizontal, where the neutron shield of water and ethylene glycol is thinnest, or near the base valve, where crud might be present. Calibration of the instruments used in these measurements was checked and independent measurements were sometimes made.

- The collective dose absorbed by the power station personnel (about 10 in number) in loading the fuel and preparing the package averaged 1.1 mSv.man.

- The collective dose absorbed by the transport workers (about 18 in number) averaged 0.50 mSv.man.

- Each shipment took about 40 hours and there were no problems except a slight skid of the transport vehicle caused by ice on the road.

- A random check of contamination of the air within the package's shock absorber at the lid level, and made to check the effectiveness of the equipment in the mobil laboratory escorting the convoy, detected only radon decay products, always present in nature.

Conclusions

On completion of the 46 shipments in December 1987, it was possible to draw the following conclusions.
The absorbed doses resulting from transport of the fuel elements were well below the limits set by Italian and international regulations both for transport workers and for the general public. Dose estimates made using INTERTRAN code proved pessimistic even taking account of the fact that the mean transport index is the result of measurements on the top parts of the container. Those on the side were only about one third of these.

Although the additional requirements for both accident and normal conditions imposed on the transport operation to meet the requests of local authorities did not much increase the level of safety already ensured by punctilious application of IAEA Regulations, they, together with the ENEA-DISP campaign of information to the local authorities concerned on the techical support available, did allow the transport operation to be completed without interruptions or interference from a general public increasingly responsive to correct information.