PACKAGING AND TRANSBOUNDARY TRANSPORT OF PUO_2 AND MOX MATERIAL

S. Lutique
Joint Research Centre
Ispra (VA), Italy

F. D'Alberti
Joint Research Centre
Ispra (VA), Italy

R. Donati
MIT Nucleare
Carugate (MI), Italy

R. Vespa
MIT Nucleare
Carugate (MI), Italy

C. Osimani
Joint Research Centre
Ispra (VA), Italy

ABSTRACT

The Joint Research Centre (JRC) is a Directorate of the European Commission, distributed over sites in Belgium, Germany, Italy, the Netherlands and Spain. Its mission is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies.

Peripheral to its fundamental mission are the Decommissioning and radioactive Waste Management (D&WM) activities associated with the JRC's nuclear installations constructed and operated on its research sites during the early years of the Centre. Since the 1980s, the JRC's evolving mission has progressively reduced the need for nuclear installations, that must now be decommissioned. The removal of nuclear material from an installation is a prerequisite to start the decommissioning.

This paper reports the successful experience at the JRC Italian site (Ispra) on the conditioning, packaging and transfer of Plutonium (PuO_2) and Mixed Oxides (MOX) reference materials used for over twenty years, from the Ispra PERformance LAboratory (PERLA) to the original owner abroad. In particular the design, licensing and construction of new glove box lines and auxiliary tools as well as the revision of safety provisions for material containers handling and transport off-site are described.

A significant return of experience has come from the preparation of the material to be loaded in the transport casks, with particular reference to unexpected occurrences in the original packaging and preparedness for recovery procedures in case of major unknown events.

INTRODUCTION

The JRC site in Italy at Ispra hosts a number of nuclear plants, as research reactors, a radiochemical laboratory and a cyclotron. Most of them have halted their activities with the exception of the cyclotron and few small laboratories. Consequently the JRC has initiated a Decommissioning and Waste Management (D&WM) programme that requires also the management of the nuclear materials still present on-site. Some of these materials do not belong to the JRC but were lent by European nuclear companies or research centres. The project described in this paper successfully allowed the return of some PuO_2 and MOX material to its owner after over twenty year of use on the JRC Ispra site. This material was hosted in PERLA (PERformance LAboratory), one of the operating facilities in the INE (Impianto Nucleare ESSOR) complex, where reference NDA (Non-

Destructive Analysis) measurements have been carried out for a long time on sealed nuclear sources or material.

THE MATERIAL

The material [1] consists mainly of PuO_2 and MOX reference sources used to train the European Safeguard Office (ESO) and the Atomic Energy Agency (IAEA) nuclear inspectors on their non-destructive analysis techniques. The samples are of two types: powders or rods/pins. The Plutonium has a high content of Americium leading to a maximum contact dose rate of 6 $mSv.h^{-1}$ and ca. 40°C contact temperature.

The powders are conditioned in four types of cylindrical containers (named “model boxes”) with different sizes (see Figure 1), each of them made of one or more internal containers and one external containers. The inner container is made of stainless steel or brass with a non-leak proof tap screwed. An additional inner glass container is present for the PuO_2 samples only. The main inner steel container is packed in a welded PVC bag and inserted in an outer stainless steel container with a metallic gasket leak proof closure system.

The model boxes are named Model 5, Model 200, Model 1000 and Model 2500 depending on the maximum net mass of power contained. All the boxes are regularly tested (every two years) to assure the tightness of the containment system by using a bubble test methods.

The rods/pins samples consist of 16 MOX short rods (max length of 0.5m) and 17 MOX long pins (max length of 2.5 m). The cladding are made of stainless steel or zircalloy.

Figure 1. Outer containers packing the powder samples

The main difficulty of the project consisted in the fact that the material was stored in a plant to be decommissioned in which no similar operations (Pu handling) had been performed over the last 20 years.

LICENSING FRAMEWORK

The transfer of the material concerns a transboundary transport from Italy to France, that has caused licensing activities to obtain the following authorisations for the shipper, the receiver and the transporters in both countries:

1. JRC internal authorisation for INE modification (new glove box), validated by the Italian Safety Authority I.S.P.R.A (Istituto Superiore per la Protezione e la Ricerca Ambientale);

2. authorisation for the receiving plant modification issued by the French Safety Authority ASN (Authorité de Sûreté Nucléaire);
3. export license for the material issued by the Italian Ministry of Economical Development;
4. transport license for the road carriers issued by the same authorities in both countries;
5. nuclear safety transport permit (Attestato di Sicurezza Nucleare) issued by I.S.P.R.A.;
6. technical safety certificate (Certificato Tecnico di Sicurezza Nucleare) for road transport issued by the Italian Ministry of Transport;
7. transport casks certificates validated by the safety authorities in both countries;
8. emergency response plan for road transport accidents validated by the safety authorities in both countries;
9. nuclear liability policy covering the entire transport;

This paper will focus on the transport related aspects (material preparation, cask loading and transport). In particular, the technical aspects of authorizations mentioned in point 4, 7 and 8 have been the core activity, having led to a unique experience in Italy since few year decades.

Transport organisation and specific Italian law

Due to the specific nature and quantity of the fissile material involved, the road transport was organized with two special armored vehicles from the French carrier fleet as well as a complex organisation for active physical protection along the route and changeover of responsibility at the Italian/French border.

The responsibility and organisation of transport over the Italian territory was at care of the authorised carrier MIT Nucleare, which was also the main contractor for material handling and packaging and for the application for the transport authorisations.

Requirements for transportation of radioactive material in Italy are provided by Law n°1860 of 31/12/1962 [2] and by the applicative decree D.Lgs. 230/95, as further modified [3]. In particular, Art. 21 of the Decree establishes that a carrier must be authorised by Italian control authorities for class 7 transport material, regardless the means of transport. Some limitations and constraints can be included in the authorization, as it is for example for fissile material. In this specific case, the French carrier has operated in Italy under the responsibility of the Italian authorised carrier MIT Nucleare. The synthesis between security and safety is in this case a challenging matter. In one hand, the responsibility for the safety aspects imposes at the Authorised carrier a deep knowledge of the means and procedures, but on the other hand, the security aspects (for example on vehicles features) imposes a strict limitation of the information made available by the physical carrier.

A key role was played by the French and Italian Safety Authorities which have been involved in the very early period of the project. A bilateral agreement has been stipulated on the type of information to be exchanged and on the limitations imposed in the usual procedure, for example:

1. the vehicle inspection during loading phase and in transport has been limited to the authorised drivers and forbidden to all other organizations including the authorized carrier, the shipper and even the public force in charge for physical protection;
2. the Customs procedures have been limited and arranged before loading the transport vehicles;
3. long stops of vehicle along the route have been avoided increasing turnover of drivers;

Package approvals

The transport of the material required the use of two types of packages: some TN-BGC 1 package (type B(M)F-96) for the powder samples and FS 65 (type B(U)F-85) for the pins and rods. Due to the specificity of the material, both casks required an extension of the authorised content included into the French package approval certificates by ASN and a specific validation by I.S.P.R.A. according to the provision of the Circolare n°162/96 [4], which includes some additional Italian requirements for the package validation.

In particular for the use of the TN-BGC 1 casks, the package approval has meant some special requirements for the preparation of the material in its original packaging, namely the PVC bag between the inner and outer containers of the model boxes for powder. The presence of hydrogenous material inside the package is in fact normally forbidden for this kind of material transport. Hydrogen gas could be generated by the radiolysis induced by the gamma radiation field of the polymers. A special authorisation has been required to maintain the plastic bag as its removal would have been a more critical activity leading to increasing risks of contamination during the container manipulation. Such an authorisation has been granted by both ASN and I.S.P.R.A. on the express condition that the model boxes would be vented. The venting consisted in the opening of the leak-tight outer container under an inert atmosphere (He with a residual O_2 < 2 vol.%) inside a glove box system, to allow H to be replaced by He. In order to limit the production of H during the transport, the Authorities have decided a time limitation between the venting itself and the reopening of the material at the receiving plant. Table 1 shows the time constraint imposed for the venting activity at JRC plant before the transport departure.

A similar venting procedure has been imposed also to the transport casks hosting the Model 2500 before sealing them.

Table 1. Venting time constraint per Model type

Type of samples	Number of samples to be vented	Max days between closure and opening at destination	Margin for transport and opening	Max days for for venting prior departure
Model 5	29	175	18	157
Model 200	5	115	18	97
Model 2500	19	58 to 28	18	30 to 10
Model 1000	6	24	18	6

Emergency response plan for transport in Italy

The Decree of the Prime Minister (DPCM) of 10/02/2006 [5] sets the guidelines for emergency response plan during the transport of radioactive and fissile materials, pursuant to Art. 125 of D.Lgs. 230/95, as modified [3].

The emergency response plan for the transport has been arranged both at national and local level. In this context, it is of paramount importance to identify risk scenarios, human and technological resources and countermeasures for emergency situations. The I.S.P.R.A. provides the technical framework that allows the carrier to prepare risk assessment and the control authorities to develop national and/or local emergency plans.

On this basis, a general emergency plan was developed by the Italian Province of departure (Varese): it has been considered suitable also for the other parts of the Italian territory involved in the transport and therefore it has been validated also by the competent relative Provinces and Regions.

TRANSPORT PREPARATION

The preparation of the transport consisted in three main steps: the modification of the JRC plant, the venting of the samples and the loading of the transport casks.

Modification of the plant at JRC ISPRA

Due to the high level of dose rate of some samples, performing the venting in glove box required a better protection of the worker than the one provided by the existing unshielded glove-boxes of the plant. It has then been necessary to modify the plant in order to install a new shielded glove-box system. The new system is described in details elsewhere [1]. This modification has required the fabrication of a glove-box and its connection to the existing auxiliary systems such as ventilation, fulfilling the current INE licensing prescriptions. Figure 2 shows the new glove-box system in operation in PERLA. The installation of a new feeding system for the He and its connection to the new glove-box system was also necessary. In this way it was possible to switch from air to He the atmosphere inside the glove-box during venting operation and a continuous monitoring of the residual O_2 was performed to check the respect of its quantity imposed in the package approval certificate.
An INE internal authorisation process has been applied prior to its installation and commissioning.

Figure 2. New glove-box system installed in PERLA for venting purposes

Venting

After cold and hot trials performed in the first months of 2009 in order to validate the entire venting process, the venting of the 59 powder samples extended on a period of 6 weeks from mid March to mid April 2009. Due to the mentioned time constraints imposed by control authorities, the work has been performed on the basis of a two-shifts working day, from 7 a.m. to 2 p.m. and 2 to 8 p.m. Each shift team was made of operating, radiological, supervision and security personnel, assisted by an on-duty support team made of medical, general maintenance and decontamination personnel.
An efficient radiological control [6] was obviously put in place.
The venting process was the critical operation of the project. No evidence about the condition and mechanical behaviour of the PVC bags and tightness of the inner containment were available before the hot trials have been made. The latter had revealed that great care and particular handling were

needed to reduce as much as possible the contamination of the external surface of the outer containers, that could be allowed out of the glove box system only with strict contamination levels (< 0,037 Bq/cm^2 for alpha emitters).
During venting operations, any deviation on the time schedule could imply to cancel the transport and wait for a future acceptance time window of the receiving plant.In fact, the receiving plant could accept only batches of materials, so if one sample could not be shipped, the entire batch of similar samples could not be shipped as well. To avoid this event, a risk analysis was prepared [1] and operational handling procedures were tested and put in place for all phases, for instance:

1. cutting procedure for opening the containers that could no be opened by simply unscrewing the cap or the screws;
2. spare validated model boxes available if leak-tightness tests failes;
3. on-duty decontamination team to quickly re-establish operational levels in case of spread of contamination
4. on-duty maintenance team to quickly re-establish operational levels in case of failure of crucial auxiliary systems (e.g. ventilation).

The hot trial performed on real samples had put in evidence some constraints of the leak-tightness bubble test method, that caused residual amount of glycol to be found in the free volume around the metallic gasket inside the outer container. Such residual glycol was removed during venting from Models 200, 1000 and 2500, while for Model 5 its internal geometry was such that the outer container itself had to be replaced with a new validated one. In addition the glycol bubble test has been replaced by a validated gas (He) leak-tightness test.

Casks loading

When all the powder samples have been vented and the transport could be thus confirmed, the material has been loaded in the transport casks. A specific internal arrangements has been developed to hold the model boxes during the transport, fulfilling both the limitation of temperature increase due to gamma radiation field and the criticality issue. Figure 3 shows on the left the internal arrangement developed for Model 5. Once filled up with the Models, the internal arrangement was inserted inside the cask cavity. Usually the TNBGC-1 casks use an internal container called TN90. It was the case for all types of Models except for the Model 2500 for which the dimensions were not fitting in the TN90, therefore a specific internal container for the cask has been designed, it named TN998. The insertion of the internal container in the cask was performed following the usual loading procedure. Before their sealing, the casks containing Model 2500 have been filled with He, closed and leak-tightness tested.

In parallel, the rods and the pins have been loaded in the internal basket of the FS65 transport cask. This container has been developed for the project together with a specific internal arrangement. Figure 3 shows on the right this arrangement. Once filled up, the internal basket was welded and checked by a qualified welder. Then welded basket was then put in the FS65 cask, which was closed according to the ususal procedure.
The closure of every casks has been witnessed and validated by ESO and IAEA inspectors.
Finally, on the day of departure, all the TNBGC1 casks and the FS65 have been loaded on two armored trucks, strictly kept under the surveillance of the JRC security service.

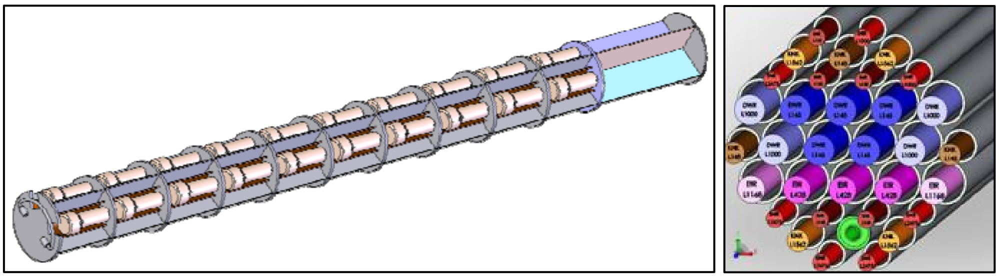

Figure 3. Internal arrangements for the Model 5 (left) and for pins and rods (right)

CONCLUSIONS

A total number of 50 people were involved at the JRC for the venting operation, including the contracted operators and support teams. The Italian escort of the truck was made of 28 vehicles including police, fire brigade and technical assistance for mechanical intervention and radioprotection. Despite the difficulties encountered during the project, the transport of Plutonium samples from Italy to France was successful and respected all the time constrains imposed by all parties. The operation has reduced drastically the inventory of Plutonium in Italy.

ACKNOWLEDGMENTS

The authors would like to acknowledge all their colleagues at the JRC and at MIT Nucleare and the contracted experts who have contributed to successfully achieving the project.

REFERENCES

[1] F. D'Alberti, S. Lutique, F. Maluta, M. Mazzuccato, "Repackaging and Transport of PuO_2 and MOX Reference Materials: the Experience at the Joint Research Centre in Ispra" European Nuclear Conference, Barcelona, Spain, 30 May - 2 June 2010.

[2] Italian Law n°1860 on 31/12/1962, as modified.

[3] Italian Decree n° 230 on 17/03/1995, as modified.

[4] Circolare del Ministero dei Trasporti e della Navigazione n°162/96.

[5] Decree of the Prime Minister (DPCM) on 10/02/2006.

[6] G. Macchi, D. Giuffrida, C. Osimani, F. Graboleda Castells, "Attività di "Venting" dei Campioni di Plutonio al Joint Research Centre di Ispra" XXXIV Congresso Nazionale di Radioprotezione, Frascati, Italy, 28-30 October 2009.