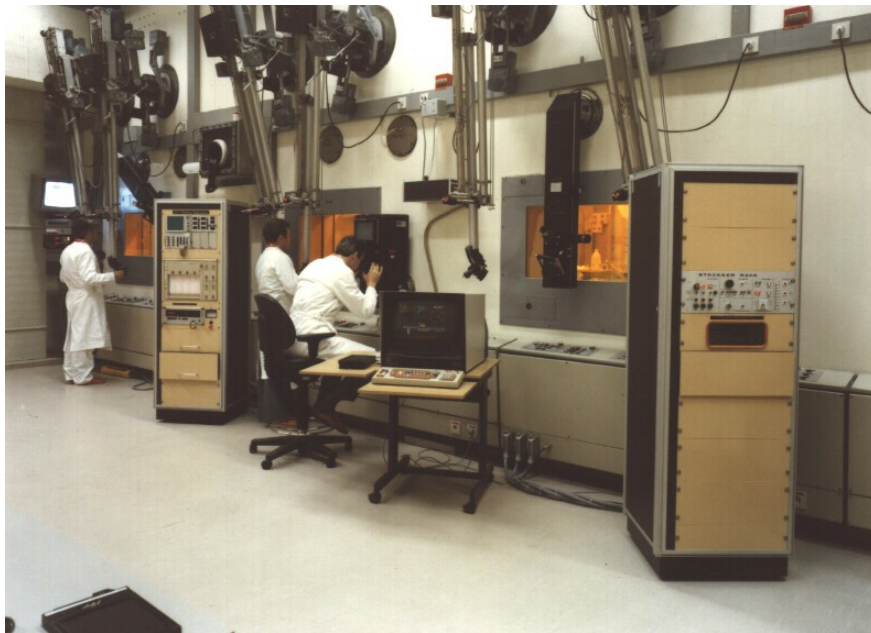


# European Working Group "Hot Laboratories and Remote Handling"

## Proceedings of the Plenary Meeting 2002

Mol, Belgium, September 25-27



**SCK•CEN**

Belgian Nuclear Research Centre

Boeretang 200

B-2400 MOL

March 2003

BLG-929

# European Working Group "Hot Laboratories and Remote Handling"

## Proceedings of the Plenary Meeting 2002

Mol, Belgium, September 25-27

### **SCK•CEN**

Boeretang 200 – 2400 MOL, Belgium  
[www.sckcen.be](http://www.sckcen.be)

Editor: Leo Sannen

### International Scientific Committee

G. Bart	PSI, Villigen, CH
J.I. Blanc	CEA, Saclay, FR
R. Duwe	FZJ, Jülich, DE
L. Nystrand	Studsvik, Nyköping, SW
B. Oberländer	IFE, Kjeller, NO
J. Quinones	CIEMAT, Madrid, ES
L.P. Roobol	NRG, Petten, NL
L. Sannen	SCK•CEN, Mol, BE
E. Toscano	ITU, Karlsruhe, EU

## Contents

Summary	4
Transport of Radioactive Materials	7
Transport Procedures at ITU: Licensing and Technical Aspects	20
Radioactive Transports	23
Nuclear transport into and from Belgium	25
A New Generation in the Family of Packages for Transportation	50
Transport of Radioactive Materials on CEA Sites – A Major Challenge for the 2000s : How to Comply with the Safety Regulations and the Control Procedures defined by the French Regulatory Authority	58
Microstructure of spent MOX and UO <sub>2</sub> fuel stored for 25 years	64
Oxidation of spent UO <sub>2</sub> fuel stored in moist environment	70
Advanced Wet-Reprocessing System: Separation Experiments on Real Spent LWR Fuel Solutions	71
First modelling approach to (U <sub>1</sub> -y <sub>238</sub> Pu <sub>y</sub> )O <sub>2</sub> (+x) leaching behaviour in water	78
Conceptual Study of a System for the Recovery, Safe Storage and Transportation of JRC Ispra High Level Liquid Wastes	85
Radiolysis in intermediate level waste of the STAR process	96
Treatment of PVC-Containing Nuclear Waste	104
A 250 kN tensile machine in hot cell	110
Mechanical Testing Facilities at AEA Technology	118
Fabrication possibilities and experience of fuel elements based on high-activity fuel types at the SSC RF RIAR hot laboratories	134
The new PSI metallography-box	138
Digital video cameras to supervise and document hot laboratory processes	144
A new high active facility at BNFL's Technology Centre, Sellafield	150
Determination of density and open porosity of irradiated fuel by the immersion method	158
Fuel Activities Related to ADS development at the SCK•CEN: (application to MYRRHA)	162
Advanced fuel cycles for Accelerator Driven Systems: Hot Laboratory availability for PIE on MA-bearing fuels and targets.	172
MA Laboratory	174
Infrastructure at PSI for the fabrication of Pu-Pellets (MOX and IMF) and segments	179

## Summary

With a tradition of almost four decades, the European Working Group on "Hot Laboratories and Remote Handling" is firmly established as the major contact forum for the nuclear R&D facilities at the European dimension. The yearly plenary meetings intend to:

- exchange experience on analytical methods, their implementation in hot cells, the methodologies used and their application in nuclear research;
- share experience on common infrastructure exploitation matters such as remote handling techniques, safety features, QA-certification, waste handling, etc.;
- promote normalisation and co-operation, e.g., by looking at mutual complementarities;
- prospect present and future demands from the nuclear industry and to draw strategic conclusions regarding further needs.

The proposed main themes of the three topical oral sessions of the Mol plenary meeting cover:

- **nuclear transports:** available transport containers, technical characteristics such as weight and shielding capacity, content specifications, hot-cell compatibility, regulatory aspects, accountancy of nuclear materials, licensing, legal matters such as insurance;
- **post-irradiation examination:** updated and new remote techniques and methodologies, new materials such as inert matrix fuels and spallation source materials;
- **fuel back end and waste issues:** hot laboratory waste characteristics and handling, spent fuel research.

### ***Summary of Session 1 "Nuclear Transports" chaired by G.L. Tjoa (NRG- the Netherlands) and co-chaired by H. Sannen (Transnubel-Belgium)***

Six presentations were given in this session dealing with transport of nuclear materials and its packages.

National and international transport standards of nuclear materials are strictly regulated by the ADR.

Safety aspects are the main concern in this respect.

In the first paper by NRG, the Dutch situation with respect to safety requirements and training requirements of persons involved, as well as the types of containerisation, allowable radiation and contamination levels were presented and a summary of some of the basic requirements of the international transport regulation was given.

JRC-ITU discussed several licensing rules, such as the Atomic Act Licensing, Transport and Container Licensing and the non-proliferation issues. A demonstration was given about the differences between requested and the time needed in practice for licensing containers.

An overview of the PSI-Swiss activities with respect to nuclear transports was given. This also includes the transports of MOX fuel, leading to a continuous upgrade of their technical transport systems. High safety records are sustained through efficient management and teamwork.

TRANSNUBEL presented an overview of the required documents and organisations involved with respect to nuclear transports in Belgium. The radioactive materials are coming from fuel cycles, waste production, research institutes and laboratories and contaminated objects from hospitals. The various packages and containers used for these purposes are presented as well.

In their presentation, COGEMA (France) highlighted a generation of 4 new transport packages, which have been developed recently. It was suggested that these new types are able to propose long-term solutions for international transport of different kind of materials and sizes.

The difference between internal and external transport was presented by CEA-France. This also includes the summary of the internal transport rules and the methodology to set up these rules. Old packages were investigated to demonstrate their full compliance to the internal rules. As a consequence renewal of a number of casks was necessary to comply to these rules.

#### Conclusions and recommendations

After the presented information it seems worthwhile to consider some kind of harmonisation and standardisation with respect to containers for external transports. Therefore, an inventory on the various types of containers has to be started, whereby the ADR rules can serve as a basis. After all, the classification of containers and or packages is part of these rules.

*The impression was given that at least a part of the participants did not have a clear understanding of the different types and levels of regulations and rules that have to be complied with. Some of these regulations are:*

- *UN regulations;*
- *IAEA Transport Regulations, IAEA/Euratom rules for fissile material transfers*
- *ADR, IMDG, ICAO;*
- *National Regulations;*
- *Convention on Physical Protection;*
- *Local and facility specific requirements etc.*

An inventory of (part) of these regulations could be helpful to facilitate the organisation of transports.

Despite of the presence of the ADR rules the transport of nuclear materials is subject to a number of local regulations, which are experienced as frustrating and delaying. The need for one European regulation is therefore desirable. This goes further than harmonising containers, since this meant that European Governments have to commit to a set of standards and it does not matter anymore where containers are being certified.

### ***Summary of Session 2 "Fuel Back End and Waste Issues" chaired by F. Minot (CEA, France) and L. Sannen (SCK•CEN, Belgium)***

Session 2 comprised six papers addressing

- the fuel cycle back end, both in terms of
  - the long term behaviour of spent fuel upon direct disposal (2 papers)
  - the separation of spent fuel into its different classes of radionuclides in view of an advanced reprocessing/disposal strategy (1 paper)
- the waste packages arising from hot laboratories:
  - with two papers on the problems turned up with waste packages stemming from the past
  - and a third paper on the current measures taken to anticipate future evolutions in present-day waste packages.

A. Leenaers (SCK•CEN, Belgium) presented a study on the impact of an extended storage period of 25 years on the microstructure of spent fuel. In an intact rod the spent fuel – being exposed to inert atmosphere found to be unchanged after the long storage period – does not show any alteration of its microstructure. Spent fuel stored under dry air shows evidence of modification of the coherency of the matrix attributed to a very limited oxidation (~ 0.02 %) as evidenced by the minor oxygen depletion of the contact atmosphere. Moisture enhances this oxidation: spent fuel

stored under moist air shows a more pronounced matrix decohesion and a more pronounced formation of higher oxides (~ 0.2 %) as evidenced by the large oxygen depletion of the contact atmosphere and confirmed by the appearance of a distinct second phase at the fuel grain boundaries. An oxidation reaction scheme, giving rise to the concurrent formation of H<sub>2</sub> – as found in the contact atmosphere – is being proposed as well.

On a question how the data presented compare to literature data, A. Leenaers answered that literature data on the subject are limited and rely all on accelerated experiments. The present results indicate that the oxidation is slower than derived from the the accelerated experiments results as reported in literature.

The paper on the “First modelling approach to (U<sub>1-y</sub><sup>238</sup>Pu<sub>y</sub>)O<sub>2(+x)</sub> leaching behaviour in water from J. Quinones et al. (CIEMAT, Spain) was not orally presented as the authors could not attend the meeting due to unforeseen circumstances. Nevertheless, the paper is included in this proceedings.

P. Goethals (SCK•CEN, Belgium) described the implementation of an advanced ion exchange process in a hot-cell for partitioning research. It is based on a new type of anion exchanger made up of radiation resistant porous silica particles bearing benzimidazole exchange sites – as developed by IRI (Japanese Institute of Research and Innovation). The results of the first separation experiments performed on real spent fuel were presented and revealed that optimization of the overall process is still needed in order to assess its full potential for partitioning.

R. Covini (JRC Ispra, Italy) described the strategy being developed to dispose of high level liquid wastes stemming from spent fuel experiments and being stored in containers which are inadequate – according to present day standards - both for long-term storage and off-site transport. The historical and future liabilities as well as the technology and methodologies being developed to cope with them are described. Two potential final disposal schemes are envisaged: vitrification in an external plant or cementation in an own facility.

F. Minot (CEA Saclay, France) presented a study on the H<sub>2</sub> hazard risk of intermediate level waste packages from the STAR facility at Cadarache containing hydrogenated materials. The radiolytic production of H<sub>2</sub> in the waste packages has been assessed – experimentally and theoretically – to be linearly related with the total activity. On base of this linear relation, the maximum allowable storage time without any hazard risk due to H<sub>2</sub> accumulation has been established.

M. Huntelaar (NRG, The Netherlands) described the studies undertaken at NRG to deal with degraded high active nuclear waste storage cans. Their degradation is due to corrosion caused by the radiolytic decomposition products of the PVC materials contained in the cans. Reconditioning of this waste has to be done in order to make safe storage/disposal possible. The different treatment methods that have been studied to render the waste chemically neutral are described. It lead to the conclusion that only a combination of two methods – thermal decomposition of PVC and storage in suitable containers – leads to an acceptable result.

### ***Summary of Session 3 "Post-Irradiation Examination & Infrastructure" chaired by L. Davies (AEAT, UK) and S. Van den Berghe (SCK•CEN, Belgium)***

The PIE session of the Hot Labs conference at Mol (25-27 September 2002) covered a variety of topics.

A presentation of mechanical testing facilities was given by AEA Technology, and BNFL presented its new high active facility BNFL Technology Centre (BTC) at Sellafield. Also Didier Haas presented an overview of the new Minor Actinide labs at JRC-ITU aimed at P&T research during the ongoing 6<sup>th</sup> framework programme.

A range of innovative equipment inside hot cells was described. This included a 250kN tensile machine in hot cell (P. Mongabure, B.Boisdanghien (CEA, France), the new metallography box at PSI which should be operational in the new year, a digital video camera to control and document hot laboratory processes (IFE, Norway), and the infrastructure at PSI for the fabrication of Pu-Pellets (MOX and IMF) and segments.

Recent developments in Accelerator Driven Systems (ADS) were presented; Fuel activities related to ADS development (SCK•CEN), and hot laboratory availability for PIE on MA-bearing fuels and targets (Studsvik).

Other talks in this section were fabrication possibilities and experience of fuel elements based on high-activity fuel types at the SSC RIAR hot laboratories, and the determination of density and open porosity of irradiated fuel by the immersion method (Studsvik, Sweden).