

European Working Group

# Hot Laboratories and Remote Handling

Plenary Meeting, June 5-6, 1997



**Studsvik Nuclear**

**Studsvik Material**

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## **French R&D Facilities for Reactor Fuel Examination Trends for the Next Century**

J.-Ph. Girard\* and F. Lefèvre\*\*  
Commissariat à l'Énergie Atomique  
Nuclear Reactor Directorate

\* Fuel Studies Division, Centre d'Études de Cadarache

\*\* Technology & Mechanics Division, Centre d'Études de Saclay  
France

Since the beginning of the nuclear reactor era, the CEA has operated hot cell facilities in each of its research centers, particularly at:

- Fontenay-aux-Roses, where the RM2 laboratory was successfully operated from 1968 to 1981, and at present is being dismantled because of its now urban location;
- Grenoble, where the dual operation of SILOE, an irradiation facility, and LAMA, a hot cell laboratory, will have been successfully managed since 1964, and will progressively be shut down, in compliance, here again, with the French policy of decreasing nuclear activities near areas of high-density population;
- Saclay, where, since 1959, the LECI has examined irradiated fuel and will now be adapted to enable the examination and mechanical characterization of irradiated materials;
- And finally, Cadarache, where the CEA intends to concentrate all its research on reactors and fuel. It is on this site that the next-century irradiation facility will be implemented, most likely a 100 MWth water moderated and cooled pool-type reactor, to be called Jules Horowitz, which will be operated jointly with the hot cell examination facilities designed around the existing LECA-STAR laboratories.

In this perspective, the last two above-mentioned laboratories have to be upgraded and extensions to be planned:

- For the LECI, the evolution of experimentation imposes two actions:
  - Renovating the hot cells and installing new equipments, and
  - Building an extension to the installation to receive a new line of hot cells: the M line. These hot cells are intended for mechanical tests. The start-up of the facility is scheduled for the year 2000.

The second laboratory (LECA) has been operated since 1964; its capacity has been recently increased, but only with respect to specific activities related to spent reactor fuel encapsulation. The laboratory will now have to address forty years of operation focused on advanced fuel examination (high plutonium contents, high burn-up, etc.). We explain how safety analysis and operating rules, together with a certain number of improvements and extensions will permit us to meet today's new requirements.

## **Formation and Investigation of Artificial Hydride-Blisters on Pre-Irradiated Fuel Cladding for In-Reactor Degradation Experiments**

E.H. Toscano#, R. Schreiber#, A. Nascimento#, H. Ruhmann°, M. Körzendörfer°

# Institute for Transuranium Elements, Karlsruhe, Germany.

° Siemens AG - KWU/BTW, Erlangen, Germany.

In order to investigate the fuel cladding in-reactor behaviour under simulated secondary degradation conditions, pre-irradiated cladding segments were locally charged with hydrogen. The resulting hydride blisters are considered to be the initiators for the development of long axial cracks typical for secondary degradation. This paper describes the charging procedure, the developed experimental device and presents the results obtained.

Artificial hydride blisters were generated on the surface of two segments cut from different BWR-fuel rods previously irradiated in BWR-reactors to burn-ups of 13 and 23 MWd/kgU.

An experimental device, based on the local application of a controlled temperature ( $\leq 400$  °C) on the surface of the samples under a hydrogen atmosphere, was developed and installed in a hot cell. Nickel metal was brought, by mechanical alloying, onto the previously machined surface of the segments to allow the ingress of hydrogen. Hydrogen gas was continuously supplied to the hydrating chamber at a pressure of about 2 bar. Temperature and pressure were maintained constant typically for about 20 hours.

This treatment has successfully been performed in the hot cells and resulted in the formation of locally hydride areas (blisters). Periscope observations and metallographic cross sections of samples cut from similar irradiated material will be presented.

## Microscopy on Nuclear Fuel

K. Bakker

Netherlands Energy Research Foundation ECN, Petten  
The Netherlands

In recent years the transmutation of plutonium and americium and the use of high burnup  $\text{UO}_2$  and MOX-fuel have attracted considerable interest.

At ECN the ceramics  $\text{Al}_2\text{O}_3$ ,  $\text{MgAl}_2\text{O}_4$ ,  $\text{Y}_3\text{Al}_5\text{O}_{12}$  and  $\text{CeO}_2$  are under investigation as support materials for the transmutation of plutonium and americium. Pellets of these ceramics have been irradiated in the High Flux Reactor in Petten up to  $5 \cdot 10^{25} \text{ m}^2$  at 710 K. The influence of neutron irradiation on the microstructure of these ceramics has been investigated using optical microscopy, scanning electron microscopy and transmission electron microscopy. The TEM studies show dislocation loops in neutron irradiated  $\text{Al}_2\text{O}_3$  and  $\text{CeO}_2$ , while edge dislocations were observed in irradiated  $\text{Y}_3\text{Al}_5\text{O}_{12}$ . No dislocations were observed in the irradiated  $\text{MgAl}_2\text{O}_4$  samples. No influence of irradiation on the microstructure of these four ceramics has been detected using optical microscopy and scanning electron microscopy. The swelling or densification of these pellets has been determined geometrically. The swelling of  $\text{Al}_2\text{O}_3$  under neutron irradiation is considerable, while irradiation has only a minor influence on the pellet sizes of the other three materials.

At ECN the microstructure of high burnup  $\text{UO}_2$  is studied using optical microscopy and scanning electron microscopy and the plutonium and fission-product distribution is studied using WDX-microanalysis. The results of this analysis will be discussed.

## **Addition of EBSP Equipment to the Studsvik HCL SEM**

Sven Bengtsson  
Studsvik Nuclear AB  
Nyköping  
Sweden

The principles of and the components necessary for obtaining electron backscattering patterns (EBSP) are outlined. The information obtained by the EBSP method is discussed. Applications in the nuclear fuel field include texture in Zircaloy, phase identification and characterisation of high burnup structure in  $\text{UO}_2$ . The computerised measurements and presentation of results are discussed.

The EBSP method can obtain information on the grain lattice that is not readily available by any other method. The method fills a gap between X-ray diffraction and transmission electron microscopy.

By moving the beam and observing the pattern it is possible to measure the extension of different grains. When the beam moves into a grain with a different orientation, the pattern changes. The resolution in orientation is approximately  $0,5^\circ$ .

By making  $150 \times 150$  measurements in a grid of  $25 \mu\text{m}$  side length it is possible to create a map showing several properties related to the lattice itself. The first is the orientation of the individual grain that can be presented as a grain map where each orientation is represented by a specific colour. The second property that is presented is the pattern contrast, called the "band contrast" which is a measure of the disturbance of the lattice in that spot. This property is sensitive to cold deformation, grain boundaries, pores or other phenomena that change the lattice symmetry or size. It is possible to make calculations in order to find e.g. mismatch orientations of different types. If the orientation changes between two measurements more than  $10^\circ$  it can be considered a grain boundary. These mismatch positions can be collected into a map that shows the grain boundaries. Other, more complicated relations can also be calculated.

A sample of  $\text{UO}_2$  fuel irradiated to a burnup of 67 MWd/kgU was examined. The fuel had developed a high burnup structure near the periphery, gradually vanishing towards the centre. It was demonstrated that the EBSP method was able to characterise the extent of the sub-grain formation at a given radial position.

## Status of Refabrication and Instrumentation of Irradiated Fuel Rods at CEA

J.-Y. Blanc<sup>(1)</sup>, P. Chantoin<sup>(2)</sup>

<sup>(1)</sup> DRN/DMT/SEMI, CEA/Saclay, France

<sup>(2)</sup> DRN/DEC/SDC, CEA/Cadarache, France

This paper presents in the first part the technical achievement of a re-instrumentation by cryogenic drilling of a high burn-up fuel rod with a high temperature fuel centerline thermocouple, and the following irradiation in the Osiris reactor. In the second part, we present the strategy which is underway to transfer the refabrication technique from Saclay to Cadarache hot cells.

As described in previous papers, about a hundred of fuel rods have been refabricated in Saclay hot cells in the last two decades. The final improvement of that technique was to adapt the technique of cryogenic drilling from the Risø National Laboratory. Some modifications were necessary, as to reduce the overall length of the bench to match the size of our cell, or to reduce the hole diameter to 2 mm, instead of 2.5 mm, to reduce thermal disturbances. Some difficulties have had to be overcome with roll bearings on the drilling machine, and some modifications were introduced in the welding of the instrumented plug to protect the thermocouple connecting lines.

The qualification of the technique was achieved in 1994, by irradiating in the Osiris reactor a double fuel rod including in one segment a fuel centerline thermocouple in annular fresh pellets, and in the other segment another thermocouple implemented by drilling a fresh full column in hot cell. Temperature and diameter measurements, as well as cracks in the pellets were similar in both fuel rods.

A 62 GWd/tU UO<sub>2</sub> fuel rod was prepared by cryogenic drilling, instrumented and finally irradiated in Osiris in June 1996. Results with power levels ranging from 150 to 300 W/cm were obtained and compared with similar data previously given by irradiating a fresh fuel rod. Neutron radiography confirm the good position of the thermocouple.

In 1997, the refabrication technique is going on in Saclay, mainly for the need of the Reactivity Initiated Accident program in Cabri reactor, and for ramp testing in Osiris. It has been decided to transfer this technique to Cadarache where fuel studies will concentrate, whereas Saclay will focus on examination on non-fissile material, such as mechanical studies on cladding and structural materials (see joint paper from J.-Ph. Girard and F. Lefèvre). The refabrication is already managed by a joint team composed of staff from both laboratories.

In Cadarache, at the moment, it is intended to use a slightly modified equipment, using the same machine for both end plug welding and seal welding. The hot cell has been cleaned and is in the process to be equipped. A qualification programme has been set up and cold tests are due to start in a short time.

This process in its actual state is necessary and fulfils its purpose when the observation of parameters during irradiation can be done with external means of observation or after irradiation (some safety experiments or irradiation of material samples).

When fuel is irradiated in view of fuel modelling, the recording of fuel parameters (temperature, FGR, fuel length change, clad elongation, clad diameter,...) is very important to reach a suitable interpretation. With that in mind, it is foreseen to make the FABRICE process evolving, starting by the transfer of the Risø drilling method and continuing by developing on line measurement of the suitable parameters.

## **Refabrication and Instrumentation of Irradiated Fuel Rods**

H.-J. Kleemann, K. Lunde, B.C. Oberländer  
Institute for Energy Technology, Kjeller  
Norway

The special techniques 'refabrication' and instrumentation' applied at IFE make further testing and insitu measurements of irradiated fuel rods in the Halden reactor possible. Instruments, necessary for such operations were designed and produced at IFE in the years 1991-92. Hot lab operations called 'refabrication' include all modifications necessary to fit a used, commercial fuel rod into the Halden reactor for further testing. 'Instrumentation' includes all operations necessary to fit instrumented end-plugs onto an irradiated fuel rod segment to insitu measure temperature (at the outside of the canning or in the centre of a pellet), pressure increase in the fuel rod and/or increase of the length during reactor experiments.

The presentation describes the possibilities at the IFE Hot Lab to refabricate and instrument irradiated fuel rods. The main part of the presentation concerns the equipments used in those operations. The equipments used are referred to as: 'Cutting and Grinding Unit', 'Freezing and Drilling Unit', and 'Welding and Drying Unit'. The welding and drilling unit includes a He-leak test chamber and a hydraulic press. Further, an overview will be given on the different end-plug instrumentations attachable to high burn-up nuclear fuel rod segments - a speciality of the Halden Reactor Project.

## Studies of Secondary Hydriding in BWR Test Fuel

Anders Lassing, Christian Gräslund  
Studsvik Nuclear AB  
Nyköping  
Sweden

A total of 20 tests have been performed in the R2 reactor with the aim to study secondary hydriding of cladding caused by water from a simulated primary defect in test rodlets of 8x8 BWR design. Three kinds of Zircaloy-2 cladding have been compared, namely standard cladding, cladding with unalloyed zirconium liner and so called *rifled* cladding, which is a proposed remedy.

18 tests were carried out with previously unirradiated test fuel in two exploratory test series, DEF-1 and DEF-2, and in the DEFEX Project. In these tests the intrusion of water through the primary defect was simulated by applying an open water reservoir in an extended plenum on top of the rodlet in the DEF and DEFEX tests.

In order better to simulate defection of a rod during operation, the technique was modified in the last two DEMO tests with irradiated fuel of medium burnup. The water was contained in a closed ampoule in the extended plenum, and the ampoule was made to burst when the test rodlet had been irradiated at full power for a predetermined period of time. The rodlets were refabricated at the Hot Cell Laboratory using the STUDEFAB process.

Neutron radiography, eddy current scanning and profilometry measurement at the R2 reactor showed that most of the hydrides and the cracks developed in the lower part of the rodlets. Subsequent PIE was done at the Hot Cell Laboratory. Visual inspection showed that only in the DEMO tests did the cracks grow outside the hydrided region. Gamma scanning of the rodlets was performed after each test in order to determine the distribution of fission products and the average power profile during irradiation. Investigation by SEM gave hydride distribution and oxide thickness. Ceramography was done optically for porosity and grain size measurement. Metallography was also performed. X-ray powder diffraction was used to determine the hyperstoichiometry of the uranium dioxide. For those rodlets that did not fail, the internal gas was analysed with respect to remaining hydrogen and fission gases.

## **Electronic Data Treatment within PIE**

H.-K. Jenssen, B.C. Oberländer, M. Espeland, S. Thorshaug  
Institute for Energy Technology, Kjeller  
Norway

At the IFE hot lab at Kjeller electronic data aquirement, treatment and storage have been used in PIE since a couple of years. The techniques are used especially within dimensional measurements,  $\gamma$ -scanning, auto-radiography, neutron-radiography, SEM, and metallography/ceramography. Electronic data treatment is a powerful tool within evaluation and graphic presentation of measuring data, documentation of structural/microstructure images with photographic quality, quantitative image analysis of microstructures, archiving, and quality assurance.

The presentation gives an overview on the experiences gathered at the Kjeller hot lab.

## **Small Specimen Manufacturing and Testing**

G. Pott, Hr. Derz, M. Herren  
Forschungszentrum Jülich  
Germany

Material properties of components (e.g. water degrader, beam degrader) irradiated in accelerators should be examined with respect to radiation embrittlement.

As the diameter of the proton beam is 3 - 5 cm the amount of irradiated material is so small, that the testing of standard samples according to ASTM regulations is not possible. From there bending-test samples of about 2 x 2 x 15 mm and shear punch samples of 3 x 3 x 0,3 mm had been manufactured and tested.

## **Material Testing with Reconstituted Specimens at Siemens Hot Cell Laboratory**

R. Hoffmann, G. Hofmann, E. Kelm, R. Langer  
Siemens-KWU NT 22  
Germany

After a short introduction of the Siemens Hot Cell Laboratory facilities at Erlangen the fabrication of reconstituted specimens and their qualification is described. Test results of reconstituted specimens of the compact and subsize Charpy type are presented and compared to data acquired by testing original Charpy specimens. Comparing index temperatures of compact and subsize specimens, a simple correlation function is shown which converts data from subsize specimens to data derived from compact specimens.

Thus, the use of subsize and/or reconstituted Charpy specimens is warranted in cases where only small amounts of material to be tested are available.

## **Tensile Testing of Irradiated Miniature Specimens**

G.L. Tjoa

Netherlands Energy Research Foundation ECN, Petten  
The Netherlands

Miniature tensile specimens were successfully used to investigate high temperature helium embrittlement of alloys. Helium was introduced in the specimens by  $\alpha$ -particle irradiation in a cyclotron. Thickness of the specimens was limited to 0.25 mm by the range of the  $\alpha$ -particles. The gauge length and width of the specimens, 8 and 1.5 mm respectively, were kept small to minimize the cyclotron irradiation time and, to a smaller extent, to keep the reactor volume small during subsequent neutron irradiation. To load specimens in a testing machine by remote handling without deformation prior to the actual test turned out to be a challenging problem. A procedure which was developed to do so reliably, is described in this paper. Additional aspects, such as fabrication of specimens and reproducibility of the results, are discussed.

## **The Dynamic Tension Test Installation of LECM**

V. David  
DMT/SEMI/LECM, CEA/Saclay  
France

The dynamic tension test installation, which is in hot cell, has been transformed. This installation is used to realise static and dynamic tension tests which are generally associated to temperature ramps.

A new piloting and acquisition systems have been installed, allowing an automatization of the test references and the acquisition of information.

All the system (hydraulic jack, regulation and power unit) is piloted by a PC thanks to a special software.

It allows to realise strength and displacement automatic control, and also to reproduce temperature ramps.

Acquisition cards which have two waves and sampling frequency about 160 kHz maximum, allow rapid measure of strength and displacement. Then it is possible to record 500 to 1000 points on each waves (strength and displacement) during a period of 20 ms.

This installation, easier to use, allows exact adjustments and specially the realisation of quick tests (up to 500 mm/s).

## Fracture Toughness Derived from Small Specimens

M. Scibetta, R. Chaouadi and al.  
SCK-CEN, Mol  
Belgium

Pre-Cracked Charpy V-notch (PCCV) and circumferentially Cracked Round Bars (CRB) are used to derive the fracture toughness of reactor pressure vessel steels. Both geometries are of practical interest for the nuclear industry as it only requires a small amount of irradiated material.

This paper describes experimental procedures to obtain a fracture toughness measurement from these two geometry. Irradiated and non irradiated PCCV specimens are loaded in three point bending up to rupture, whereas non irradiated CRBs are precracked using the rotating bending fatigue technique and are loaded in tension. Emphasis is put on the formulae used to analyse the load displacement trace of a fracture toughness test and on the applied correction to take the loss of constraint and size effect into account.

Promising results show that both methods have the potential to derive fracture toughness values from the lower shelf to the lower transition region.

**KEY WORDS:** circumferentially cracked round bar, Pre-Cracked Charpy V-notch specimen (PCCV), fracture toughness, lower shelf, transition region, cleavage, precracking, rotating bending fatigue.

## Creep Test Device of LECM

Th. Breidel  
DMT/SEI/LECM, CEA/Saclay  
France

The LECM creep test machine comprises six independant furnaces equiped with capacitive transducers and a pneumatic circuit.

This device may be used on PWR and FBR materials and for all the rod or pin geometries. That is the reason why the temperature range is relatively large ( $T_{max}=900\text{ }^{\circ}\text{C}$ ) and the furnace conception is flexible enough to permit adaptation to various geometries.

The device qualification has necessited the calibration of the six furnaces, the pressure and the displacement transducers and the thermocouples. The following stage has consisted to test the measurement lines.

Many blank tests have been performed on non irradiated materials essentially to verify the furnace equivalence. No atypic comportment has been detected.

In order to evalute the inflence of some parameters as sample length, we have performed a creep test campagn on non irradiated samples with different lengths.

An intercomparision campagn with two other laboratories (CEA/SRMA and EDF/EMA) has been performed on non irradiated tubes taken in an homogeneous series. The very good fit between the three laboratories has permitted the tests on irradiated materials.

## **Low-Cycle Fatigue Testing of LWR Fuel Rod Cladding**

**P. Ramsay, J.G. Gravenor**  
AEA Technology plc, Windscale  
United Kingdom

The low-cycle fatigue properties LWR cladding are important with respect to fuel performance under load following conditions. To study the LCF properties a test facility has been developed in which short specimens of defuelled cladding can be subjected to cyclic pressurisation using inert gas while at operational temperatures. The pressures used are sufficient to generate maximum cladding stresses typical of those experienced in service. The radial cladding deformation during cycling is continuously measured during the test using an optical scanning device. Controlled quantities of iodine can be introduced into the cladding bore prior to testing to examine the effects of stress corrosion caused by fission products.

## **The Equipment and Techniques for In-cell Overheating of Bundles Rods**

V.A. Tsykanov, I.M. Golovtchenko  
SSC RIAR, Dimitrovgrad  
Russia

On the previous meeting of Workgroup was reported and is shown, that in emergencies the behaviour unirradiated and irradiated single fuel rods differs not only quantitatively, but also qualitatively.

In development of these researches calculations and experiments were spent which have shown that in emergencies the behaviour of irradiated single rods and bundles of irradiated rods can also differ. In the greatest degree these distinctions (differences) can appear in fuel assemblies of reactors as VVER, in which bundles contain diverse rods from diverse materials (fuel rods, directing channels, rods of burning out absorbant, managing rods). With reference to fuel assemblies of reactors as VVER is developed and is made the equipment for in-cell overheating of bundles of similar and diverse rods (up to 19 rods of diameter of 9,15 mm in a bundle). Types of possible thermal and corrosion tests of bundles and parameters of these tests are described. Tests of a various types of bundles of unirradiated rods, including video recording of processes of tests are spent.

The realization of teleological abnormal tests of bundles of irradiated rods is possible with involvement of the foreign partners.

## **Testing Procedures of some Construction Rigidity Characteristics for the Irradiated FAs in the Hot Cells**

S. Pavlov, V. Dvoretzkey, V. Polenok, V. Smirnov  
SSC RIAR, Dimitrovgrad  
Russia

During operation of the VVER reactor blocks the bowings of complicated form can appear. Their value is determined by a number of factors that can result in failure at work of the reactor control protection system.

In particular, the FA bowing can appear due to the increased axial stress associated with the spring block operation. One more factor promoted the decrease of the FA construction rigidity is deterioration of the fixing condition for FEs and guiding channels in the spacer grid cells. It is intensified after fuel burnup increase.

That's why one of the principal parameters necessary for creation and verification of the thermo-mechanical model of the FA and core is the bowing rigidity with which the FA constriction stability is associated.

The report presents the descriptions of the techniques and equipment which are used during examination of some FA construction rigidity characteristics in the RIAR hot cells.

In particular, the following is presented in the report:

- technique for determination of the FA form change;
- facility for FA bowing measurement at the cross stress;
- methods for determination of the gaps between FEs and spacer grid cells;
- methods and devices for examination of the spring block characteristics.

The report presents the technical specifications of the facilities and methodical providing.

## Neutron Dosimetry in Nuclear Facilities

G. Bruhl, M. Chemtob  
CEA/IPSN/DPEA, Fountenay-aux-Roses  
France

The evaluation of ambient and personal doses due to neutrons in nuclear facilities is one of the most difficult problem in radiation protection field.

Neutrons are present in many installations concerned by the nuclear fuel cycle (fuel rod manufacturing, nuclear power plants, transportation packaging, research laboratories involved in radiographic applications, neutron radiotherapy purposes,...). The neutrons produced in those facilities cover a large spectrum of energy, from  $10^{-3}$  to  $10^8$  eV. In a practical point of view the dosimetric systems shall be able to measure doses on a neutron energy range of 10 decades.

Neutrons are neutral particles and are, by the way, not directly detectable. Dose due to neutrons is obtained by the production of secondary particles and detection of neutrons is also achieved by measuring the secondary particles emitted during interaction between neutrons and absorption material. So the evaluation of "neutron doses" is a very complex phenomena which is directly linked to the nature of the reaction produced in the body or in the detection material.

On the other hand, the biological effect of the secondary particles on organs or tissues, created during the interactions of neutrons with matter, is strongly dependant on the energy of the neutrons. So it is required to know adequately the energy distribution of neutrons during the study and the evaluation of the dosimeters.

Dosimetry of neutrons has also to take into account the new ICRP (1) recommendations (ICRP 60), which have simultaneously introduced new basic radiation protection quantities and lower operational dose limits for workers and general public. In order to be consistent with the new concepts of ICRP 60, ICRU 51 (2) has revised the neutron quality factors, especially in the range of 100 keV to 2 MeV. This lead to increase numerical values of the operational quantities which are used during the calibration of the dosimeters.

The majority of the radiation protection instruments available on the market at the present time do not satisfying completely these different requirements, especially those which measures personal doses. These different reasons require a new approach of neutron dosimetry.

The present communication intends to give some explanation on the previous radiation protection concepts, on the different techniques in use for neutron measurement and on the main research programs which are achieved in different countries in order to develop new neutron dosimetric systems.

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- (1) ICRP: International Commission on Radiological Protection
  - (2) ICRU: International Commission on Radiation Units and Measurements

## **Current Status of Ciemat Facilities for Radiactive Materials**

Jesús Lapeña  
CIEMAT-ITN, Madrid  
Spain

Ciemat had hot cells for fuel but they are being modified because it is not the intention to work with fuel any more. In these hot cells, the surveillance of capsules of NPP will continue together with the testing of samples: charpy and tensile tests, reconstitution of specimens, etc. In other laboratories there are "semi-hot" cells for, mechanical testing, microscopy (optical, SEM, TEM, Auger and Esca), and a loop for IASCC (Constant load and CERT) of irradiated samples. The presentstate and intended projects are briefly presented.

## Examination of Control Rods from Magnox Reactors

M.D. Thornley  
Magnox Electric, Berkley Centre  
United Kingdom

The CO<sub>2</sub> cooled reactors (Magnox Reactors) operated by Magnox Electric have in some cases been in service for over thirty years. As part of the programme to secure the safety cases for continued reactor operation, Post Irradiation Examination has been performed on a total of eleven control rods at the Berkeley Centre Hot Labs, both as failure examinations and as surveillance to enable extrapolation to higher doses. Magnox reactor control rods consist of boron steel inserts in a mild steel or stainless steel sheath. The principal issues are the continued structural integrity of rods under normal and fault conditions.

The conference paper briefly describes the basic visual and metallographic examinations and then describes the studies performed to underwrite the continued structural integrity in greater detail. The latter include mechanical testing in the hot cells and microstructural examinations (shielded SEM, TEM, FEGSTEM and SIMS) within the Electron Optics suite integrated with the Hot Labs at Berkeley. The paper concludes with examples of how these techniques have been used to determine temperature, dose and physical property profiles within rods and thus failure modes and remnant lives of the rods.

## **Decommissioning Management of a Hot Cell Used for Post Irradiation Research on Irradiated Material**

S. Harnie, L. Noynaert  
SCK-CEN, Mol  
Belgium

The decommissioning of the oldest hot cell of the laboratory LHMA at the SCK-CEN was just completed. The cell was used for 20 years for post irradiation research on irradiated materials and fuel pins. The cell consists on a L-shaped air-tight alpha-box of 18 m<sup>3</sup> surrounded by a biological shield in lead. The cell equipment, such as a small lathe and several cutting devices, could be operated by 12 tongs and 2 MA11 manipulators.

The decommissioning project was broken down into 4 main phases

- **Phase 1: dismantling of the equipment**  
After a volume reducing of 65 % of the equipment, the reduced parts were conditioned in tinned cans and transferred in shielded containers to the waste services.
- **Phase 2: decontamination of the cell**  
Mechanical polishing combined with intensive vacuum cleaning was used to reduce the contact radiation levels (up to 1.4 mSv.hr<sup>-1</sup>).
- **Phase 3: dismantling of the cell**  
An air-tight construction surrounding the cell was build. 70 ton of lead were removed. The working table and the cell were cut using a plasma torch.
- **Phase 4: waste management.**  
The decommissioning of the cell lays to a production of 16 ton of radioactive waste, x ton of material to be recycled in nuclear industries and y ton to be free released.

This paper will discuss the main features of each phase i.e. the techniques used, the dose uptake... The lessons learned will also be summarised.

## **Encapsulation of Studsvik Nuclear Fuel Waste for Interim Storage at CLAB**

Arne Holmér  
Hot Cell Laboratory  
Studsvik Nuclear AB  
Nyköping  
Sweden

Nuclear fuel waste has been generated since 1960 at Studsvik, Sweden. Fuel testing in the Research Reactor, R2, and PIE in the Hot Cell Laboratory had produced about 2100 kg of UO<sub>2</sub>-fuel waste up to 1986.

At that date a decision was taken to treat and encapsulate the accumulated older waste as well as the waste currently generated at Studsvik to fit the interim storage for spent fuel, CLAB, and later disposal in the planned Deep Rock Repository in Sweden.

CLAB and the Deep Rock Repository are essential parts of the Swedish Nuclear Waste Management System.

The presentation describes the treatment and the storage technology used and the experience after 16 transfer operations of fuel residues from Studsvik to CLAB.

## **Refurbishment of a Hot Cell for Decontamination of In-Cell Equipment**

T.R. Black  
AEA Technology plc, Windscale  
United Kingdom

AEA Technology have recently installed and are currently commissioning a decontamination facility within their Active Handling Facilities in Building 13 (B13) at Windscale. An existing shielded cave and adjoining active workshop have been refurbished and used to house the decontamination and associated equipment. The shielded cave provides the primary, remote decontamination area and the adjoining active workshop provides the secondary, hands on, area. The primary decontamination process involves soaking items in tanks containing a hot detergent/water mixture. Propeller type agitators, ultrasonic transducers and spray heads are fitted to the tanks. The decontamination facility will be utilised to clean contaminated equipment and materials prior to maintenance (to reduce personnel dose uptake) and prior to disposal (to reduce waste disposal costs). This paper describes the decontamination facility and its integration with the Active Handling Facilities.

# Studsvik Nuclear

## EWG "Hot Laboratories and Remote Handling" Plenary Meeting at Studsvik, Sweden, in June 1997

### List of Participants

*Birgitta Eriksson 03/06 1997*

<b>Country</b>	<b>Name</b>	<b>Organisation</b>
<b>Belgium</b>	Sven Hamie	SCK - CEN, Mol
	Marc Scibetta	SCK - CEN, Mol
	José Van de Velde	SCK - CEN, Mol
<b>Czech Republic</b>	Michal Falcník	Nuclear Research Inst, Rez
	Milos Kytka	Nuclear Research Inst, Rez
	Petr Novosad	Nuclear Research Inst, Rez
<b>France</b>	Jean-Pierre Lévêque	CEA Cadarache
	Nicolas Parisot	CEA Fontenay aux Roses
	Jean-Yves Blanc	CEA Saclay
	Thierry Bredel	CEA Saclay
	Virginie David	CEA Saclay
	Francis Lefèvre	CEA Saclay
	Luc Marchand	CEA Saclay
	Jean-Philippe Girard	CEA-CEN Cadarache
	Laurent Mercier	EdF
Gilbert Bruhl	IPSN Fontenay aux Roses	
<b>Germany</b>	Gérard Samsel	CEC - ITU Karlsruhe
	Enrique Horacio Toscano	CEC - ITU Karlsruhe
	Hermann Josef Buecker	Forschungszentrum Jülich
	Günther Pott	Forschungszentrum Jülich
	René Pejsa	Forschungszentrum Karlsruhe
	Rüdiger Hoffmann	Siemens-KWU NT22
<b>Norway</b>	Marit Espeland	Ife, Kjeller
	Håkon Kristian Jenssen	Ife, Kjeller
	Hans-Jörg Kleemann	Ife, Kjeller
	Barbara C Oberländer	Ife, Kjeller
	Svein Thorshaug	Ife, Kjeller
<b>Russia</b>	Serguei Pavlov	SCC RIAR
	Ioulian Golovtchenko	SSC RIAR

# Studsvik Nuclear

<b>Country</b>	<b>Name</b>	<b>Organisation</b>
<b>Spain</b>	Dolores Gomez-Briceño	CIEMAT
	Jesus Lapeña	CIEMAT
<b>Sweden</b>	Bertil Josefsson	Studsvik Material AB
	Sven Bengtsson	Studsvik Nuclear AB
	Leif Ericson	Studsvik Nuclear AB
	Christian Gräslund	Studsvik Nuclear AB
	Stefan Hammar	Studsvik Nuclear AB
	Arne Holmér	Studsvik Nuclear AB
	Anders Lassing	Studsvik Nuclear AB
	Karl Malén	Studsvik Nuclear AB
<b>Switzerland</b>	Friedrich Groeschel	PSI
	Peter Schleuniger	PSI
<b>The Netherlands</b>	Klaas Bakker	ECN Petten
	Klaas W De Haan	ECN Petten
	Klaas A Duijves	ECN Petten
	Gin-Lay Tjoa	ECN Petten
<b>United Kingdom</b>	Huw Gwilym Morgan	AEA Technology
	Martyn Selby Stucke	AEA Technology
	Martin Thornley	Magnox Electric