European Working Group

« Hot Laboratories and Remote Handling »

Proceedings of the plenary meeting 2003, held in Saclay September 22-24

Hosted by Nuclear Energy Division and National Institute for Nuclear Science and Technology

Saclay Nuclear Research Centre

http://www-instn.cea.fr/

1. Introduction

With a tradition of 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 scale. 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…
- 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.

This meeting has been regularly held in different countries since the early sixties:

Year	Date	Place	Number
1963	May 7-8, 1963	Cadarache, France	
1964	May 14-15, 1964	Ispra, Italy	Meeting 7
	October 29, 1964	Petten, Netherlands	Meeting 8
1965	October 21, 1965	Jülich, Germany	Meeting 9
1966	September 22-23, 1966	Casaccia, Italy	Meeting 10
1967	September 21-22, 1967	Karlsruhe, Germany	Meeting 11
1970	May 25-26, 1970	Cadarache, France	Meeting 12
1971	June 24-25, 1971	Jülich, Germany	Meeting 13
1972	June 08-09, 1972	Petten, Netherlands	Meeting 14
1973	June 14-15, 1973	Geesthacht, Germany	Meeting 15
1974	September 18-19, 1974	Winfrith, England	Meeting 16
1976	May 25-26, 1976	Casaccia, Italy	Meeting 18
1979	June 19-20, 1979	Risø, Denmark	Meeting 19
1981	May 21-22, 1981	Karlsruhe, Germany	Meeting 20
1982	June 10-11, 1982	Mol, Belgium	Meeting 21
1983	June 08-10, 1983	Petten, Netherlands	Meeting 22
1984	June 13-15, 1984	Harwell, England	Meeting 23
1985	June 26-28, 1985	Cadarache, France	Meeting 24
1986	May 21-22, 1986	Brasimone, Italy	Meeting 25
1987	September 23-24, 1987	Ispra, Italy	Meeting 26
1988	September 28-29, 1988	Jülich, Germany	Meeting 27
1989	September 27-28, 1989	Karlsruhe, Germany	Meeting 28
1990	June 12-13, 1990	Risø, Denmark	Meeting 29
1991	June 25-26, 1991	Barnwood, England	Meeting 30
1992	June 24-25, 1992	Suze-la-Rousse (Marcoule), France	Meeting 31
1993	June 15-16, 1993	Chinon, France	Meeting 32
1994	June 14-15, 1994	Mol, Belgium	Meeting 33
1996	May 14-15, 1996	Petten, Netherlands	Meeting 34

1997	June 5-6, 1997	Studsvik, Sweden	Meeting 35
1998	September 21-23, 1998	Windscale, England	Meeting 36
1999	October 13-15, 1999	Karlsruhe, Germany	Meeting 37
2000	September 27-29, 2000	Villingen, Switzerland	Meeting 38
2001	October 22-24, 2001	Madrid, Spain	Meeting 39
2002	September 25-27, 2002	Mol, Belgium	Meeting 40
2003	September 22-24, 2003	Saclay, France	Meeting 41

The Saclay meeting was divided in three topical oral sessions covering:

- Post irradiation examination: new analysis methods & methodologies, small specimen technology, programmes and results;
- Hot laboratory infrastructure: decommissioning, refurbishment, waste, safety, nuclear transports;
- Prospective research on materials for future applications: innovative fuels (Generation IV, HTR, transmutation, ADS…), spallation source materials, candidate materials for fusion reactors…

A poster session was opened to transport companies and laboratory suppliers.

A fourth session included a technical visit to hot laboratories and Osiris reactor of CEA Saclay.

2. Organisation of the Meeting

The technical programme of the meeting was elaborated by the International Scientific Committee consisting of:

G. Bart	PSI, Villigen, CH
J.Y. 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

Practical organisation was in charge of: L. Sannen (Chairman), J.-Y. Blanc (Co-chairman), C. Verdeau (member), S. Bosonnet (Secretary), M. Cottin (Secretary).

The 41st plenary meeting was held in CEA Saclay from September 22nd to 24th, 2003 in the premises and with the technical support of the INSTN (National Institute for Nuclear Science and Technology). The Nuclear Energy Division of CEA sponsored it.

It should be mentioned that this European Working Group has launched a proposal for a Coordinated Action inside the Sixth European Framework Programme, called “HOTLAB”, currently under negotiation.

The next meeting is foreseen to be hosted by IFE hot laboratory, Kjeller, Norway, around September 2004 (to be confirmed).

3. Summaries of the sessions

Session 1: Post Irradiation Examinations
Chairmen: G.BART (PSI, Switzerland) & L. Desgranges (CEA Cadarache, France)

A clear general trend in PIE consists in applying more and more sophisticated instrumental methods both for solid state and surface analysis as well as for wet chemical assays. Obviously such instrumental techniques have normally been introduced and applied successfully in non nuclear material research areas and have only to be adjusted for remote control and hot cell or glove box applications.

Out of 12 papers (including 1 poster) 7 dealt with surface and solid state micro analysis, another one with an equally complex wet chemical instrumental analytical technique, namely inductively coupled plasma mass spectroscopy (ICPMS) for isotope concentration measurements in conjunction with an in line chemical sample separation by high performance liquid chromatography (HPLC). Now back to the solid state methods. Today several institutes have shielded and operate a secondary ion mass spectrosmeter (SIMS) instrument both for structural material characterization (e.g. boron burn up or lithium profiling in fuel cladding) as well as for fuel analysis. As actinide isotopes under irradiation or fission become activated, SIMS is a powerful tool to characterize the allocations and concentrations of built up fission products and bred higher z number actinide isotopes. The fact that SIMS can be applied also in depth profiling is very helpful in assessing e.g. rim pores containing fission gases in highly burnt fuel samples.

But new results have also been presented applying scanning electron microscopy (SEM), electron probe microanalysis (EPMA) and transmission electron microscopy (TEM) indicating the ongoing strong interest in these standard tools.To underline the trend in instrumental solid state analysis a focused ion beam (FIB) dual beam technique has been presented to combine both, very tiny and accurate sample preparation (reducing waste problems and operator time) and simultaneous instrumental microstructural (STEM, SIMS) sample characterization options. Two other instrumental techniques dealt with hydrogen analysis in zirconium base alloys and zircone corrosion layers by elastic recoil detection (ERDA) with a nuclear microprobe (applying protons and helium as primary ions) and helium analysis by hot gas extraction and subsequent gas mass spectroscopy. Last but not least the mentioned HPLC-ICPMS paper showed that instrumental analysis does as well replace tedious, lengthy sample separation steps and liquid waste arisings and provides highly accurate and reproducible fuel burn up results in very short time.

The other four papers (including the poster) presented new concepts for digital x ray image analysis (needed e.g. to characterize the quality of tube weldings) and planned or realized equipment for studying environmental degradation aspects of LWR structural materials, be it by improving the reactor pressure vessel embrittlement assessment by fracture toughness testing with miniature refabricated subsized compact tension specimens and applying the master curve concept or by setting up corrosion loops and reference electrodes i.e. a hotcell operable high temperature Ag-AgCl or pH electrode to measure the corrosion potential in fracture growth studies under specified water chemistry and mechanical loads.

Altogether it was exciting to hear from many new tools being introduced and applied to characterize highly radioactive samples under shielded or in boxed conditions.

Session2: Hot laboratory infrastructure (including waste theme).
Chairwomen: B.C. oberländer (IFE, Norway) & M. Ranchoux (CEA-Marcoule, France)

This session could be as a matter of fact divided in two parts :

- First, a mutual share of real examples about the "life" in hot laboratories : waste management, decommissioning and release, safety,
- Second, a presentation of tools or facilities dealing with PIE or defueling.

Special radwaste management was presented by :

- ISPRA, for heavy water

ISPRA site was confronted to a very special problem with a great volume of heavy water. Since 1985, ISPRA was trying to get rid of those liquids. It was only in 2000 that the decision, and a contract, was made with a Canadian company to package then send the heavy water. First, characterizations had to be made in order to respond to the strong specifications of the Canadian company. A surprising measure of TOC was obtained. Efficient studies were made to discover the product responsible for that value. Acetone was identified, and therefore, a special but very simple and practical purification process was settled with success. Questions were asked about the use of heavy water, and the release of 3H, which always stays under the safety specifications during the operation.

- IFE Kjeller, for old stored steel waste

IFE Kjeller site reported an interesting experience about old radwaste. Solid and metallic waste were stored for 25 years in pits and baskets. The purpose of the operation was to expertise and characterize the waste, to repack them and to store them again in a special device ready for the interim Norwegian storage facility (low and medium radioactive waste).The very beginning of this operation was in 1997 and the first campaign was held in 2001. The last one is planned during 2004. A small but efficient team managed to do the work without any trouble. Questions were asked about the detection limit used in gamma spectrometry and about the assurance that no fuel was allowed to be stored.

- FZ Jülich presented an example of decommissioning and re-opening of hot laboratories.

A poster was also available for discussions. Great hot cells were operating during the 60's till the end of the 90's (PIE, R&D studies for HTR, …). Decision was taken for decommissioning in order to reduce the nuclear areas and to propose new nuclear facilities and tools in regard of the actual R&D programs. Decommissioning led to develop new measurement device, for lead bricks for example, and operations and implementation were made in order to minimize the volume of radwaste. Indeed, a very high percent of the waste removes were radwaste. A lot of questions were asked about the release of the waste and the techniques used for the dismantling of concrete.

- IFE Kjeller presented a synthesis of two questionnaires sent to European Hot Laboratories on "the fire preparedness measures in buildings with hot laboratories". This interesting exercise permitted to compare the different fire protection programs in seven European countries. It was decided that before the publication of this work, the answers were double-checked by hot labs colleagues. It was obviously clear for all of us that each hot lab has to spend money for prevent fire in hot cells and labs. A question, very interesting too, dealt with real cases of fire registered in hot cells during the past forty years: the conditions, what happened, how the fire was managed, etc. It was decided to add a special paragraph in the IFE report on these cases. It was commented that this whole study could be of interest for the international entity such as ISO, working already on fire measures in "nuclear" buildings.

The other presentations deal with tools and facilities for PIE or defueling.

- The creep test device settled in K6 LECI Hot Cells in CEA at the SACLAY site was then described. The safety authorization was obtained in last July. In this facility the effect of long term dry interim storage of spent fuel with respect to cladding creep/cladding rupture at internal pressures up to 200 bar can be studied. A predictive creep model of the irradiated cladding has to be obtained and qualified through experimental data obtained in K6 LECI. The creep testing of spent fuel cladding involves amongst other processes defuelling of the cladding and TIG welding, namely circular welding and seal welding at internal pressures up to 200 bar. A lot of technical questions were asked such as how the fuel is retreated from the samples? This is done in a chemical process. There were questions concerning the influence of the circular weld and the seal weld of pressurized rods. In the creep test realistic weak points can be tested, such as HAZ. The hoop stress / hoop strain can be measured. Creep testing at temperatures of 300 to 700°C can be done with a small axial thermal gradient on a sample length of about 100 mm. And questions concerning the creep model and if the cladding oxide is taken into account. It seems that the cladding surface oxide thickness is not taken into account in the calculation model.

- During long term dry interim storage high temperatures occurring in spent fuel may lead to recovery of the mechanical properties of the cladding materials. ITU Karlsruhe/FZ Jülich presented experimental details and results from a study on a Vicker hardness test to verify the influence of thermal treatment (up to 600°C) on fast neutron flux induced hardened cladding materials.

- CEA/VALRHO presented the two newest facilities of Atalante: high shielded process line called CBP and high shielded analysis line called CBA. Descriptions and programs of the two facilities were detailed, and especially the dissolution in CBP of 15 kg of spent nuclear fuels in order to demonstrate the technological feasibility of the portioning of the minor actinides. The analytical support by CBA was presented. Questions were asked about the capacities of CBP for defueling other nuclear spent fuel like MOX fuel, carbides and nitrides.

Session 3: Prospective Research on Materials for Future Applications
Chairmen: R.Duwe (FZ-Jülich, Germany) and P. Yvon (CEA Saclay, France)

Session 3 comprised four presentations concerning the development of future gas cooled reactors and the materials research for nuclear fusion plants.

- E.H. Toscano (European Commission, ITU-Karlsruhe,Germany) described a new facility to measure the fission product inventory of an irradiated spherical HTR (High Temperature Reactor) fuel element by gamma spectrometry. The activity of Cs-137 is used to calculate the burn-up of the irradiated fuel. A specially designed collimator is positioned in the cell wall to reduce the irradiation intensity to a level, which is compatible to the gamma detector electronics. In the frame of safety investigations, the facility is also used to measure the release of Cs-137 after a high heating test of a fuel element (1800°C for several hours).

- V. Basini (CEA Cadarache, France) presented results of HTR fuel development and innovative elaboration processes of fuel particles. The investigation of new microstructural characterization methods and devices to determine different thermo mechanical properties was described.

- M. Rödig (FZJ, Jülich, Germany) reported on post irradiation experiments on plasma facing materials and miniaturized components for the next step fusion device ITER. Samples made from tungsten alloys and carbon reinforced carbon (CFC) were irradiated up to 0.2 and 1 dpa in the High Flux Reactor in Petten. Experiments concerned simulations of normal and abnormal operational conditions by means of a high power electron beam, thermal conductivity measurements and mechanical testing.

- J. P. Coad of (EFDA-JET, Abingdon, U.K.) gave an overview on the tritium related technology programs at JET. The fuel for next step fusion machines (e.g. ITER) and commercial fusion reactors will be a mixture of tritium and deuterium. Tritium is also used in the JET tokamak, and hence it can be used to study the technological problems associated with tritium. These activities concern programs in the areas of waste management and safety, tritium recovery, tritium analysis and accounting, as well as the testing of model components.

PROGRAMME

September 22, 2003

10h30 Registration

11h45 Lunch

Session 1: Post Irradiation Examinations

Chairmen: G. Bart (PSI, Switzerland) & L. Desgranges (CEA Cadarache, France)

13h15 Welcome

13h30 SEM and EPMA Analysis of Unusual Hydride Structure in In-pile Cracked Zircaloy Cladding
R. Brutsch, R. Restani, D. Gavillet (PSI Villingen, Switzerland)
G. Lederberger (Kernkraftwerk Leibstadt AG, Leibstadt, Switzerland)

14h00 SIMS – An Effective Addition to the Traditional SEM and EPMA Methods for Examination of Irradiated Oxide Fuel
Yu.D. Goncharenko, L.A. Evseev, V.A. Kazakov, F.N. Kryukov (SSC RIAR Dimitrovgrad, Russia)

14h30 One Year of Operation of the Shielded SIMS with Irradiated Materials in the LECA Facility
L. Desgranges, B. Pasquet (CEA Cadarache, France)

15h00 High Resolution Transmission Electron Microscopy: Fables, Facts & Figures
W. Van Renterghem,M. Verwerft (SCK-CEN Mol, Belgium)

15h30 Coffee Break

16h00 Characterisation of Nuclear Fuel Samples by Quadrupole and Multicollector Inductively Coupled Plasma Mass Spectrometry
B. Wernli, I. Günther-Leopold, J. Kobler Waldis, Z. Kopajtic (PSI, Switzerland)

16h30 Determination of Helium Content in Irradiated Structural Materials by Mass Spectrometric Method
S.V. Belozerov (SSC RIAR Dimitrovgrad, Russia)

17h00 Feasibility Study of On-line Digital X-ray Imaging for Irradiated Fuel Rods
Y. Parthoens, V. Smolders, A. Gys (SCK-CEN Mol & Katholieke Hogeschool Kempen, Belgium)

17h30 Use of Elastic Recoil Detection Analysis for Hydrogen Content Mapping on Irradiated Zr Alloys
P. Bossis, F. Couvreur, D. Boutard (CEA and Lab. Pierre Süe, Saclay, France)

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Session 1: Post Irradiation Examinations (continued)

08H30 **Focused Ion Beam Technology Offers New Potential for Rapid Analysis of Hot Samples**
J-J Dupuy, L. Peto (FEI Company)

08h55 **Machining and Fracture Toughness Testing of Miniature Compact Tension Specimens in Hot Cell**
J.-L. Puzzolante, M. Scibetta (SCK-CEN Mol, Belgium)

09h20 **High Temperature Electrochemical Corrosion Testing in a Hot Cell Environment: Problems and Pitfalls**
R.-W. Bosch, S. Van Dyck (SCK-CEN Mol, Belgium)

***And presented as a poster during this session*:**
Design and Installation of an Autoclave Recirculation Loop at the LECI Laboratory
Ph. Bossis, F. Gomez, P. Plantevin, D. Hyvert, C. Chéron (CEA-Saclay, France)

Session 2: Hot laboratory infrastructure (including waste theme)

Chairwomen: B. C. Oberländer (IFE, Norway) & M. Ranchoux (CEA-Marcoule, France)

09h45 **The System for the Collection, Purification and Re-drumming of the Heavy Water at the JRC Ispra: Design, Operation and Implementations**
R. Covini, S. Bertelli, G. Bielli (JRC Ispra, Italy)
M. Mariani, F. Maluta, M. Giola (CeSNEF, Politecnico di Milano, Italy)

10h10 *Coffee Break*

10h30 **Identification and Removal of Organic Pollutants from JRC-Ispra Heavy Water: Lab-tests for the Design of On-Site Purification Process**
M. Mariani, F. Maluta, M. Giola (CeSNEF, Politecnico di Milano, Italy)
R. Covini, S. Bertelli, G. Bielli (JRC Ispra, Italy)

11h00 **Decommissioning and Re-opening of the Hot Materials Laboratory in Forschungszentrum Jülich**
R. Duwe, W. Kühnlein, M. Rödig, D. Bensch, H.J. Bücker (FZ Jülich, Germany)

11h30 **Fire Preparedness Measures in Buildings with Hot Laboratories**
B. C. Oberländer (IFE Kjeller, Norway)

12h00 **Inventory of Dry Stored Steel Waste after 25 Years**
H.-J. Kleemann, M. Sobieska, B. C. Oberländer (IFE Kjeller, Norway)

12h30 *Lunch*

14h15 **Visit to the LECI hot lab and Osiris reactor**

20h00 **Conference Dinner:** Cruise on the Seine river on board “Le Capitaine Fracasse”

September 24, 2003

Session 2: Hot laboratory infrastructure (continued)

08h30 **Long Term under Internal Pressure Creep Test Device in K6 LECI Hot Cell**
C. Cappelaere, G.M. Decroix, O. Howald, P. Duigou, L. Moitrelle (CEA Saclay, France)

09h00 **Influence of the Thermal Treatment on the Hardness of Highly Irradiated Cladding Samples**
E. Toscano (TUI Karlsruhe, Germany), W. Goll (Framatome-ANP Erlangen, Germany)

09h30 **CEA Atalante: High Level Process Shielded Line and High Level Analysis Shielded Line**
M. Ranchoux (CEA Marcoule, France)

10h00 *Coffee Break*

Session 3: Prospective Research on Materials for Future Applications

Chairmen: R. Duwe (FZ Jülich, Germany) & P. Yvon (CEA Saclay, France)

10h30 **Development of a Collimator for Gamma Measurements of Spherical Fuel Elements**
M. Betti (TUI Karlsruhe, Germany), W. Kühnlein (FZ Jülich, Germany), E. Toscano (TUI Karlsruhe, Germany),

11h00 **New Techniques Dedicated to the Characterization of Future Nuclear Fuels**
V. Basini, F. Charollais, L. Paret (CEA Cadarache, France)

11h30 **Post-Irradiation Testing of Materials for High Heat Flux Components of ITER**
M. Rödig, W. Kühnlein, J. Linke (FZ Jülich, Germany)

12h00 **Tritium-related Fusion Technology Programmes under EFDA-JET**
J.-P. Coad, S. Ciattaglia, R. Lässer, G. Piazza (UKAEA & EFDA UK, FzK Germany)

12h30 *Lunch*