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Conclusions and recommendations from the 4th European ISOE Workshop on Occupational Exposure Management at Nuclear Power Plants

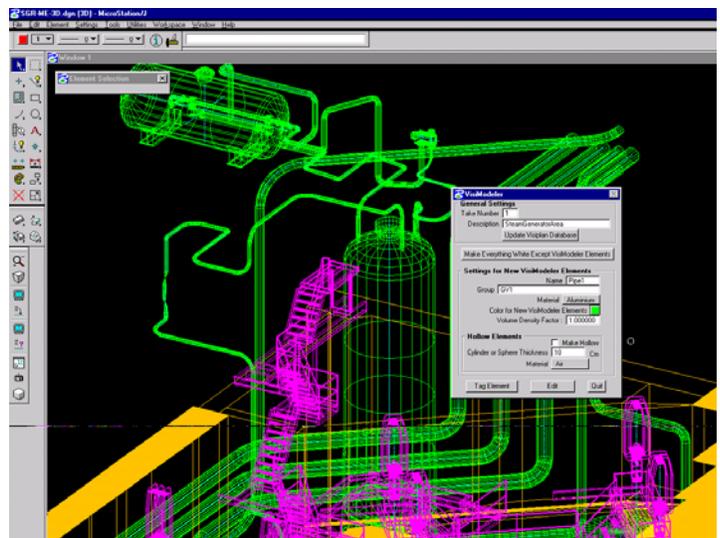
The European ISOE Technical Centre co-organised with the International Atomic Energy Agency the 4th Workshop on Occupational Exposure at Nuclear Power Plants in March 2004, at Lyon, France. Almost 200 participants from 26 countries, European (all countries from western and central Europe with nuclear power plants) American (Canada and United States) and Asian (China, Japan, Korea) attended the meeting with a good balance between utilities, regulatory bodies and contractors. The IAEA supported participants from Central and Eastern European countries as well as from Eastern Asia. There were 35 oral presentations and 28 posters. A very informative exhibition was held by vendors and allowed participants to know more about their products during the coffee-breaks.

Distinguished presentations

Three technical presentations were awarded and invited to make their presentation in 2005 at the Miami ISOE North American International ALARA Symposium. These papers were dealing with both technical and managerial problems and proposed very practical solutions:

- “Advantages of combining gamma scanning techniques and 3D dose simulation in dose optimisation problems”, F. Vermeersch, SCK•CEN Mol, Belgium

Presented was a method of combining results from gamma scanning equipment with a 3D dose simulation tool with the aim to achieving a reliable dose characterisation of the work site. This method uses VISIPLAN software (the right figure) providing the ALARA analyst with a tool that allows a fast dose assessment for work planned in a radioactive environment. The calculations are based on a 3D model of the work place.



- “Recent International Developments on Contamination Limits on Packages”, J. Hesse, RWE Power, Germany / B. Lorenz, GNS, Germany

The results of the model are presented in Bq/cm² corresponding for each nuclide to dose constraints of 2mSv/year for the workers and 0.3 mSv/year for the public (IAEA Co-ordinated Research Project on the Radiological Aspects of Package and Conveyance of Non-Fixed Contamination).

- "ALARA versus Reactor Safety concern - a practical case", S. Hennigor, B. Ögren, Forsmark NPP, Sweden.

This presentation is a very practical one describing the modification of the moist separator (upper part of the steam dryer) at Forsmark BWR that took place in 2003 due to cracks.

The success of this Workshop is largely due to the important organisational support from EDF in particular in providing the translation from English to French and French to English, while FRAMATOME and COGEMA Logistics provided the other translations from German and Spanish to English.



Working groups recommendations

All participants were split into small groups devoted to 10 pre-selected themes. Each group met twice and reached recommendations. Five main recommendations were agreed on by the participants:

- There is a need for harmonising regulations in order to maintain a high status of radiological protection at an international level in a deregulated context;
- The regulatory bodies should also harmonise the contents of training, particularly in the context of workforce ageing;
- The international organisations and regulatory bodies should take the lead to harmonise at the international level a dose passport for itinerant workers;
- Radiological protection indicators should be selected to help in optimising doses, provide indication for continuous improvement, estimate the effectiveness of radiological protection departments, provide means for benchmarking, create consistency between sites;
- The radiological protection teams should increase their assistance "patrols" at workplaces.

Next European Workshop in 2006

The next European ISOE Workshop will take place in Essen (Germany) from the 13th to 19th March 2006. It will be preceded, on the 12th of March by a day for the NPPs radiological protection managers and a day for the regulatory bodies senior representatives. The workshop will allow visiting one NPP and a mine.

International Commission on Radiological Protection (ICRP)

A next set of fundamental ICRP Recommendations, intended to replace the 1990 Recommendations in ICRP Publication 1990 is being prepared. This work has been in progress for several years. A number of iterations of conceptual ideas for these Recommendations have been presented, and ICRP has received many useful comments on these concepts and also some helpful input through ISOE and IAEA/NEA. Based on those discussions, the Commission now presents a draft text of 2005 ICRP Recommendations for consultation at the following web address: www.icrp.org.

Commonality in EDF Nuclear Power Plants

Presented at Lyon Workshop by Yves GARCIER M.D, Vice President Radiation Protection, EDF – Nuclear Power Plants Operations Division

Electricité de France is State owned company with 120 000 workers. It has 6 branches and 25 divisions. Nuclear Power Plant Operations Divisions generates 80% of the electricity in France. There are 58 PWR units at 20 plant sites. EDF has 20 000 employees and 20 000 contractors.

Radiation Protection in EDF

RP has been included in the EDF nuclear program since the design phase. In the last decade an increase in radiation exposure was observed since 1991 due to increase of maintenance activities and non-destructive examination programme. At the same time, RP standards were in the process of being revised.



To address this issue the ALARA approach was adopted in 1991 to reduce radiation exposures. EDF initiative started in 1999 was « *cleanliness programme as an integral part of radiation protection* » and a new management approach was implemented for the radiation protection. Radiation protection granted same priority as nuclear safety. Now, this guarantee radiological cleanliness, quest for perfection and ongoing progress.

In the new organizational structure of EDF there are three upper management levels for RP at corporate level: Corporate Operating Review Committee, Operational branches and at the Plants is one Associate RP Director per Site who manages ALARA initiatives.

Utility Wide ALARA initiatives and RP Policy

ALARA initiatives for past 10 Years were: Co-ordination of experience feedback by means of high-performance radiation exposure database codes; and optimized dose reduction related to craftsmen working on 11 repetitive jobs accounting for 80% of total outage dose intake.

Source term management was improved following requirements and recommendations for shutdown for oxygenation and purification of coolant system and increase in pH to 7.2 during cycle. Preventive and remedial actions were taken with regard to hot spots.

ALARA Strategic Projects are :

- Dose assessment during operations, as well as optimization
- Renewed usage of craft networks for exchange of good practices between sites and dissemination of experience feedback
- Reduction of average and exceptional source term (Hot spots and contamination events, depleted zinc injection)
- Susceptible work-force management

RP Policy

There are three RP related groups within EDF: Radiation Protection Council, Radiation Protection Department and Inspector General for Nuclear Safety and RP. The main strategy of these groups is to enhance the skills, monitoring, and engineering support by RP engineering structure.

The main RP goals are:

- Collective radiation exposure levels should be reduced by 10 % per year (i.e. 0.85 manSv/unit/yr. in 2004).
- Individual radiation exposure levels: Less than 2 workers above 18 mSv/yr.
- Spent fuel shipments: Zero fuel cask contamination.

EPRI Radiation Exposure Management Program Highlights

Following Dennis Hussey presentation at ISOE Workshop in Lyon (dhussey@epri.com, Electric Power Research Institute, USA)

EPRI Experiences In Field Control show that the easiest way to get radiation control technology implemented is to identify another high profile benefit of the technique, for example mitigation of materials or fuels issues. Win-win situations help in implementation of new techniques. It may still be an uphill task, but perhaps not quite such a steep hill for the RP Manager.

PWR Zinc Addition Program

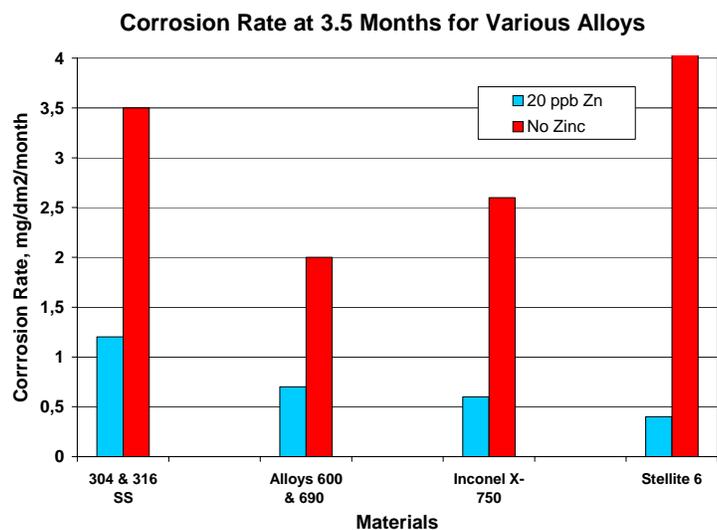
Zinc injection is already used at most BWRs to control radiation fields. The objective of the PWR program was:

- To evaluate the long term effect of zinc addition in mitigating Alloy 600 corrosion crackings and radiation fields
- To ensure that zinc does not have an adverse effect on fuel performance and other components

Natural zinc addition demonstrations were conducted at Farley-2 and Diablo Canyon-2. Palisades and European plants use depleted zinc to reduce radiation fields.

For example, Diablo Canyon-2 results presented after two refuelling cycles (R10) show decrease in average dose rate inside steam generator (SG) channel head - from 133 to 55 mSv/h.

General effect of zinc on corrosion rates is showed in the Figure for various alloys in case of 20 ppb zinc concentration in comparison to no zinc addition.



Conclusions on zinc are:

- PWRs Farley, Diablo Canyon and Palisades show significant reductions in PWR shutdown radiation fields with zinc additions
- No adverse effects of zinc additions observed on Zircaloy (or ZIRLO) fuel cladding corrosion
- There is only a need to resolve potential issues associated with zinc injection on fuel performance in high duty plants
- Latest EPRI Primary Water Chemistry Guidelines (Revision 5 September 2003) recommend that PWRs should consider implementing 5-10 ppb zinc to reduce radiation buildup

Briefing on BWR Chemistry Topics

Current Status about the Effect of Noble Metal Chemical Addition (NMCA) on Out-of-Core Radiation Fields is:

- NMCA effectiveness is high but there is a need for higher hydrogen availability. Crud on the fuel restructures from hematite to magnetite, releasing cobalt Co-60 (insoluble and soluble cobalt is increased in reactor water). The restructuring occurs quickly after the introduction of hydrogen, and much time is required to return the dose rates to initial levels.
- It is necessary to introduce a limit on amount of NM deposited on fuel to alleviate concerns of the highly reducing environment creating adherent crud that may impact the thermal performance of the fuel.

- Fuel concerns are related to adherent crud and potential spallation issues . Deposition on out-of-core surfaces increases (the effect is important at high cobalt plants). It is mitigated by zinc. Limits on feed water zinc injection rates should be in use. Radiation dose rates are controlled by maintaining the soluble reactor water Co-60/zinc ratio to less than $2,0E-5$. High feed water (FW) iron increases the effect of collecting crud on the fuel and reduces the effectiveness of zinc. It is required to reduce FW iron input to mitigate fuel/radiation issues.
- Future developments are focused at ultrasonic (UT) fuel cleaning.
- All the above becomes more complicated for plants that add hydrogen and/or zinc after NMCA

Recent Developments in Ultrasonic Fuel Cleaning

Ultrasonic fuel cleaning is a new technique designed to remove crud from fuel cladding surfaces. Fuel assemblies are cleaned one at a time in the fuel pool during refueling outages within a few minutes. There is a little or no impact on critical path of the refueling. Crud is collected on filters in containers in fuel pool. This method was already used on 4 PWRs, and the first BWR application is planned for 2004.

Original objective was to reduce local neutron flux depression in PWRs, but significant dose rate benefits were also observed. The BWR application will mitigate dose rate increase following noble metal application.

Feasibility studies were completed with Exelon, NMP and TVA. The method was qualified for BWR use. It was applied on 16 fuel assemblies at Quad Cities BWR, in March, 2004. The corrosion products were collected on 4 filter cartridges (~8 Gy/hour).



Potential benefits are:

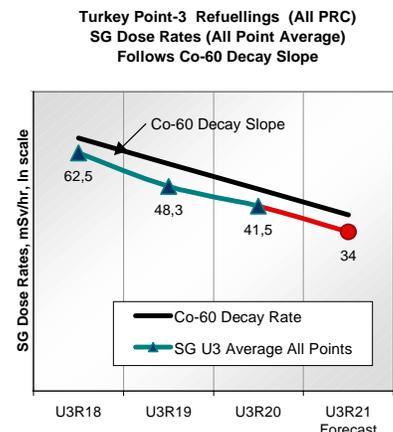
- Reduced radiation buildup on out-of-core surfaces
- Mitigating fuel concerns by removal of crud
- Reduce loading of noble metals on fuel, increasing the relative proportion of NM on the internals

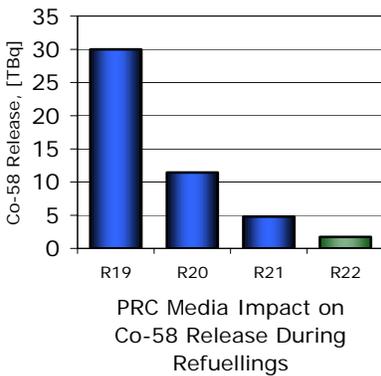
Recent Source Term Reduction Solution

New technology option for reducing plant source term and outage exposure with the demonstrated operating experiences of five USA PWRs has been reported by David Miller, David Kozin, D.C. Cook plant, and Patricia Robinson, (n,p) Energy, Inc (NPE) - radwasted@aol.com. The five plants have reduced radiation exposure up to 50% and reduced refuelling outage critical path up to 24 hours.

Florida Power & Light (FPL) has forged new opportunities to excel the economic operation of nuclear power reactors while achieving substantial reductions in worker radiation exposure during refuelling operations. The focus has been on technology exclusively licensed from Los Alamos National Laboratory.

The result was an engineered solution enabled by the capability of a new technology, product PRC-01 media, which performs two purification functions simultaneously; capture and removal of extremely small particles < 0.1 microns in size, and an ion exchange media. The research and development was driven by unpredictable outage RCS clean-up time, deposition of radioactive crud, high dose rates, high contamination levels with hot particles, and delay of the refuelling outage critical path time.





It is enough to use existing plant equipment – chemical and volume control system demineralizer vessel. This solution has enabled the successful acceleration of the reactor shutdown sequence prior to refuelling, greatly improved radiological work conditions including reduction in outage worker radiation exposure, reduction in critical path time at FPL nuclear units, substantially reduced contamination levels, reduced steam generator dose rates, reduce low radioactive waste costs, improved fuel performance, all combining to reduce overall outage costs. Some of the data presented is the trend showing a substantial decline in the total cobalt Co-58 activity released from the core during forced oxygenation of RCS, and the SG dose rates declining exactly to the Co-60 decay rate.

The conclusion is that successfully reduced source term can be achieved, in this case without the use of zinc injection, chemical cleaning or fuel decontamination. The chemistry strategies applied were:

- Strict control on pH during cycle
- Decrease pH at the end of cycle and shutdown
- Solutions and capability of PRC-01 technology owned by NPE Inc.

CRPPH

COMMITTEE ON RADIATION PROTECTION AND PUBLIC HEALTH (CRPPH) at Nuclear Energy Agency (OECD) was held in Paris, March 2004, chaired by Rick Jones. Some of the highlights from the Report on General Activities of the OECD and the NEA are:

- NEA Steering Committee encouraged the CRPPH to continue its dialogue with the ICRP.
- The new draft NEA Strategic Plan demonstrates the increased level of interest that member countries currently have in radiological protection, raising RP to the Agency's third priority behind Nuclear Safety and Waste Management.

Some of the ongoing CRPPH Projects are:

- Working Party on Nuclear Emergency Matters (INEX)
- Information System on Occupational Exposure (ISOE)
- Expert Group on the Regulatory Application of Authorisation (EGRA)
- Expert Group on the Implications of ICRP Recommendations (EGIR)
- Expert Group on the Evolution of the System of Radiological Protection (EGRP)
- Expert Group on the Process of Stakeholder Involvement in Radiation Protection Decision-Making (EGPSI)
- Other Work of the CRPPH: Decommissioning, Collaboration with the OECD, Chernobyl

It should also be noted that two new Expert Groups were discussed and created as a result of Topical Session discussions. These are:

- Expert Group on the CRPPH Collective Opinion (EGCO)
- Expert Group on the Implications of Radiological Protection Science (EGIS)

With new ICRP recommendations being prepared, with the new NEA Strategic Plan being developed, and with the success that the CRPPH has had addressing the issues before, the CRPPH had chosen an appropriate moment to discuss future challenges. These challenges are related to the Implications of radiological protection science, interactions with the ICRP and Chernobyl 20 years anniversary.