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NUCLEAR ENERGY AGENCY
NUCLEAR SCIENCE COMMITTEE

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Working Party on Nuclear Criticality Safety

The Sixteenth Meeting of the Working Party of Nuclear Criticality Safety

Summary Record

21 September 2012
NEA Headquarters
Issy-les-Moulineaux

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ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

Nuclear Energy Agency
Nuclear Science Committee
Working Party on Nuclear Criticality Safety

THE SIXTEENTH MEETING OF THE WORKING PARTY ON NUCLEAR CRITICALITY SAFETY

21 September 2012

NEA Headquarters, Issy-les-Moulineaux, France

SUMMARY RECORD

1. Introduction & Welcome

The new WPNCS chair, Ms. Michaele Brady-Raap (USA) presided over the meeting. **Brady-Raap** opened the meeting and welcomed the participants; those present briefly introduced themselves. Ten countries were officially represented by their delegates, with some observers present (see participant list in annex).

2. Review of actions from previous meeting

All actions from past meeting were reviewed (see summary record of previous WPNCS September 2011 meeting). There were no outstanding actions.

3. Approval of the summary records and agenda

The summary records of the past meeting (link or reference here) were approved with minor editorial modifications. Upon request, a short presentation to be made by Kent Wood (USNRC, USA) on potential scenarios of re-criticality after degradation of neutron absorbers in spent fuel pools in a case of loss of cooling accident was accepted and scheduled at the end of the meeting.

4. Feedback from the Nuclear Science Committee meeting

Gulliford briefly presented highlights of the last NSC meeting of June 2012**,** mentioning responses to the Fukushima accident continue and forthcoming activities will include a policy debate on defence-in-depth as well as initiatives in the area of education and training. **Gulliford** also reported on NEA increasing engagement with China and India, and on Russia's confirmed accession to the NEA on January 1st 2013. A memo of understanding between the NEA and China has been drafted. Engagement with India continues in certain areas of NEA activity, including that of the NSC Working Party on Nuclear Criticality Safety.

5. Nuclear Criticality Safety National Programmes and other International Organisations Activities

Before the meeting, delegates were kindly requested by the Secretariat to submit a written country report providing an overview of criticality safety related programmes or issues to report from their

home countries. Some delegates provided an oral report only and were requested to submit it in written form after the meeting.

Germany Report (Neuber, Bock)

Overview of National Context

After the Fukushima accident, Germany has decided to phase out nuclear energy production. The nuclear power plants currently in operation will be shut down until 2022. The concentration is thus on the installation of a final repository for the high activated waste. Therefore, a site has to be identified that will host the final repository. From criticality safety point of view, the risk of criticality has to be excluded both during operation and in the post closure phase of the final repository for the whole reference period of one million years after closure.

A preliminary safety case study for a potential final repository at the Gorleben site is near completion. The project includes amongst others scenarios a criticality safety analysis, with the aim to exclude criticality during the reference period of 1 million years. The main result is that for LWR fuel criticality can be excluded if the neutron absorption cross section of the isotope ^{35}Cl is taken into account. However, this analysis relies on the feasibility of the validation of this cross section. Since there is only an insufficient number of critical experiments that contain chlorine available, this validation analysis is challenging and has to be supplemented by extensive sensitivity and uncertainty studies. Critical experiments that contain chlorine for example as a brine solution are highly recommended therefore.
In the future, the criticality safety analysis of a final repository will be one of the main challenges, once a site has been identified. If the selected site is a salt stock, the preliminary safety case study of the Gorleben site will be very valuable. In a different kind of host rock, different measures to ensure subcriticality have to be provided.

The phase out and programmed shut down of nuclear power plants will lead to fuel assemblies that have to be removed from the reactor core and put into storage and transport casks. Some of those fuel assemblies feature quite high initial enrichment but due to short irradiation time only a very small burn up. Thus, the licensing of new storage and transport casks, probably taking into account burn up credit, might become of interest within the near future.

Code development

On other R&D programmes, GRS has started the development of an improved version of its burn up code KENOREST. As a key feature it will contain an advanced inventory code. One main goal is to improve the capabilities with respect to irradiated BWR fuels, including validation as well as uncertainty and sensitivity analyses. The development of the SUnCISTT that is applied in uncertainty and sensitivity analyses in all aspects relevant in the nuclear fuel cycle (e.g. criticality safety or burn up credit) will be continued. The mid-term goal is to perform uncertainty analyses in burn up credit scenarios, also taking into account axial burn up profiles.

UK Report (O'Connor)

Overview of National Context

Following decades of decline in the nuclear industry, a UK government review of energy policy in 2006 gave the green light to a new generation of nuclear power. However, any new reactors would need to be wholly financed and built by the private sector with no direct subsidy.

There are plans to build up to 13GW of new nuclear power capacity (€50 billion), with the first reactors expected to be operational by the end of the decade. Eight sites around the UK have been identified as suitable for new nuclear power stations (Sellafield, Sizewell, Hinkley Point, Oldbury, Wylfa, Bradwell, Heysham and Hartlepool), all of which contain existing nuclear plants. Preliminary work for Hinkley Point C is currently underway. Peak construction activity was scheduled for 2014-16 but EDF Energy is currently adjusting its timetable.

Two reactor designs are being considered for UK new build: Areva's EPR (European Pressurised Reactor) (1600MW output) and Westinghouse's AP1000 (1150MW output). Both reactors have undergone a generic design assessment (GDA) by the Office for Nuclear Regulation (ONR) and have been granted interim acceptance. There are still some outstanding issues with both designs; Areva might be able to close out their issues by the end of 2012; Westinghouse do not intend to address their issues until a customer for the AP1000 has been secured.

EDF Energy, in partnership with Centrica, is proposing to build four Areva EPRs. A final investment decision is expected by the end of 2013.

Horizon Nuclear Power, a joint venture between E.ON UK and RWE npower, will not proceed now with their planned 3GW of new build capacity due to difficulties in raising finance. They are seeking a new owner for the venture. The China National Nuclear Power Corporation (CNNPC) and the China Guangdong Nuclear Power Corporation have expressed an interest.

NuGeneration, a joint venture between Iberdrola and GDF Suez, is intending to build 3.6GW of new capacity. A reactor design has not yet been selected; final decision is expected around 2015.

Although the Sellafield MOX Plant (SMP) closed last year, due to reported technical and commercial failures, the preferred policy of the Nuclear Decommissioning Agency (NDA) to deal with the UK's plutonium stocks is to convert the material into MOX for commercial light water reactors (LWR). A second MOX plant could therefore be built.

However, other options are being considered for the disposition of the plutonium. For example, there is the Enhanced CANDU 6 reactor and the American fast PRISM reactor by General Electric-Hitachi. The PRISM reactors would be built as a pair at Sellafield and would be attractive to the UK taxpayer as there would be no up-front cost. Instead a charge would be levied per kg of plutonium disposed. The NDA will consider the output of the feasibility studies currently in progress. A decision will be made at the end of the year. Licensing and operation could potentially occur within a decade.

In preparation for new nuclear build, it is anticipated that the skills capability of the UK will need to be increased.

Operating Issues (e.g. unusual occurrences to report)

During a criticality exercise at a UK nuclear site in September 2011, a minor fire occurred. However, the fire alarm could not be heard over the criticality alarm.

This incident identified the need to consider coincident emergencies. The potential conflict needs to be recognised between emergencies requiring evacuation and emergencies requiring shelter; for example criticality or fire against toxic release. Site personnel also need to understand what is an exercise and what is not, particularly on this occasion where an exercise and a real event occurred simultaneously.

Code development

The MONK neutronics code is the UK industry standard. The latest version, MONK9A, is developed by the ANSWERS software service, currently part of AMEC (used to be SERCO). The development version of MONK now includes a CAD (computer aided design) import capability. BINGO continuous energy nuclear data libraries based on JEFF3.1, ENDF/B-VII and CENDL3.1 have been produced and are being used with the MONK verification and validation test sets.

The development of a version of MONK for the parallel processing of burnup calculations is continuing. The novel parallelization method is based around the use of distributed computing elements.

The graphical visualization program, Visual Workshop, used with MONK allows the user to view their input models in 3D (with the use of 3D goggles). The program can also be used to view the location of the neutron action events that occurred in the system to produce the final value of k_{eff}.

Sellafield Ltd, previously British Nuclear Fuels Plc (BNFL), is in possession of the source code and intend to develop MONK separately to ANSWERS.

Challenges

Time and money issues are impacting on the UK nuclear industry to get involved in various international activities. We are aware that there is insufficient coverage of various OECD/NEA and ANS standards committees. There is also inadequate UK funding to appropriately support nuclear data activities such as ICSBEP. The UK Nuclear Science Forum used to monitor and interface with related international activities but is now no longer meeting, possibly due to lack of funding. There are concerns that this will impact on the UK's ability to both submit and receive information in this area.

Development activities within the field of criticality and sharing information / best practices have deteriorated over the last few years. Namely due to fragmentation of the site licensing companies, increased commercial pressures, increased focus on intellectual property rights and the closure of various industry bodies.

UK funding is needed to support various international activities and to write up old experimental data.

Another major challenge currently facing the UK nuclear industry is the criticality safety assessment of fissile wastes and the development of a strategy for packaging, long term storage, transport and ultimate disposal of fissile waste material. Traditional methods of assessing fissile wastes have resulted in pessimistically low fissile mass limits for transport packages. Several pieces of work have been performed in order to produce a consistent UK approach for the derivation of appropriate fissile waste package limits.

The aim of this is to relax some of the fissile limits while allowing an acceptable criticality safety case to be made. The benefit will be that there will be fewer package movements which will lead to a reduced conventional as well as radiological risk in addition to considerable cost savings. A risk based methodology will be used and this is likely to be a key area for capability development in criticality safety assessment in the UK over the next few years.

Approval for the GDF (Geological Disposal Facility) safety case is on-going. The operation of such a facility is still considered to be a number of decades in the future.

O'Connor asked whether NEA was willing to contribute in funding some activities to preserve currently existing experimental data in UK that have not been written up. **Gulliford** answered the NEA is willing to consider on a case by case basis the need to support such targeted activities for data to be included into one of NEA's integral databases such as IRPHE/ICSBEP/SFCOMPO

Switzerland (Vasiliev)

Overview of National Context

All 5 operating Swiss reactors (at 4 NPPs) shall be shut-down after 50 years of operation (according to the government plans) and the criticality safety for all types and stages of storage, handling and transportation of the nuclear fuel from the Swiss reactors shall be ensured.

By law, the Swiss utilities are responsible for the radiation protection of human beings and environment. The utilities should take any appropriate measures to reach this goal and report any known safety issues to the nuclear regulatory body. They should follow up and implement the recent technology and research achievements. They set up and support research programs to solve identified safety issues.

On the other side, the nuclear regulatory body (ENSI) supervises the abidance by the law. ENSI initiates research programs in case of generic safety concerns, establish regulations and provide regulatory guidance. Regarding criticality safety, only basic safety requirements are defined in several ENSI-regulations. No specific criticality safety guidance is provided by ENSI rather than a reference to international standards and guides.

There is no nuclear front-end in Switzerland. Thus, criticality safety plays a role in storage of fissile material in pools, intermediate storage facilities and research facilities, in transportation of fissile material, and in final depository. So far, no safety issues have been identified by ENSI to start a special dedicated research program on criticality safety.

It can be pointed out also that the Swiss industry supports R&D works towards establishment of a methodology for Criticality Safety Assessment including Burnup Credit, and the related studies are on-going at NAGRA (a co-operative formed by nuclear utilities and the federal government and responsible for investigations for geological disposal of radioactive wastes in Switzerland) and at PSI.

R&D Programmes, Code development

At PSI R&D works towards development and validation of an enhanced calculation methodology for criticality safety evaluations including an option of burnup credit are on-going. One of the current objectives is development of computation tools for assessment of relevant uncertainties (e.g. associated with uncertainties in the nuclear data, technological parameters, calculation methods, etc.) in routine criticality calculations with the Monte Carlo code MCNPX and general-purpose neutron data libraries. Validation of CASMO5-M against the LWR-PROTEUS Phase II experiments has been started with the calculation of isotopic inventories.

Proteus: The refurbishment project for the PROTEUS experimental reactor at PSI has been cancelled in April 2011 and the facility is currently planned for decommissioning. Also, the PROTEUS fuel has been unloaded from the reactor.

ZWILAG Zwischenlager at Wuerenlingen AG "Low and medium-level radioactive waste from Swiss nuclear power plants as well as from medicine, industry and research is processed in Zwilag. The site also provides interim storage for all types of radioactive waste and spent fuel assemblies from Swiss nuclear power plants."

Planned collaborations

Collaboration between PSI and IRSN is planned towards assessment and validation of the Monte Carlo based depletion calculations using the IRSN code VESTA, including analysis of the PIE data available at PSI. From the PSI side the codes MCNPX-2.7E and CASMO-4E are in use. (A similar collaboration was recently established with GRS (Germany) involving usage of the KENOREST code.)

Collaboration between PSI and NRG (the Netherlands) is planned on assessment of different implementations of the stochastic approach for nuclear data uncertainty propagation in criticality calculations with Monte Carlo codes. (Comment: Methodology on statistical sampling of ACE-formatted neutron cross-sections with MCNPX is under development and verification at PSI in the frame of an on-going PhD project. First results and achievements were reported at the Physor-12 conference and UAM-6 meeting. More results shall be presented at the forthcoming ND-2013 conference.)

Finland (Ranta-aho, Rantamaki)

Overview of National Context

Finland has four nuclear power reactors operated by Fortum Oyj and Teollisuuden Voima Oyj (TVO) at Loviisa and Olkiluoto, respectively, and fifth unit is under construction at Olkiluoto. The two units at Loviisa are VVER-440 type reactors (Loviisa 1 and Loviisa 2) with net electricity output of about 490 MWe and commissioned in 1977 and 1980. The two units at Olkiluoto are ASEA-Atom type BWRs (Olkiluoto 1 and Olkiluoto 2) with net electricity output of about 880 MWe and commissioned in 1978 and 1980. Currently, a 1600 MWe EPR (Olkiluoto 3) is being built at Olkiluoto and will be operated by TVO.

The Finnish Parliament ratified the Decision-in-Principle of the Finnish Government in 2010, regarding two new nuclear power units applied by TVO and Fennovoima Oy. The new units are currently in bid phase and the companies should apply for the construction permit during 2015.

Spent nuclear fuel is stored at reactor pools and intermediate wet storage facilities located in Loviisa and Olkiluoto. The intermediate storage facility at Olkiluoto is currently being enlarged with three new pools to accommodate spent fuel coming from Olkiluoto units 1, 2 and 3.

Posiva Oy, a company owned by Fortum and TVO, is responsible for the disposal of the spent nuclear fuel coming from the nuclear power plants at Loviisa and Olkiluoto. The underground disposal facility will be located in Olkiluoto. Posiva has completed the excavation of the underground research facility (ONKALO) 455 m below ground and will continue technical studies in the demonstration tunnels. Posiva will apply for the construction permit for the disposal facility during 2012 and according to present plans the disposal should begin in 2020.

Government Policies (related to Criticality Safety issues)

In 2010, the Finnish Parliament ratified the Decision-in-Principle of the Finnish Government regarding two new nuclear power units applied by TVO and Fennovoima Oy (units Olkiluoto 4 and Hanhikivi 1, respectively). TVO and Fennovoima should apply for the construction permit for the new units during 2015.

In 2010, the Finnish Parliament also ratified the Decision-in-Principle regarding the extension of the disposal facility in order to accommodate spent fuel from Olkiluoto 4. Posiva will apply for the construction permit for the final disposal facility during 2012.

The Nuclear Safety Authority, Finland (STUK) is currently revising the national regulatory guides (YVL-guides). Criticality safety requirements regarding the fuel in the reactor, storage facilities and final disposal facility will be stated in two guides, B.4 and D.3.

Industry Requirements (skills capability, training, etc.)

After the Decision-in-Principle in 2010, the Ministry of Employment and the Economy set up a working group to survey the needs for know-how in the nuclear energy sector in the long run. The conclusion of the working group was that there is an increasing need for high-grade national know-how in the power companies, research facilities and regulatory bodies. Especially the new nuclear plant projects but also the running nuclear power plants, as well as the progression of the final disposal require new experts in the field. The working group estimated that the need for workforce will increase by 38 % by the year 2025 (about 1200 employees). If one takes into account the retirement of the current staff, the need for new employees within nuclear energy sector will be about 2400 by the year 2025.

The Ministry of Employment and the Economy has initiated a four-year (2011 - 2014) national research programme SAFIR2014 on the safety of nuclear power plants (http://safir2014.vtt.fi/).

R&D Programmes

Criticality safety is included as a task in the project "Fuel research and reactor analysis" within the national research programme SAFIR2014. The main purpose of the task is to train new experts in the field. As a part of the task, a validation package for criticality calculation of VVER-440 fuel will be developed.

Within the SAFIR2014 programme a discussion group on criticality safety was started in 2011. The group consists of members from regulatory authority, power companies and research facilities in Finland. The aim of the group is to enhance the transfer of information between organisations and to identify key requirements and to provide support for research and development. In 2012, also Posiva joined the group.

Code development

A calculation package for criticality safety studies of the transport and storage systems of the Loviisa NPP has been developed at VTT Technical Research Centre of Finland. The package called LoKriTu is based on MCNP and is written using Perl scripting language. Currently it enables sensitivity studies of geometry parameters at the assembly level and the fuel composition. Future development involves extending the sensitivity studies to the pool level. Pool means here the whole transport or storage system. Also the possibility to vary the composition of some selected materials will be incorporated.

A system called MCNPLINK has been continuously developed since 2003. It is designed for criticality safety analysis of BWR and PWR fuel and is currently used for Gd credit analysis of TVO's wet storage facilities and transportation cask. The system combines CASMO-4E burnup calculation and MCNP5 criticality calculation using the depleted fuel composition and performs necessary sensitivity analysis regarding fabrication tolerances and code biases and uncertainties.

A new criticality calculation route that includes CASMO-4E burnup calculation, ORIGEN decay calculation and MCNP5 criticality calculation has been developed at TVO. It has been used for a highly detailed modelling of BWR cold critical experiments (Olkiluoto 1 and Olkiluoto 2). The aim is to generate a validation database of the reactor cold critical experiments in order to be able to carry out a combined validation of CASMO-4E/MCNP5 for criticality analysis. The same calculation system can be used for the criticality safety analysis of the final disposal canisters, where the analysis of each

canister could be done separately using the actual operating data and burnup distributions of the assemblies to be loaded.

Considerable effort has been devoted to the development of the Serpent Monte Carlo code since 2004. The work is carried out at VTT, and currently funded from the national SAFIR2014 programme, the EU-HPMC project (High-performance Monte Carlo Reactor Core Analysis), and the Academy of Finland NUMPS project (Numerical Multi-physics). Serpent is optimized for reactor physics calculations, with built-in methods for group constant generation and fuel depletion. Current development activities aim at extending the field of applications to coupled Monte Carlo / thermal-hydraulics calculations and photon transport. Serpent is distributed by the OECD / NEA Data Bank and RSICC in the U.S, and has about 200 users in 76 organizations and 27 countries around the world. Typical applications range from lattice physics and fuel cycle studies to research reactor modelling.

Experimental needs

The experimental needs are mainly related to the validation of the burnup and criticality calculation codes. The availability of high quality radiochemical assay data is a key issue for validation of the burnup calculation for burnup credit criticality safety assessment.

Fortum and VTT have participated in the ISTC 2670 project where the radiochemical analysis of the spent VVER-440 type fuel was carried out. The project objective is to provide data for validation of burnup credit application.

Two rods from ATRIUM 10B fuel assembly irradiated at Olkiluoto 1 have been experimentally characterised in Studsvik. TVO is planning radiochemical assay of several samples as a collaborative project. The aim would be to bring benefit for many application areas involving handling and disposal of spent nuclear fuel.

The criticality safety analysis of the final disposal canisters requires consideration of the evolution of the disposal facility for at least million years. During that time many processes may occur in the disposal holes where the integrity of the canisters and the fuel assemblies may be affected. Experimental characterisation of the various processes may be necessary in the future in order to select plausible scenarios to be analysed in the criticality safety assessment of the final disposal concept.

International Collaborations

Finnish representatives are participating in the OECD/NEA/WPNCS and its expert groups programme of work. The focus has been on the application of burnup credit, sensitivity and uncertainty analysis and the availability of the data for validation of the codes used in the criticality safety analysis.

Fortum and VTT are participating in work of the Atomic Energy Research (AER) community that focuses on safety and economic use of VVER type reactors. Criticality safety issues of the VVER type fuel are considered in the working group E of AER.

Finland is a member of OECD. OECD NEA Data Bank is an invaluable source of nuclear data and codes for the assessment of criticality safety.

Challenges

TVO aims at increasing the discharge burnups from the current assembly average burnup of about 45 MWd/kgU to an average burnup of about 53 MWd/kgU (with the maximum allowed burnup of 55 MWd/kgU). Due to increased enrichments the criticality safety margins to the regulatory limit decrease which calls for more detailed calculation models, improved validation and as a possible alternative, the application of burnup credit in the storage of spent fuel.

The criticality safety analysis of final disposal will require the use of burnup credit and the consideration of various factors such as the structural integrity of the canister and fuel assemblies, chemical stability of the spent fuel isotopes and analysis of various scenarios that can happen during long time frames. Depending on the level needed for burnup it may be necessary to assess applicable level of burnup credit (actinide-only, actinides+fission products, actinides+rare earth elements) and the uncertainties in various calculated variables such as burnup distributions of the fuel assemblies. It may become necessary to make a criticality analysis for each canister separately using the actual burnup distributions of the fuel assemblies to be loaded. This may require canister loading optimisation that will be affected by the shielding and decay heat requirements as well.

One key issue identified by STUK has been the criticality safety of the fuel in reactor. The focus has been on the prevention of consequences of a possible human error in fuel shuffling during the outage. Because of few incidents that have occurred in the power reactors in the world STUK may require special arrangements to ensure criticality safety in case of human error. The new regulatory guides may address the requirements for detection of approaching criticality and the prevention of criticality. These, in turn may have implications to the licensing of new reactor types in Finland.

The items discussed above require a continuous development and validation of accurate calculation codes in the reactor simulation and criticality safety analysis. Training and mentoring of new experts will be needed in order to assure that knowledge is transferred and there is sufficient competence for criticality safety assessment and independent review also in the future. International collaboration will be needed in order to make sure that the best internationally accepted practices can be applied.

Japan (Miyoshi)
Overview of National Context

Utilization of nuclear energy has been the main energy strategy of Japan from 1950's. After the severe accident occurred at the Fukushima Daiichi nuclear power station following the 2011 off the Pacific coast of Tohoku Earthquake, the public opinion is leaning toward opposition to nuclear power in Japan. From 2011, the government of Japan (GOJ) has started the reconstruction of its energy strategy. It is expected that the share of the nuclear in the total electricity supply in Japan will be decreased drastically. Industry sector opposites to decrease in the nuclear energy because it will increase the electricity cost.

Industry Requirements (skills capability, training, etc.)

Because of the severe accident at Fukushima, almost all research and development activities had been focused on the countermeasure to the Fukushima accident. Criticality safety is one of the main topics in such activities. But if the reprocessing project is stopped, direct disposal should be considered. For this idea, few ministries have plans to setup research activities on the direct disposal. In order to develop technologies for recovering Fukushima pants, JAEA has newly formed three Fukushima Project Teams in Tokai and Oarai research centers. The Fukushima Project Team and Department of Fukushima Technology Development in Tokai center will promote research on nuclear criticality safety.

R&D Programmes, Code development

There are several code development activities going on in JAEA;

- SRAC and MOSRA (deterministic neutron transport)
- MVP (Monte Carlo code for vector/parallel processor)
- SWAT (burnup codes; SRAC/MVP/MCNP + ORIGEN2.2)

- PHITS (particle transport)
- AGNES and DOCTORIN (kinetics of transient behavior)

Nuclear reactor vendors and fuel suppliers develop own neutronic codes.

After the severe accident at Fukushima, operation of the research reactors (including critical assemblies) in JAEA has been stopped. JAEA is conducting integrity inspection and seismic resistant evaluation of the research reactors. JAEA hope to start reactor operation in FY2012 to FY2013. But the schedule may change depending on revision of the safety standard.

Post irradiation examination to obtain the assay data of spent nuclear fuel had been carried out in JAEA for BWR fuel assembly during FY2010 to FY2011 under the contract with JNES. From FY2012, further PIE is planned for BWR and PWR fuels for fostering the ability to measure the isotopic composition data for Fukushima.

Criticality data for fuel debris (melted/broken fuel system) is required. JAEA has a plan to carry out mockup experiments in revised STACY. STACY in JAEA-Tokai is a tank-type, solution system critical assembly. In order to utilize it for various reactor physics experiments including the fuel debris criticality problem, STRACY will be modified and re-criticality in FY2016 is planned. For simulating the neutronic characteristics in core vessel, FCA (Fast Critical assembly) will be used to mockup fuel debris condition with solid fuel and structural material. Development of sub-criticality monitoring system during treatment of mixture of fuel and constructional material will be important for criticality safety control.

Challenges

Criticality safety data and methods for treating fuel debris in Fukushima site is our challenge. Because of Fukushima accident, direct disposal of spent fuel will be considered in future. In this case, criticality safety issue will be studied.

France (Santamarina, Ivanova)

French Context (CEA)

- ASTRID (French industrial demonstrator 600MWe of GEN-IV SFR) : preliminary design is achieved, CFV heterogeneous core characterized by negative Na void worth.

- French EPR-1600MWe at Flamanville: in the Reactor Building, vessel hole and core catcher are achieved.

- JEFF3.1.1 library is used in French neutronics codes, and within the international package ARCADIA of AREVA.

1. ***R&D Programmes in particular:***

   - MAESTRO experiment in MINERVE devoted to structural materials: on-going.
   - Burnup Credit for MOX assemblies (CRISTAL.V2/JEFF3.1.1 safety-criticality package)
   - Improvement of the RIB automated tool (assessment of calculation bias and uncertainty).
   - CEA/EDF Qualification Report R1 (V&V) of the lattice code APOLLO2.8 issued in Dec 2012.
   - New lattice+core deterministic code APOLLO3 is under development.
   - Design of EGERIE experiment in EOLE reactor dedicated to EPR neutronics.

2. International Collaborations

Collaboration with ORNL and European JEFF Group to improve nuclear data, particularly for FBRs (future JEFF3.2 library).

3. Future Challenges

- Completion of covariance matrices (Actinides & FPs) associated with JEFF3.1.1 evaluations.
- Recommendation of ICFs (Isotopic Correction Factors) and FP worth penalties in BUC MOX.
- Edition Dec-2012 of the BUC-PhaseVIII intermediate Report (Exercise 1 and 2)
- ICSBEP Evaluation in 2013 of the CERES-Minerve experiment (separated FPs oscillation).

4. Input to/from NEA/NSC Programmes of Work

- Correlations between ICSBEP experiments (ICSBEP Group, UACSA)
- Blind benchmark on Bias and bias Uncertainty (UACSA)
- LWR P.I.E measurements at the **end of each** irradiation cycle, in **various pins**, particularly in the central zone of the assembly (ADSNF) → required for nuclear data trends and for BUC applications (ICFs)

Czech Republic

Markova

As reported at EG ADSNF, the VVER PIE Consortium agreed at Seminar held in Rez, Czech Republic, in May 2012 on the **release of ISTC # 3958 PIE data without any restrictions**. The data will be filed into SFCOMPO. Despite not being in a very good agreement with the calculated ones, the data have been used for the evaluation of the k_{eff} uncertainty connected with the isotopics determination for VVER cask BUC applications. Due to spread of the measured-to-calculated data the direct difference method resulted in quite big uncertainties. We hope the explicit results and their visible impact on the design safety assessment will point out how important is to support more (and better-quality) VVER PIEs.

The four-year NRI project supported by government focusing on **the study of properties of the materials for safe disposal** of radioactive wastes, which started in 2009, is coming to completion. One of the findings is to be engaged more in the repository cask design using BUC implementation.

At request of the CEZ power company, safety analyses assessing the **possibility of the BUC implementation in the currently used CASTOR 84/M casks** are in progress **for higher enriched new VVER-440 spent fuels (up to initial enrichment of 4.9 wt.% ^{235}U)**. A plan to use a specific loading pattern decreasing criticality will be very probably applied at first. Also analyses on the **PBC implementation in pools at VVER-440 reactors related to the new fuels** are ongoing.

The **degradation of permanently installed neutron absorbers** seems to be one of the next issues under review in the Czech Republic.

Collaboration of the Czech experimentalists with ICSBEP group continues (a specific new benchmark project proposed under IRPhEP - International Reactor Physics Evaluated Experiments Project).

USA

The U.S. Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP) is chartered with maintaining the technical infrastructure necessary to ensure safe, efficient operations from a criticality safety perspective. Information regarding the NCSP and all of its projects and activities can be obtained from the NCSP website http://ncsp.llnl.gov/. Select FY2012 highlights from the five technical program elements of the NCSP follow:

- Analytical Methods – Methods development is centred at ORNL, LANL and LLNL. Both SCALE and MCNP have made wonderful advances in the Sensitivity/Uncertainty area, and SCALE is embarking on an extensive modernization program. LLNL has led valuable code comparison efforts in their PREPRO/COG work.

- Information Preservation and Dissemination – Extensive development on the NCSP website has been made in support of the NCSP Integral Experiment Requests (IERs) and the Critical/Subcritical Experiment Design (CED) process. Support of the Benchmark Experiment Project activities are also covered in this program element. The U.S. made good contributions to the May 2012 ICSBEP meeting (covered elsewhere) and the new 2012 handbook has gone into publication.

- Integral Experiments – The first critical experiment was successfully performed at the National Criticality Experiments Research Center (NCERC) on June15, 2011 using the old Lucite plates and HEU foils. Two new subcritical experiments [Pu sphere reflected with Ni and Pu sphere reflected with W] are being performed this week in Nevada. These subcritical experiments are utilizing a new detector and data collection system, and will be analyzed with a new patch in MCNP which can analyze the list mode data in a number of ways. Both experiments are expected to be documented as ICSBEP benchmarks.

- Nuclear Data – NCSP support of data evaluation and validation included new measurements at RPI, international collaboration by ORNL in measurements at IRMM (Geel) and evaluations work in the resonance region; new evaluations for the above-resonance region by LANL, and the testing and release of the ENDF/B-VII.1 files by BNL (CSEWG) in December, 2012. Among the more important advances in the new VII.1 data files are the much more extensive (than ENDF/B-VII.0) covariance data.

- Training and Education – Under the auspices of the NCSP, the U.S. has established a two-week NCS training course where students must demonstrate proficiency in NCS fundamentals to successfully complete the course. The NCS training course is comprised of a one-week classroom course at Los Alamos National Laboratory (LANL) followed by a one-week hands-on critical experiment training course at either the U.S. NCERC or Sandia National Laboratory. Three classes were held in 2012. The NCSP is working to establish a condensed one-week hands-on critical experiment course for managers in 2013 with plans to conduct two one-week manager's courses by September 30, 2013. In addition to the manager's course, the NCSP will also conduct two two-week NCS training courses in 2013.

The NCSP is planning a Mission and Vision Planning Meeting October 9-11, 2012 at ORNL to extend the Mission and Vision Statement to extend the present planning document beyond the FY2009-2018 period.

Slovakia

Chrapciak gave a brief oral report on the situation in Slovakia. The government has not issued clear policies on the Work on final depository was stopped years ago. New regulations of NRA were issued in 2012 which allow for the possibility to use BUC and boron credit. A guide for BUC is currently in progress and expected in 2013. New safety analyses at reactor pools are expected by end of 2012. New safety reports for transport cask C-30 with basket KZ-48 and ISFSF in Jaslovske Bohunice for fuel 3.82%, 3.84% and 4.25% are in progress and expected in early 2013. Measurement of decay heat of fuel in transport cask is in progress (methodology was developed, measurement is planned in 2013). Codes used are SCALE 6, MCNP5, and adaption of SCALE 6.1.1 is in progress.

WPNCS and Expert Group Mandates

The five expert groups of the WPNCS had met previously on that week. The WPNCS Mandate will be rediscussed in June 2013 at the annual Nuclear Science Committee meeting and a 3 year extension will be requested. As all EG mandates formally ended in September 2012, the WPNCS recommended, pending the NSC ratification of the WPNCS mandate, to extend all expert groups for an extra 2-year mandate extension, pending new deliverables. As the Mandate of the WPNCS is formally discussed and extended at the June meeting, the dates of the Expert Groups Mandates should be adjusted to this date). This modification was proposed and accepted for all EG mandates (e.g; next mandates will be June 2013- June 2015).

A revision to the Mandate of the Expert Group on Advanced Monte Carlo Techniques was discussed (see annex 3 for all EG Mandates)

– Modifications involve the change of Chairman, and additional considerations of technical activities (such as tackling study of perturbation techniques) in the scope of the Mandate of the EG.

- Correction to the actual name of the ICSBEP as WPNCS ICSBEP Technical Review Expert Group instead of formerly *EG on Criticality Safety Benchmarks*.

In the discussions that followed it was also noted that the fairly large number of Expert Groups (five), with active programmes and many common participants is causing some logistical challenges, particularly in the organisation of common meetings, often with parallel sessions, which is not optimal for participants.

Review of Expert Group Activities

Highlights:

- The Expert Group on Advanced Monte Carlo Techniques (EGAMCT) was officially restarted, and is currently pending the definition of its first Benchmark specifications to start technical activities.
- During the meeting it was proposed that the WPNCS consider the possibility of having the Expert Group on Burnup Credit (EGBUC), which had just held its 21st annual meeting, change or broaden its focus. It was decided however the current working structure of the WPNCS will be retained while deliverables under EGBUC are still pending; for the time being the EGBUC has been granted a 2 year mandate extension. This restructuring could be discussed again at the June 2013 NSC meeting.

The Chairs of each of the Expert Groups gave a summary of recent progress within their EG, as follows.
Note: The Summary Record of each individual Expert Group can be found under the following references:

- *EGADNSF: NEA/NSC/WPNCS/DOC(2013)1*
- *EGUACSA: NEA/NSC/WPNCS/DOC(2013)2*
- *EGAMCT: NEA/NSC/WPNCS/DOC(2013)3*
- *EGBUC: NEA/NSC/WPNCS/DOC(2013)4*
- *EGCEA: NEA/NSC/WPNCS/DOC(2013)5*

The Expert Group on Assay Data for Spent Nuclear Fuel (EGADSNF)

Chair: Ian Gauld (USA)

The Expert Group focuses on performing evaluations of isotopic assay data for code validation, and providing guidance on how to do these evaluations. Part of the expert group also focuses on creating the databases and tools needed to store and handle this information.

Significant progress has been achieved on the development of the new SFCOMPO data base. An early prototype version developed by ORNL was demonstrated at the meeting. Starting from October 2012, the new SFCOMPO development will be migrated to NEA Databank entirely, where development will continue, the aim is to deliver a functioning prototype early in 2013 that is well adapted to the NEA DB database management procedures. This tool will replace the old SFCOMPO currently online.

Spain has contributed new draft evaluation reports to be reviewed by the group. These include BWR assay data. Spain also announced the continuous support to assay data evaluation activities over the 3-4 years to come, with new evaluations foreseen to be contributed periodically to the Expert Group. The completion of the evaluation of BWR fuel by Germany is however still pending. It is expected that this evaluation will include analysis of the impact of uncertainties/simplifications in irradiation history data on spent fuel composition.

The Guidance report on the Evaluation of Assay Data is currently in its 5th revision, and is still pending modifications by group. It is noted that the guidance to provide to evaluators is one of the main deliverables and central discussions of this EG, as such it is expected this document evolves along with the definition of a new database and new formats for evaluations.

The Expert Group on Uncertainty Analyses for Criticality Safety Assessments (EGUACSA)

Chair Tatiana Ivanova (France)

The Expert Group was established to address issues related to Sensitivity/Uncertainty studies for criticality safety calculations and to carry out the comparison and testing of methods and computing tools for uncertainty analysis, and assist in selection and development of safe and efficient methodologies.

Ivanova reported on a large participation attendance this year and requested future meetings last longer, possibly to enlarge this to 1.5 days instead of 1.

The State of the Art Report Part 1 and Part 2 are finished and pending publication. Phase III benchmark *(keff sensitivities to Nuclear Data)* has been completed and a draft report is pending. A proposal for a new Phase IV benchmark *(on establishment of correlations in experimental uncertainties)* is under discussion and specifications are expected before the next meeting.

The Expert Group on Burnup Credit (EGBUC)

Chair: Michaele Brady-Raap (USA)

The Expert Group focuses on studying burn-up credit as applied to criticality safety in the transportation, storage and treatment of spent fuel for a wide range of fuel types and reactors, including UOX and MOX fuels for PWR, BWR, and VVER.

Phase VIII benchmark *(on reactivity worth calculations / analysis of small-sample reactivity experiments)* is now nearing completion and a report is expected for publication at the end of 2013.

New Phase III-E benchmark on BWR burn-up for assessing compositions of damaged fuel was proposed by Japan. A report is expected before the end of 2013.

Phase II-E benchmark report on the study on the *Impact of Changes in the Isotopic Inventory due to Control Rod Insertions in PWR UO_2 Fuel Assemblies during Irradiation on the Reactivity and the End Effect* is pending (post meeting note : it has since been received and is pending review by the group before publication.).

Brady-Raap reported that the pending report on *Lessons Learnt on Burn-Up Credit* is now to be a Summary Report on Burn-up Credit, summarizing major conclusions from the activities of the EGBUC over more than 20 years of activities. The Expert Group indeed feels it is more appropriate to provide a summary of the particular cases studied as it is found strong conclusions on burn-up credit methodologies are to be done on a case by case basis, rather than general lessons learned that could be applied in the different scenarios considered. A draft of this summary report is pending. A complementary handbook with documented PWR - BUC bibliography is being compiled and is expected for completion in 2014, which will be compiled in collaboration with University of Florida Master degree student (A. Scurlock) under supervision of Sedat Goluoglu.

As was mentioned, it was proposed that the WPNCS consider the possibility of having the Expert Group on Burnup Credit (EGBUC), which had just held its 21st annual meeting, change or broaden its focus. Also noted was the fact that more and more activities requests coming from the spent fuel management area are now to be considered under a criticality safety approach (i.e: damaged fuel in spent fuel pools). This also reflects an increasing interest in improving assessment methodologies for Spent Fuel operations, some of which do not lend themselves easily to the traditional worst-case deterministic methods traditionally applied in criticality safety cases. It was tentatively proposed that a new EG on “spent fuel management” could take the follow up of EGBUC, which would close down.
It was decided however that the current working structure of the WPNCS will be retained while deliverables under EGBUC are still pending; for the time being the EGBUC has been granted a 2 year mandate extension. This restructuring could be discussed again at the June 2013 NSC meeting.

The Expert Group on Criticality Excursion Analyses (EGCEA)

Chair: Yoshinori Miyoshi (Japan)

The Expert Group studies the modelling and simulation of criticality excursions (accidents or experiments) by identifying and compiling criticality transient data from experimental programmes and from accident data. The group continues work on Phase II benchmark exercise on slow transient experiments at TRACY and SILENE reactors (*Ramp Mode Experiments with Uranyl Nitrate*), pending new contributions. Final submission of Phase II report is expected in 2013.

Miyoshi-san also presented activities on the STACY Modification Program and Critical Experiments using Pseudo Fuel Debris and also provided an informational overview of the road map for Decommissioning of Fukushima-Daiichi NPPs (more detail included in Japan’s National Report in annex).

International Criticality Safety Benchmark Evaluation Project

Briggs briefly reported on the annual International Criticality Safety Benchmark Evaluation Project (ICSBEP) Meeting was held in Paris, in May 2012, with the new 2012 Handbook to be published soon (October 2012). In particular, it is noted the mandate of the review group of the ICSBEP was updated and, in order to reflect more accurately the key objective of the group, it is renamed as the *Technical Review Group for the International Criticality Safety Benchmarks Evaluation Project***.**

Presentation by Kent Wood (USNRC)

Kent Wood gave a short presentation on the potential re-criticality risks and other problems (blistering, collapse of fuel in case of seismic event) associated to using different types of neutron absorbers in case of degradation and reflooding in an accident scenario. He highlighted the multidisciplinary nature of these issues (materials, safety, waste management). The objective of his presentation was to survey the use and type of neutron absorbers used in racks across participating countries.

Neuber pointed out this issue is known in Germany and that is why Germany uses metallic borated plates. Loss of boraflex from the top region of the spent fuel racks will be addressed in the final Summary Report by the EGBUC (pending), but noted that each country/utility had its own method neutron absorber types, and geometries for racks in SF pools. A suggestion task was to create a survey of the type of neutron absorbers used in racks across participating countries.

Status of ICNC-2015.

Brady-Raap announced the USA will be hosting the next edition of the International Conference on Nuclear Criticality (ICNC-2015) in September 2015. Potential sites currently being considered include San Francisco, California; Charlotte, North Caroline, or Amelia Island, Florida. More information on venues and dates will be made available in due course.

Any Other Business and Date of Next Meeting

The next meetings of the WPNCS and associated Expert Groups will take place in October 2013. Exact dates and venues will be announced in due course to participant and through the webpage www.oecd-nea.org/science/wpncs/nextmeeting/

With no other business to discuss, the meeting was adjourned.

List of Actions

1. Action on all delegates - To confirm with NEA the name of official representatives of each member country.

2. Action on all delegates- To submit to NEA if not already done the written National Report for inclusion in the minutes.

ANNEX 1

MANDATES OF THE WPNCS AND ASSOCIATED EXPERT GROUPS

Working Party on Nuclear Criticality Safety (WPNCS)

Chair:	Dr. Michaele Brady Raap	(United States)
Members:	All NEA member countries	
Regular Observers (Non-Members):	European Commission *Under the NEA Statute*	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	June 1996	
Duration:	30 June 2013	

Mandate:

- Agreed at the 7th Meeting of the Nuclear Science Committee in June 1996 [NEA/SEN/NSC(96)3]
- Summary Record of the 15th meeting of the Nuclear Science Committee [NEA/SEN/NSC(2004)3]
- Summary Record of the 18th meeting of the Nuclear Science Committee [NEA/SEN/NSC(2007)3]
- Extended at the 21st meeting of the Nuclear Science Committee in June 2010 [NEA/SEN/NSC(2010)3]

Extract from document [NEA/SEN/NSC(2010)3]

[…]

"**Scope**

Under the guidance of the Nuclear Science Committee, the Working Party will deal with technical and scientific issues relevant to criticality safety. Specific areas in interest include, but are not limited to investigations concerning static and transient configurations encountered in the nuclear fuel cycle such as fuel fabrication, transport, separation processing and storage. Areas of activities include:

- Evaluation of available experimental data.
- Assessment of experimental needs.

- Code and data inter-comparison.
- Development of codes and models, assessment of uncertainties.
- Development of criticality methodologies and data.
- Establishment of technical basis for the application of burn-up credit.

Objectives

- Exchange of information on national programs in the area of criticality safety.
- Guide, promote and co-ordinate high priority activities of common interest to the international criticality safety community, establish co-operations.
- Monitor the progress of all activities and report to the NSC.
- Publish databases, handbooks, and reports.
- Facilitate communications within the international criticality safety community through relevant internet sites;
- Co-ordinate the on-going series of international conferences on nuclear criticality safety (ICNC), to be held every four years.
- Co-ordinate WPNCS activities with other working parties within the NEA and in other international frameworks to avoid duplication of activities.
- Provide a technical basis for other international activities (e.g. ISO, IAEA).

Deliverables

- New editions of the International Handbook of Criticality Safety Benchmark Evaluation Project (2010, 2011 and 2012).
- Update to DICE database tool for ICSBEP.
- Report summarising the findings of the Expert Group on the study of source convergence issues (2010).
- Report summarising findings of the Expert Group on the modelling of criticality transient experiments – Phase II (2011).
- Report on the analysis and benchmarking of ISTC 2670 project (Assay data for VVER440 fuel) (2010).
- New evaluations of BWR and PWR PIE data for SFCOMPO accounting for conclusions of Spent Fuel Assay Expert Group review of evaluation requirements with respect to data requirements and sensitivities. (2010, 2011).
- Report on Phase IIE (PWR axial profile study) of Burnup Credit Benchmarks.
- Report summarising the findings of the Expert Group on Burn-up Credit and lessons learned (2011).
- Web-based information resources on burn-up credit, criticality excursions, source convergence issues and PIE data.
- Benchmark report on uncertainties due to fuel assembly manufacturing tolerances (2011).
- Benchmark report on testing of codes used to generate sensitivity coefficients for uncertainty analyses (2012).
- State-of-the-art reports summarising new Monte Carlo techniques of importance to criticality safety practitioners (2011, possible update 2013).
- International coordination of ICNC2011. Delivery of technical reviews of abstracts and papers (2011)."

WPNCS Expert Group on Advanced Monte Carlo Techniques

Chair:	Dr. Joachim Miss	(France)
Members:	All NEA Member countries	
Regular Observers (Non-members):	European Commission *Under the NEA Statute*	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	1 September 2010	
Duration:	30 June 2015	

Mandate:

- Agreed at the 21st meeting of the Nuclear Science Committee in June 2010 [NEA/SEN/NSC(2010)3]
- Extension Recommended at 16th meeting of the WPNCS, September 2012

[…]

"**Introduction**

Criticality safety practitioners utilize a number of mature Monte Carlo production codes (e.g., SCALE, MCNP, MORET, TRIPOLI, MONK) to carry out their work. These computer codes are not static, however, and constantly evolve as computers become ever more powerful and innovative new analysis methods are developed by universities and national laboratories. The transfer of new, innovative Monte Carlo technology into the hands of practitioners is a continuing challenge for the criticality safety community: New methods need to be reviewed in depth for correctness by experts in the field; sufficient quality assurance and verification/validation must be performed to provide a high degree of confidence in new methods; assessment of the potential impact of new methods must be carried out; and practical guidance must be developed and promulgated to practitioners to enable correct and efficient application.

Based on these considerations, the formation of an Expert Group on Advanced Monte Carlo Techniques for criticality safety assessment within the structure of the WPNCS was proposed at the 12th meeting of WPNCS on September 25, 2009.

The goal of the Expert Group is to transfer new Monte Carlo technology to criticality safety practitioners.

To accomplish these several objectives/activities are required initially:

- Survey recent advances in the development of new techniques for Monte Carlo criticality analysis codes.
- Identify new techniques as high-priority for further detailed study, and solicit EG members to investigate each technique.

- For each selected technique, designated EG members will review the methodology, survey the literature, assess the verification/validation status, possibly establish benchmark tests that could be used by EG member Monte Carlo codes, and suggest guidelines for applying the new techniques to problems of importance to practitioners.
- Draft recommendations to practitioners for using the improved methodology in their work, and to guide its employment.

It is expected that the above activities will be repeated yearly as new, promising improved techniques appear, and as new demands are placed on criticality safety practitioners.

The above activities are intended to support and compliment the work of other Expert Groups. A review and assessment of Monte Carlo depletion methods would focus on techniques for correctly performing the Monte Carlo analysis, rather than on the methodology for applying those results to burn-up credit, for example. It is anticipated that there will be significant synergy between this Expert Group and other established Expert Groups.

Scope

Under the guidance of the Working Party on Nuclear Criticality Safety (WPNCS) the Expert Group will perform specific tasks associated with the transfer of new Monte Carlo technology to criticality safety practitioners. These activities will be selected from (but are not limited to) the following list:

- Analysis of sub-critical experiments.
- Transient suppression (i.e. convergence acceleration).
- Convergence of adjoint calculations for criticality.
- Tests for adequate population size.
- Under-prediction of statistical uncertainties for tallies.
- Random geometry (particles in solution, TRISO fuel, etc.).
- Geometric perturbations (e.g. tolerances, absorber reactivity worth).
- Monte Carlo perturbation theory- review methodology and, if necessary, revisit benchmarks.
- Monte Carlo depletion - (Burn-up credit) methodology, approximations, review, benchmark.

Objectives

- Survey of recent advances in the development of new techniques used in Monte Carlo criticality safety analysis codes. This will involve:
- Identify 1-3 of the new techniques as high-priority for further detailed study, and solicit EG members to investigate each technique.
- For each selected technique, designated EG members will review the methodology, survey the literature, assess the verification/validation status, possibly establish benchmark tests that could be used by EG member Monte Carlo codes, and suggest guidelines for applying the new techniques to problems of importance to practitioners.
- Draft recommendations to practitioners for using the improved methodology in their work, and to guide its employment.

Deliverables

- Selection of initial techniques for study and evaluation. Expert group restart meeting in

September 2012

- Draft of Benchmark 1st report, selection of additional techniques for study and evaluation Expert Group meeting in September 2013

- State-of-the-art reports summarizing new Monte Carlo techniques of importance to criticality-safety practitioners. Guidance will be provided on the applicability of the new techniques, potential benefits, availability in various Monte Carlo codes, and suggested techniques for implementing and assessing the new techniques.

WPNCS ICSBEP Technical Review Expert Group

Chair:	Dr. Joseph Blair Briggs	(United States)
Members:	All NEA Member countries and experts from contributing countries	
Regular Observers (Non-Members):	European Commission *Under the NEA Statute*	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	September 2000	
Duration:	September 2014	

Mandate:

- Approved at 4th meeting of the Working Party on Nuclear Criticality Safety, 2001 [NEA/SEN/NSC/WPNCS(2001)1]

- Reviewed and extended at 16th meeting of the WPNCS, September 2012

[…]

Scope

Under the direction of the Working Party on Nuclear Criticality Safety (WPNCS) the Expert Group will coordinate the programme of the International Criticality Safety Benchmark Evaluation Project (ICSBEP).and the development of the ICSBEP handbook and database. These comprise an evaluated set of benchmark specifications derived from experiments performed at various nuclear critical facilities around the world. The benchmark specifications are intended for use by criticality safety engineers to validate calculational techniques used to establish minimum subcritical margins for safe operations with fissile material.

Development of a database tool (DICE) to facilitate user access to the ICSBEP benchmarks.

Objectives

To provide the nuclear industry with an evaluated set of benchmark specifications by collecting criticality experiment data from the nuclear criticality laboratories, world-wide. More specifically the objectives are as follows:

- Identify and evaluate a comprehensive set of critical and sub-critical benchmark data.
- Verify the data, to the extent possible, by reviewing original and subsequently revised documentation, and by talking with the experimenters or individuals who are familiar with the experimenters or the experimental facility.
- Evaluate the experimental data and uncertainties.
- Compile the data into a standardised format.
- Perform calculations of each experiment with standard criticality safety codes.
- Formally document the work into a single source of verified benchmark critical data.

The Expert Group will closely coordinate its work with other NSC groups developing databases of integral experiments. In particular there will be close links with the Working Party on Scientific Issues of Reactor Systems (WPRS) Expert Group on Reactor Physics and Advanced Nuclear Systems (WPRS-EGRPANS). This group is responsible for coordinating the development of the International Reactor Physics Experiments **(IRPhE**) database.

A key element of the evaluation process is a rigorous analysis of the uncertainties, including quantification of correlations between experiments. There will be strong linkage between the ICSBEP Technical Review Group and the WPNCS Expert Group on Uncertainty Analysis for Criticality Safety Assessment (EGUACSA).

Deliverables

- Provide annual editions of the handbook on DVD and provide downloadable versions through suitably protected websites in accordance with NEA Data Bank protocols.
- Develop and maintain a database tool (DICE) to allow users to search the database using keywords and create listings of experiments with matched characteristics. The tool is to be distributed with the handbook in accordance with NEA Data Bank protocols.

WPNCS Expert Group on Burn-up Credit

Chair:	Dr. Michaele Brady-Rapp	(United States)
Members:	All NEA Member countries	
Regular Observers (Non-Members):	European Commission *Under the NEA Statute*	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	September 2000	
Duration:	June 2013	

Mandate:

- Agreed at the 4th meeting of the Working Party on Nuclear Criticality Safety [NEA/SEN/NSC/WPNCS(2001)1]
- Summary Record of the 15th meeting of the Nuclear Science Committee [NEA/SEN/NSC(2004)3]
- Summary Record of the 18th meeting of the Nuclear Science Committee [NEA/SEN/NSC(2007)3]
- Extended as a part of WPNCS activities at the 21st meeting of the Nuclear Science Committee in June 2010 [NEA/SEN/NSC(2010)3]

[…]

"**Scope**

Under the guidance of the Working Party on Nuclear Criticality Safety (WPNCS) the Expert Group will perform specific tasks associated with the application of Burnup Credit to criticality safety assessment. Burnup Credit is a safety approach that accounts for a reduction in reactivity for configurations with burned nuclear fuel due to the change in composition during irradiation. The goal of the Expert Group is to help establish the technical underpinning of methodologies used in the application of Burnup Credit.

The types of fuel facility and operation covered include; fabrication, transportation, storage, reprocessing, waste management and disposal. The group will consider a wide range of fuel types, including UOX and MOX fuels for PWR, BWR and VVER

Objectives

To provide expert advice to the WPNCS and the nuclear community on the development needs (methodology, validation experiments, scenario studies) for Burnup Credit as applied to different operations and facilities.

Verification & validation is a key requirement for safety methodologies, and the following activities will be carried out, with the aim of establishing high confidence in Burnup Credit assessment methods:

- carrying out international comparison exercises and benchmarks and to assess the ability of code systems to predict the reactivity of spent nuclear fuel systems, including comparison with experimental data as available;

- investigation of the physics and predictability of burn-up credit based on the specification and comparison of calculational benchmark problems;

- publication of the results for the benefit of criticality safety community, so that the work may be used to help establish suitable safety margins.

The Expert Group will aim to facilitate knowledge management in the area of Burnup Credit, through support to experimental data preservation and evaluation activities and through contributing to related state-of-the-art reports. In this context it will liaise closely with the WPNCS Expert Group on Assay Data for Spent Nuclear Fuel and with the activities of the Spent Fuel Composition Database (SFCOMPO).

Deliverables

- Report on Phase IIE (PWR axial profile study) of Burnup Credit Benchmarks.
- Report summarising the findings of the Expert Group on Burnup Credit and lessons learned (2012).
- Report on Phase VII (long-term disposal) of Burnup Credit Benchmarks.
- Report on Phase III-E on isotopic composition of damaged BWR fuel

Meeting frequency: once per year for full Experts Group with additional meetings as required in support of particular activities.

WPNCS Expert Group on Criticality Excursions

Chair:	Mr. Yoshinori Miyoshi	(Japan)
Members:	All NEA Member countries	
Regular Observers (Non-Members):	European Commission *Under the NEA Statute*	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	December 2001	
Duration:	June 2015	

Mandate:

- Agreed at the 5th meeting of the Working Party on Nuclear Criticality Safety [NEA/SEN/NSC/WPNCS(2002)1]
- Summary Record of the 1st Meeting of the Expert Group on Criticality Accidents Analyses [NEA/NSC/WPNCS/DOC(2002)3]
- Extended as a part of WPNCS activities at the 21st meeting of the Nuclear Science Committee in June 2010. [NEA/SEN/NSC(2010)3]
- Extension Recommended at 16th meeting of the WPNCS, September 2012

Extract from document [NEA/NSC/WPNCS/DOC(2002)3]

[…]

"**Scope:**

To provide scientific knowledge on criticality excursions to be used by the worldwide criticality community in relation to criticality accident analyses.

Objectives:

Under the guidance of the Working Party on Nuclear Criticality Safety, the major assignments of the Expert Group include:

- The identification and compilation of criticality transient data from experimental programmes and from accident data.
- The evaluation of the main transient experimental programmes and the creation of a database to store and disseminate the data.

- The identification and the highlighting of experimental needs for criticality accidents analyses.
- The identification and compilation of available models and computer codes for transient analyses.
- The definition of benchmark exercises aiming at comparing computer codes used for criticality accidents analyses.
- The identification of needs in terms of modelling."

Current programme of work

The expert group's work currently addresses the following areas:

- The evaluation of criticality excursion experiments. A draft format (MS word file 186 kb) was designed by extending and adapting the International Criticality Safety Benchmark Evaluation Project evaluation format.

- The organisation of inter-code comparison exercises. Benchmark proposals based on experiments performed in SILENE and TRACY solution reactors have been prepared. A report on these benchmark exercises is currently being finalised. A further four phases of this exercise are envisaged. The expert group is examining preliminary results from the second phase of the benchmark exercise, which covers slow transients from the TRACY experimental reactor. A third phase will study code performances to simulate long-duration experiments, whilst a fourth phase will examine the dilute Pu-solution. A final fifth phase will be a detailed analysis of postulated accident conditions.

- The development of a web-based information resource on criticality excursions (experimental programmes, existing modelling capabilities, criticality accidents).

Phase I report discuss the performances of four transient codes: AGNES, CRITEX, INCTAC, and TRACE to simulate experimental results from two experimental facilities SILENE and TRACY (final report is on publication)

WPNCS Expert Group on Assay Data of Spent Nuclear Fuel

Chair:	Ian C. Gauld	(United States)
Members:	All NEA Member countries	
Regular Observers (Non-Members):	European Commission *Under the NEA Statute*	
	Russian Federation	
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*	
Date of creation:	January 2007	
Duration:	June 2015	

Mandate:

- Agreed by written procedure following the Nuclear Science Committee bureau meeting in December 2006 [NEA/NSC/DOC(2006)25]
- Extended as a part of WPNCS activities at the 21st meeting of the Nuclear Science Committee in June 2010. [NEA/SEN/NSC(2010)3]
- Reviewed and extended at 16th meeting of the WPNCS, September 2012

Extract from document [NEA/NSC/DOC(2006)25]

[…]

"1. The expert group will review the facilities available for measurement of isotopic composition of spent nuclear fuel, especially in the OECD member countries. The group will also analyse the SFCOMPO database in order to assess the current situation and the need for new experimental data.

2. To collect new isotopic composition data from PIE and input them, and their associated operating histories/data, into SFCOMPO. The expert group will review the format of the SFCOMPO database. The members of the expert group will provide the interface to contact specialists in their own country and in other international communities to identify and obtain new data to be included in SFCOMPO and used by the public.

3. To keep and archive original reports on any PIE data included in the SFCOMPO database, as well as to add supporting technical references that were used in the original development. The NEA services will be used to archive the experimental reports to be made available via the NEA website.

4. To provide technical advice in support of PIE activities in member countries and to promote international collaboration in order to compensate for the fact that few PIE data are freely available. With the help of experts, the group will identify and define the methods (experimental techniques for dissolution, separations, mass measurements, etc.) for obtaining the different types of isotopic composition data. The expert group will 1) develop criteria and procedures to assure the quality of future experiments by identifying a set of minimum requirements for fuel characterization and operating history data to qualify samples to be used in isotopic composition measurements and 2) update the format used in SFCOMPO and investigate and confirm the quality of experimental data already available in the database."

Scope and Objectives for the Extended Mandate

Under the guidance of the WPNCS, the Expert Group has identified the following main areas under which it will conduct activities:

- Preservation of Data: It is one of the main objectives of the Expert Group to ensure preservation of already existing assay data, as well as continuously capturing new data as it becomes available. This is important in order to profit both from the operator and experimentalist knowledge of the conditions under which samples and measures were obtained, before such information is lost.

- Accessibility of Data: Experimental data are made accessible to users in a standardized format through the database SFCOMPO. As new parameters are identified by the Expert Group as required fields of a complete evaluation, the database and its interface tools will have to adapt accordingly.

- Evaluation of Assay Data: A significant and challenging objective, which seeks complete documentation of data sets, including all relevant design and reactor operating data, as well as an independent, peer-reviewed assessment of these data. This review process is intended to vet the data for potential errors and produce qualified data suitable for use in code validation.

- Knowledge Transfer: Guidance for the qualification of the evaluation of isotopic assay data will be developed by the Expert Group. Similar guidelines have already been established for the qualification of benchmark data by the International Criticality Safety Benchmark Evaluation Project (ICSBEP) for criticality experiments, and the International Evaluated Reactor Physics Experiments Evaluation Project (IRPhE) for reactor physics benchmarks. A state-of-the-art report on assay data for isotopic validation will be issued in 2011.

Deliverables

Publication of the State-of-the-art report on Assay Data

- Compilation and archiving of primary experimental reports (on-going activity)

- Provide specifications of the recommended template format of a complete evaluation of an assay data experiment

- Develop a new database framework for SFCOMPO for the experimental radiochemical assay measurements and uncertainties from the primary experimental reports

- Complete peer review evaluations on selected experiments for a PWR and BWR data set, providing initial recommendations based on experience from the peer reviews

- Publication of a guidance document on standard procedures for the evaluation of assay data, which should also include guidance on how to evaluate the reactor operating history and reactor parameters needed for the use of these data

Meeting frequency: The Expert Group will meet on average once per year.

Links to other NEA Expert Groups

The Expert Group on Assay Data for Spent Nuclear Fuel works in co-ordination with the WPNCS Expert Group on Burnup Credit Criticality. Because of the importance of the assay data to many different areas of spent fuel management, the Expert Group consists not only of the WPNCS members representing nuclear criticality safety, but also members of the standing technical Committee on the Safety of Nuclear Installations (CSNI) and the Integration Group for the Safety Case (IGSC), the main technical advisory body to the NEA Radioactive Waste Management Committee on the deep geological disposal of long-lived and high-level radioactive waste.

WPNCS Expert Group on Uncertainty Analysis for Criticality Safety Assessment

Chair:	Dr. Tatiana Ivanova (Russian Federation)
Members:	All NEA Member countries
Regular Observers (Non - Members):	European Commission *Under the NEA Statute*
Observer (International Organisation):	International Atomic Energy Agency (IAEA) *By agreement*
Date of creation:	31 December 2007
Duration:	30 June 2015

Mandate:

- Extended as a part of WPNCS activities at the 21st meeting of the Nuclear Science Committee in June 2010 [NEA/SEN/NSC(2010)3]
- Reviewed and extended at 16th meeting of the WPNCS, September 2012

[…]

"**Introduction**

The Expert Group on Uncertainty Analysis for Criticality Safety Assessment (UACSA) was established to address issues related to Sensitivity/Uncertainty (S/U) studies for criticality safety calculations. In the first years of the group activity two principal directions have been formed: estimation of the bias and its uncertainty for criticality safety calculations and the assessment of manufacturing/operational (including depletion when applicable) uncertainties.

At the first stage, the work of the EG was focused on approaches for validation of criticality safety calculations. Methodologies that establish uncertainties related to operations, and manufacturing parameters for application system are subject for further work.

Lessons learnt at the first stage are documented in the state-of-the-art report and bring up issues for further activities of the EG. The study shows that k_{eff} sensitivities to neutron cross sections are commonly used in similarity assessments and/or as part of the validation algorithm. Monte Carlo codes with explicit 3-Dimentional geometry have become commonly used to compute the sensitivities along with one- or two-dimensional deterministic tools. Testing the sensitivity calculation methods and tools is therefore a useful step towards improvement of S/U capabilities for CSA. A Benchmark test has been proposed to compare computation of k_{eff} sensitivities to nuclear data.

The report also concludes that it is important to ensure that the k_{eff} uncertainties for the benchmark experiments are well evaluated and that correlations between the benchmark uncertainties are established. It is essential that these types of correlation are considered at the planning stage of experimental work. Correlation matrices for some configurations from the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP Handbook) are provided in the Database of the International Criticality Safety Benchmark Evaluation Project (DICE). The method used to establish those correlations will be described by the ICSBEP/DICE Subgroup. It is

expected that other methods will be proposed by the EG. The EG will review the description, discuss the methods, and draft recommendations to the ICSBEP on the method or methods to identify, quantify and document correlations between benchmark parameters and to estimate and document the correlations between benchmark-k_{eff} uncertainties.

It is anticipated that there will be synergy between the EG UACSA and (1) the ICSBEP in the above activity on correlations and on the techniques evaluating error related to technological parameters; and (2) the WPNCS EG on Advanced Monte Carlo Techniques in the area of Monte Carlo perturbation theory for sensitivity computation. The Benchmark test on sensitivity computation may also be of interest to the EG on Uncertainty Analysis for Modeling (UAM).

Scope:

Under the guidance of the Working Party on Nuclear Criticality Safety (WPNCS) the Expert Group will perform specific tasks associated with study of uncertainty analysis methods and their use by criticality safety practitioners. The following focus areas will guide the EG work:

- k_{eff} uncertainty due to technological or manufacturing parameters;
- k_{eff} sensitivities to nuclear data;
- Parameter correlations between benchmarks and k_{eff} sensitivities to parameters, related to repeatability and reproducibility;
- Correlations in k_{eff} biases and uncertainties and their origins in benchmark parameter biases and uncertainties.

Objectives

- Survey of the techniques for establishment of best-estimate results (as opposed to nominal or design-basis results) together with biases and uncertainties due to technological parameters.
- Survey of the techniques and software tools for computation of k_{eff} sensitivities to nuclear data and draft recommendations to practitioners for using those techniques.
- Draft recommendations to the ICSBEP on methods to identify, estimate and document parameter correlations between different experiments and to identify, estimate and document k_{eff} correlations between benchmark experiments due to those parameters.

Deliverables

2010 December: State-of-the art report: Overview of Approaches Used to Determine Calculational Bias in Criticality Safety Assessment and their Comparison as Applied to Phase I of the UACSA Benchmark Exercise

2011 September: Draft of 2nd report: Synthesis and analysis of the results for Benchmark test Phase II: reactivity impact of manufacturing tolerances of parameters characterizing a fuel assembly configuration.

2011 September: Draft of 3rd report: Synthesis and analysis of the results for Benchmark test Phase III: computation of k_{eff} sensitivity to nuclear data.

2012 September: Draft of note: Recommendations to the ICSBEP on the method or methods to identify, estimate and document both parameter correlations between different benchmarks (covering both experiments and simplifications) and the k_{eff} correlations between benchmarks due to those parameters.

Meeting frequency: The Expert Group will meet at least once a year, usually in conjunction with the WPNCS meetings.

ANNEX 2

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

Nuclear Energy Agency
Nuclear Science Committee
16th Meeting of the Working Party on Nuclear Criticality Safety

NEA Headquarters, Issy-les-Moulineaux

September 21 2012, 9:00 – 18:00

PROPOSED AGENDA

1. Welcome and administrative items- *M. Brady-Raap*
2. Review of actions from the previous meetings - *F. Michel-Sendis*
3. Approval of the summary records of the previous meeting- *All*
4. Feedback from the Nuclear Science Committee Meeting- *J. Gulliford*
5. Nuclear Criticality Safety National Programmes -*All*
6. Reports from the WPNCS Expert Groups :
    - *Advanced Monte Carlo Techniques Expert Group (EGAMCT) – J.Miss*
    - *Burnup Credit Criticality Expert Group (EGBUC)- M. Brady-Raap*
    - *Assay Data for Spent Nuclear Fuel Expert Group (EGADSNF)- I.Gauld*
    - *Uncertainty Analyses for Criticality Safety Assessment (EGUACSA)- T. Ivanova*
    - *Criticality Excursions Analyses Expert Group (EGCEA) – Y. Miyoshi*
    - *International Criticality Safety Benchmark Evaluation Project (ICSBEP) – B. Briggs*
7. Extension of Mandates (WPNCS and EG's) – *M. Brady-Raap*
8. Status of ICNC 2015- *M. Brady-Raap*
9. Other future activities under WPNCS - *All*
10. Date and place of the next meeting - *F. Michel-Sendis*.

ANNEX 3

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