Session VII: summary and conclusions

Session I (some important points)

- US objective: 2030-2040 for a new fuel cycle development with a **jump to increment technology** and considering **bounding condition of repository** – "We have time to consider different possibilities" –" We need test reactors with fast spectrum"
- France objective: recycling = the key point
  - open options *(what to recycle, and how)* for closed fuel cycles - 2020 to specify the choice of direction to put the effort
- Japan objective: production of the conceptual designs of commercial and demonstration FR facilities with R&D programs 2015 for commercially introducing of FR cycle facilities 2050 – Optimization in criticality safety approach in the next process

- **More and more quantities of Pu** in fuel cycle, in various mixtures (Am main actinide to consider)
- **Some equipment** seems getting **closer to upper limit** of single process line capacity with the present criticality design concept

Session I: what are the most probable scenarios of the nuclear industrie development?

- What should be done to prepare CS practitioners to deal with or deploy advanced reactor/fuel cycle concepts?
- How to transfer knowledge?
- Do we have facilities to support innovative missions?
- What do the CS need to support future?
- What are the criticality impacts of increased throughput?
- New plants for future needs: key dates (how long the options can stay open) and what are the key knowledge based on the actual knowledge we need?

Session II (Important points that challenge extending the existing fuel cycle and transitioning to a new and innovative fuel Cycle?)

- Longer reactor cycles and higher exposures require uranium enrichments >5%
- Japan plans new critical experiments for 5% - 10% around 2014 – 2015
- Interpretation and application of international and national transportation regulations compound the effort and cost of package certifications
- Bulk shipments of U(>5%)F6 not addressed yet
- Fuel fabrication facilities have been designed and authorized for ≤5% with specific and understood materials (e.g., burnable poisons)
- >5% fuels with different materials compound facility modifications/upgrades and the licensing process
- Validation processes for >5% and different fuel materials using sensitivity and uncertainty techniques require added effort but can expand knowledge, quantify uncertainties, and assist in defining justifiable margins of subcriticality for safety
- Developing and transferring knowledge

Session II: What are some potential approaches for addressing the challenges?

- Assign sufficient lead time for planning, analysis, design, modification/construction, and licensing of facilities/equipment to accommodate >5%
- Publish (IHECSBE)
  - New Japanese >5% experiments shortly after 2015
  - Mined old experiment data
- Encourage international
  - Nuclear safety authorities to possibly collaborate in harmonizing requirements and interpretations of requirements thereby facilitating the use and exchange of the same SA reports for package certification
  - Industrial partnerships to facilitate standardization of licensing safety bases and interfaces with safety authorities
  - Further collaboration among nuclear safety authorities and industry for identifying experimental needs for validation and safety analyses (new experiments for >5% and specific materials such as Er, etc.)
  - Development for the certification of U(>5%)F6 packages
- For the US, NRC is revising their Fuel Cycle Licensing process using some reactor licensing concepts such as a risk informed process with greater predictability

WHAT ARE OTHER POSSIBILITIES? **The big question is HOW?**

Session III (some important points)

- Use of sensitivity and uncertainty analysis **can not be ignored**
- Covariance data play a crucial role
- We should give more thought and effort to defining unique or high value (differential and integral) measurements that meet specific priority data needs
- Use all measurements and experimental data already available
- Integral experiments with Separate isotopes
- Use more Monte Carlo (continuous energy) to point out only the uncertainty due to nuclear data (avoid calculation uncertainties)
- Industrials need a maximum design flexibility, so a range of data must be available

Session III: what are basic research needs that face the challengers?

- Identify need for specific experiment or determine a range of interest for new data?
- Do we need to focus first on fissile materials we know (U+Pu and perhaps Am) or not?
- How were the matrix affect the output?

Session IV (some important points)

State of the art

- Good knowledge of the range of the PROCESS PARAMETERS with the ability to guarantee the "upper limits" used for the criticality calculations
- Ability to monitor and to measure the control parameters in order to detect the "abnormal situations in a short time
- Rigor of validation techniques is sometime limited to expert judgment
- Sensitivity data is an important component of criticality validation
- Statistical data adjustment is expected to be of value for criticality safety validation

Requirements for validation methods and software tools

Requirements for new integral experiments

What we have to do

- Provide test techniques and software tools for sensitivity calculations
- Testing the impact of cross-section covariance data
- Develop test techniques and software tools establishing technological uncertainties and uncertainty of depletion calculation…

Session IV: what is the state of art for the approaches and technologies used in CS assessment? How to optimize them by advanced technical solutions?

- How to improve the relationships between “process specialists” and “criticality experts” for optimization of devices?
- How much formalization is needed for validation methods? Some fully formalized method can not be correct ?
- What kind of work can become a priority for UACSA activities?

Session V (some important points)

- Different strategies for interim management, transportation and disposal
- Different approaches for preclosure phase and post closure phase
  - deterministic/probabilistic/risk informed
- First step is to define bounding scenarios (geology, chemistry …)
- Interest in a extensive burnup credit data collection program
- Consider use of NDA measurements in safety assessment
- Neutron absorbers for long term scenarios?
- Collation of lessons learnt from previous studies

Session V: what are the specific issues and limitations related to waste management and waste disposal?

- Interest in new neutron absorbers/matrix data? (Chlorine 35)
- Interest in mineral form specificities?
- Define validation requirements, benchmarking opportunities?
- Could we organize international effort to define bounding scenarios, to look at the scenarios themselves including criticality specialists but also geological and chemistry specialists?
- How to collect and organise feedback from international studies?

Session VI (some important points)

- Flexibility is needed
- The reflection to choose the experimental configuration of primary interest
- International collaboration needed to share data and cost
- Complementarity between different international experimental programs

Session VI: what kind of facilities can be used or are available for experiments needed for CS design and analysis?

- You remember the key points of the presentations
- Do you remember the more relevant questions?