International Atomic Energy Agency (IAEA) Activities on Spent fuel Management

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International Workshop on Advances in Applications of Burnup Credit for Spent Fuel Storage, Transport, Reprocessing and Disposal
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International Atomic Energy Agency

Current environment for the nuclear energy application

- Increasing long term energy demands,
- Energy supply security,
- Climate change,
- Increased expectations of nuclear energy application,
- Recycling for optimization of resource utilization,
- New countries nuclear energy users,
- Reliable fuel cycle supply important,
- Renewed concerns about proliferation.

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Current world scene in SF management

- Spent fuel disposal projects delayed significantly (no SF repository in operation),
- “Wait and see” approach adopted by many countries in particular by countries that do not plan to have reprocessing technology,
- Increased interest for reprocessing and recycling of SF,
- Long - term SF storage of 100 years (and even more) very likely.

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Current world scene in nuclear energy application; country groups

1. Countries that have developed or are developing nuclear technologies (Canada, USA, Russia, France, UK, Japan, India, Korea, Germany, Belgium),
2. Countries receivers of nuclear technology with some experience in nuclear operations (other countries from total of 30 that have power reactors),
3. Potential newcomers.

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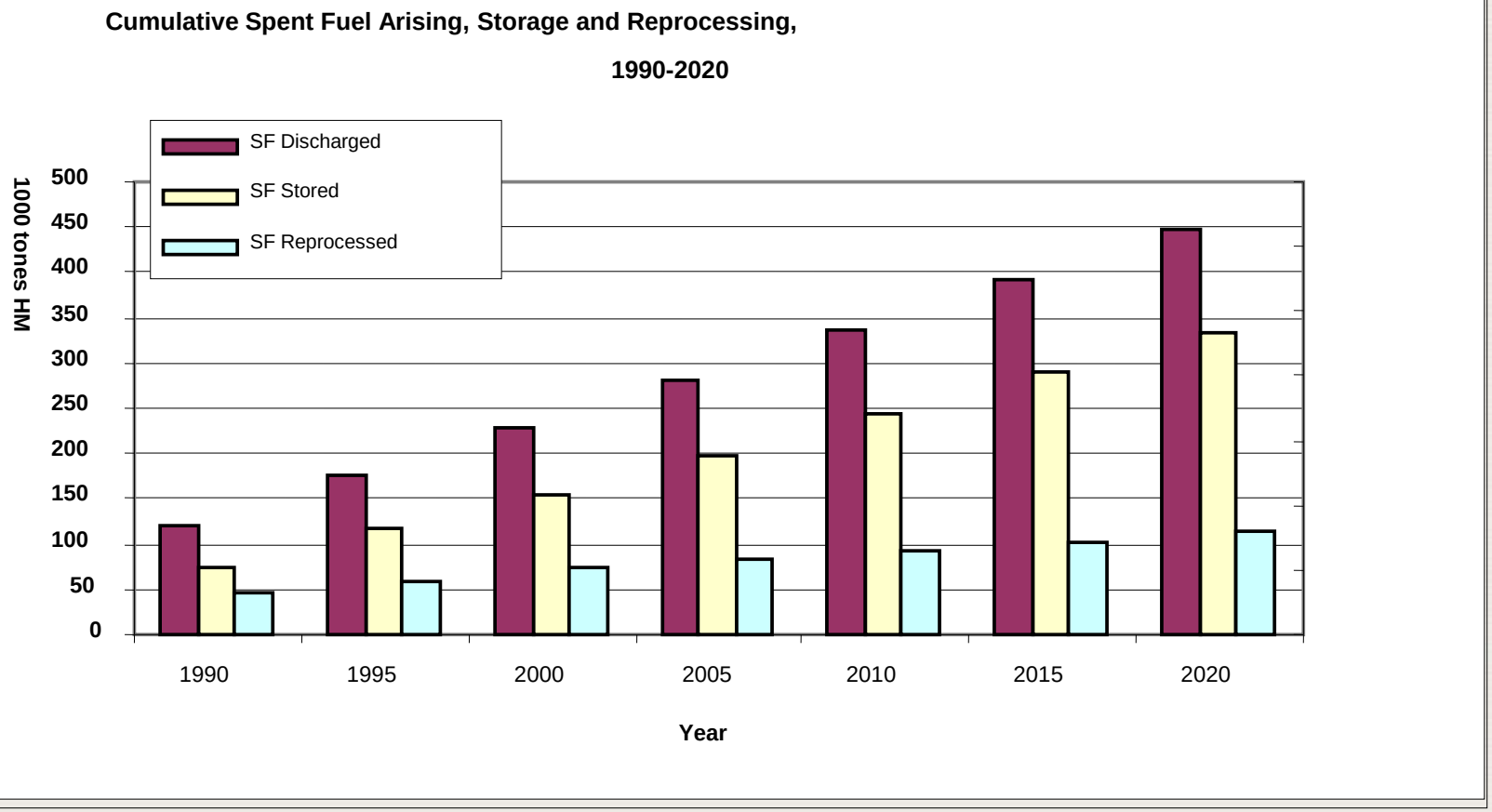
Spent fuel inventories and accumulation



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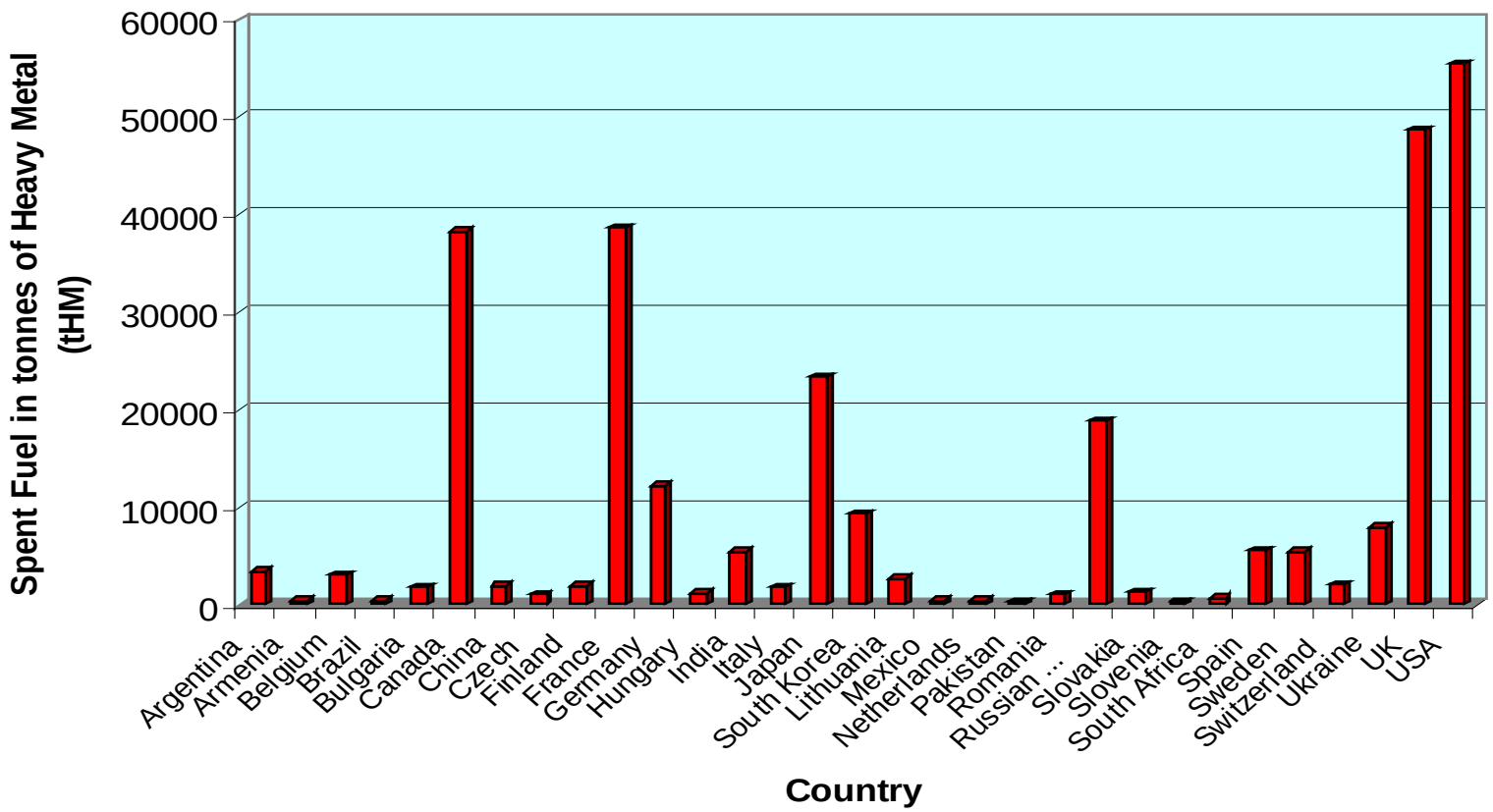
Spent fuel accumulation by countries



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Spent Fuel Management (SFM)

- Currently about 10500 tonnes of spent fuel generated in a year,
- Predictions are that this will increase to 11500 tonnes in next two years,
- Current reprocessing capacities ~ 6000 (tHM/y) with expectation of an increase to 6500 (tHM/y),
- Only less than 1/3 of generated spent fuel is reprocessed.

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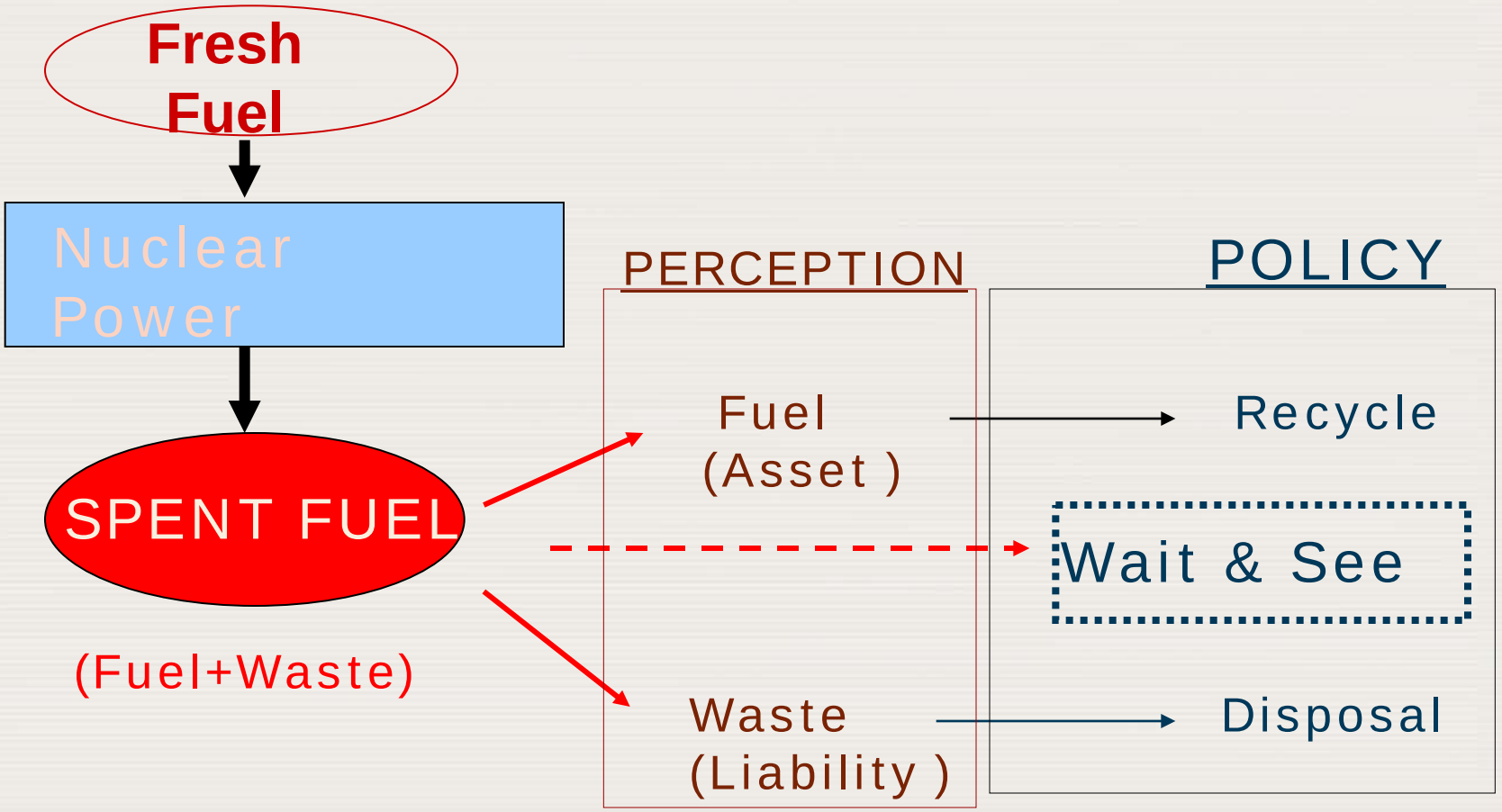
Spent fuel management strategies



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Projects of NEFW on SF management

- Promoting Strategies for Spent Fuel Management

  Objective: To improve the capability of interested Member States to plan and implement improved spent fuel management strategies by identifying problems and fostering collaboration and using information provided by the Agency.

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Projects of NEFW on SF management

- Providing Technical Guidance on Good Practices for Long –term Management of Spent Fuel

  Objective: To improve capability of interested Member States to develop individually, or through international co-operation methods for long term management of spent fuel.

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Spent Fuel Management Unit Activities in 2008/2009- reflecting the interest of Member States:

Spent fuel management unit of the IAEA Nuclear Fuel Cycle and Materials Section (NFMM) has the following topics on the agenda for years 2008/2009:

- **Spent fuel performance assessment and research (SPAR II CRP),**
- **Burnup credit applications**,
- **International conferences on management of power reactor spent fuel**,
- Implications of damaged spent fuel for storage and transport,
- Storage facility operations and lessons learned,
- **Systems integration considerations in spent fuel management**,
- Influence of high burnup and mixed oxide fuel on spent fuel
- management,
- **Spent fuel reprocessing**,
- Spent fuel storage costs,
- **Regional/multinational spent fuel management facilities,**
- Spent fuel inspections testing and monitoring for storage.

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Coordinated Research Project (CRP) on Spent Fuel Performance Assessment and Research (e.g. SPAR-II),

- This is a major program in which participating countries carry out and report on coordinated research and monitoring of fuel and storage performance over long periods (possibly 100 years and more).
- Potential aging or aging triggering mechanisms like stresses, strains, creep, corrosion and hydrogen effects were investigated for dry and wet storage technologies (2). Participants from 12 countries and European Commission are contributing with their research results and experiences to preparation of the technical document on this topic.

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Burnup credit (BUC) applications in spent fuel storage, transportation and disposal

- BUC activities attract interest of many Member States. Countries would like to get some economic benefits from its application and also show the more realistic safety margins related to criticality safety in spent fuel management activities,
- Some countries in Europe and the US are spearheading with these applications and others are following.

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IAEA Documents on Burnup Credit Applications

- Advances in Applications of Burnup Credit to Enhance Spent Fuel Transportation, Storage Reprocessing and Disposition, IAEA TECDOC-1547, Proceedings of a TM in London, 29 August-2 September 2005,
- Practices and developments in spent fuel burnup applications, IAEA-TECDOC-1378, Proceedings of a Technical Committee meeting in Madrid, 22-26 April, 2002,
- Implementation of burnup credit in spent fuel management systems, IAEA-TACDOC-1241, Proceedings of a Technical Committee meeting in Vienna, 10-14 July, 2000,
- Implementation of burnup credit in spent fuel management systems, IAEA-TECDOC-1013.

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Spent fuel systems integration (potential interface issues in SFM)

- Task related to optimization of systems and assurances of compatible interfaces between various spent fuel management, phases. Initiation of this task reflects the growing Member State awareness that in spent fuel management actions they need to be informed by full consideration of all key interfaces.
- The proposed task could contribute to subsequent resolution by gathering specific concerns regarding the storage-to-transport transition.

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Work on New Fuel Cycles In IAEA

- Nuclear Fuel Cycle and Materials Section
  - Spent Fuel Management Unit
  - Advanced Nuclear Fuels and Fuel Cycle Unit
- International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)
  - Collaborative projects – IAEA is facilitating coordination among Member States for planning the development and deployment of innovative nuclear systems.
- Nuclear Power Technology Development Section
  - Involved with INPRO.

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REPROCESSING OPTIONS (current and in development); IAEA TECDOC-1587

- **Processes implemented today in commercial plants on industrial scale** – PUREX (France, Japan, UK, Russia, India).

- **Evolutionary technologies (Gen 3) based on aqueous separation methods derived from PUREX**: COEX, NUEX, Simplified PUREX, THOREX, NEXT,REPA (France, UK, Russia, India, Japan, Russia).

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REPROCESSING OPTIONS (current and in development); IAEA TECDOC-1587

- **Innovative aqueous processes using new extractant molecules** :DIAMEX-SANEX, UREX, +3a, UREX+1a, GANEX, PARC, Water-extraction with the integrated process using two extractants, ARTIST (France, USA, China, Japan).

REPROCESSING OPTIONS (current and in development); IAEA TECDOC-1587

- **Non-aqueous technologies (dry route)-Pyrochemical processes**: DDP, Electro Metallurgical process, Pyro-chemical process (liquid-liquid) (Russia, USA, France)
- **Hybrid methods combining Hydro and Pyro processes**: FLUOREX gas-fluorine separation method, Combined process including gas fluorine and extraction technologies (Japan, Russia)

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REPROCESSING OPTIONS (current and in development); IAEA TECDOC-1587

- **Other innovative processes**: Fluid extraction, Ion exchange processes, Sedimentation processes (Japan and Russia, Belgium and Japan, Japan).

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- NOTE: Some processes may have limited applicability to specific fuels only.

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Additional Research Focus; IAEA TECDOC-1587

- **Major Actinides Separation,**

Hydrometallurgical processes (aqueous technologies**)**; Pyrometallurgical processes (non aqueous technologies); Other non-aqueous technologies.

- **Minor Actinides Separation,**
- **Fission and Activation Products Separation.**

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Some IAEA findings on reprocessing

- Some spent fuel recycling options like those that avoid separation of a pure plutonium stream, are at an advanced level of technological maturity. These could be deployed in the next generation of industrial-scale reprocessing plants, while others (such as dry methods) are at a pilot scale, laboratory scale or conceptual stage of development.

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Some IAEA findings on reprocessing

- The design of advanced reprocessing methods must deal with (1) safety, (2) the control and minimization of plant effluents, (3) minimization of the waste generation, (4) the production of stable and durable waste forms, and (5) economic competitiveness.
- International collaboration on the development of advanced reprocessing methods is essential to facilitate the future deployment of these technologies.

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IAEA involved in other nuclear initiatives

- IAEA proposal for internationalization of nuclear fuel cycle
- GNEP support; reliable fuel services and infrastructure
- Collaboration with OECD-NEA
- Russian Initiative
- NPT – Nuclear Proliferation Threat

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Connecting SF Management with Reliable Fuel Services; Interest of newcomers

- Investigating and monitoring SF performance in long term SF storage (SPAR II)- keeping all the SF management options open,
- Investigating current and future options for spent fuel management (i.e. reprocessing technologies),
- Promoting long-term SF data management.

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Connecting SF Management with Reliable Fuel Services; essential studies

- Investigating application of regional SF Management facilities.
- Investigating economics of SF Management phases.
- Improving infrastructure and conditions for financing nuclear power plants.

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Connecting SF Management with Reliable Fuel Services; Some New Initiatives

- Take-back fuel and fuel lease are appealing concepts especially for new countries interested in nuclear energy,

Advantages:

- Proliferation resistance of the concepts,
- Eliminate/minimize problems with the SF Management for new countries interested in nuclear energy.

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Some general conclusions

- Back end fuel cycle and in particular SF Management has essential interfaces with the overall nuclear fuel cycle,
- SF Management may be an obstacle for new countries interested in nuclear energy,
- Reprocessing and recycle capacities can have large impact on future Reliable Fuel Services.
- SF Management in such a way to keep the future management options open.

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Some general conclusions

- Non proliferation concerns will continue to be high on the agenda and will warrant the effort in arranging for multilateral approaches in nuclear fuel cycle,
- Long term storage over 100 years or more likely for many countries.
- Burnup Credit can be a factor in many SF activities.

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Other Agency Programs with inputs to SF Management

- INPRO (International Project on Innovative Nuclear Reactors and Fuel Cycles),
- PRIS (Power Reactor Information System),
- Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management,
- Safety standards (i.e. TS-R-1 for transport),
- Safety Review Services.

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Thank you for your attention!

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Which organizational units in the IAEA are dealing with SF Management ?

Nuclear Energy Department

1. Nuclear Fuel Cycle and Waste Technology Division (NEFW)

1.2. Nuclear Fuel Cycle and Materials Section

1.2.3. Management of Spent Fuel from Nuclear Power Reactors

Department of Nuclear Safety and Security

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