IAEA Spent Fuel Performance Assessment and Research Programmes (SPAR II and III)

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Structure

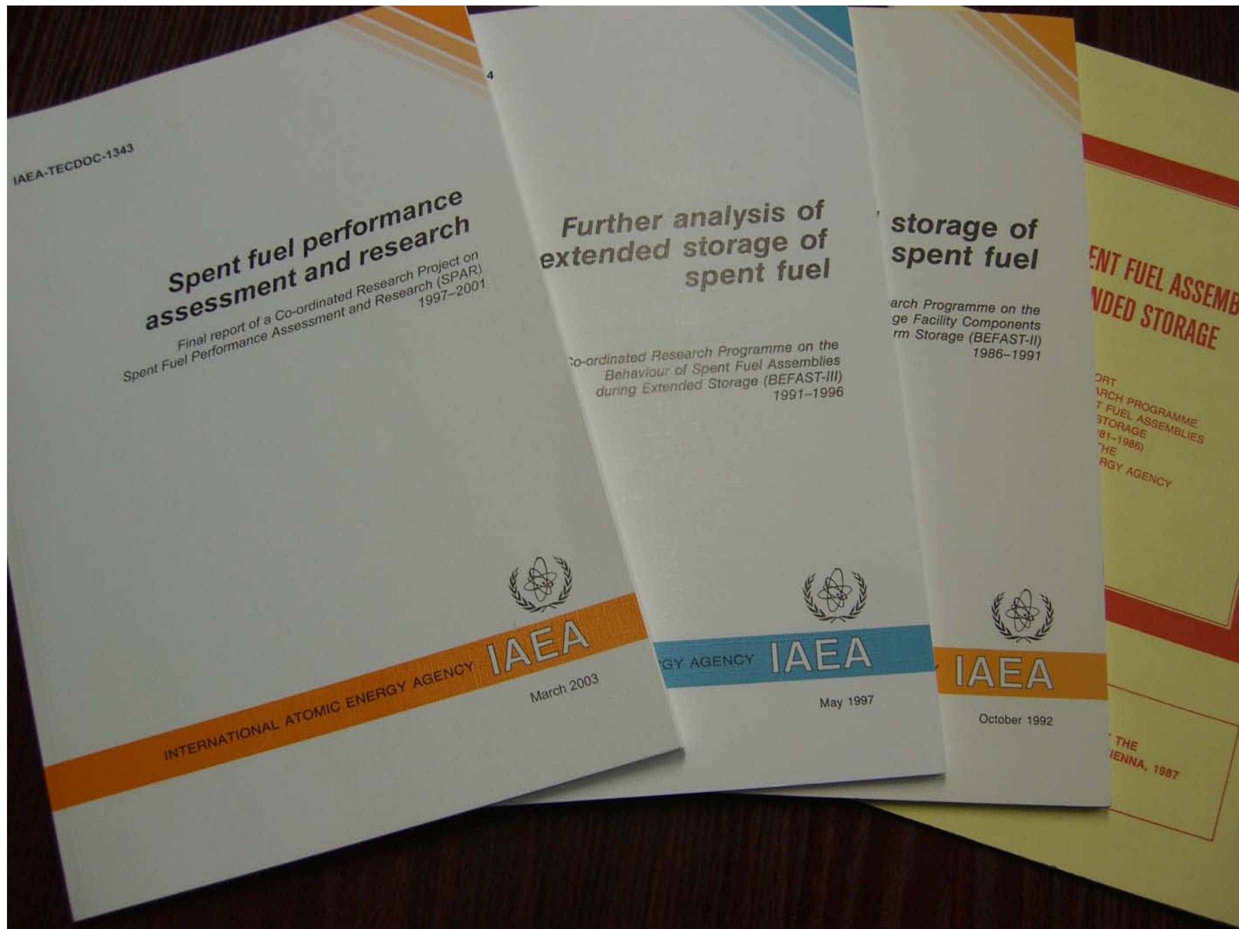
- Introduction
  - CRPs
  - SPAR history
- SPAR-II
- SPAR-III
- Conclusions
  - Wet storage
  - Dry storage

Introduction, CRP

- IAEA Statute:
  - The IAEA is authorized to encourage and assist research on, and development and practical application of, atomic energy for peaceful purposes throughout the world and to foster the exchange of scientific and technical information
  - The IAEA Coordinated Research Programmes (CRP) are designed to contribute to this mandate, by stimulating and coordinating the research by scientists in IAEA Member States in selected nuclear fields
- The typical duration of a CRP is 4-5 years
- IAEA selects the participating institutions (normally 8-12)
- Three Research Coordination Meetings (RCMs) during the course of the CRP

Introduction, CRP

- A final report is prepared and published as a Technical Document (TECDOC)



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Introduction, SPAR

- The IAEA CRP Spent Fuel Performance Assessment and Research (SPAR-I) was initiated in 1997
- A follow-up programme (SPAR-II) was started in 2002.
- SPAR-III has just commenced

SPAR-II

- Objective: Development of a technical knowledge base on long term storage of power reactor spent fuel through evaluation of operating experience and research by participating member states, namely
  - Fuel and materials performance evaluation under wet and dry storage;
  - Surveillance and monitoring programmes of spent fuel storage facilities;
  - Collection and exchange of relevant spent fuel storage experience of the participating countries

SPAR-II

- Participants: Canada, European Union, France, Germany, Hungary, Japan (2), Republic of Korea, Slovakia, Spain, and USA
- Observers: Sweden, UK
- Three RCMs:
  - 2005 Karlsruhe, Germany;
  - 2006 Tokyo, Japan;
  - 2008 Hungary
- TECDOC submitted for publication

SPAR-III

- Objective: Basically the same as SPAR-II, but more emphasis some special aspects of storage and on sharing the available information of operating experience by the participating member states. Some new elements:
  - Assessment of impact of interim storage on associated spent fuel management activities (like handling and transport);
  - Facilitate transfer of knowledge by documenting technical basis for spent fuel storage;
  - Creating a synergy among research projects of the participating Member States; and
  - Developing the capability to assess the impact of potential deterioration mechanisms on fuel and spent fuel storage components

SPAR-III Specific Activities

- **Zirconium-based alloys**
  - Review of potential fuel degradation mechanisms and their relevance for extended long term storage and future spent fuel management activities
  - Questions related to the storage of high burnup, or MOX fuels and their impact on materials
  - Systematic review of criteria for fuel storage licensing, re-licensing and for use of burnup credit
  - Questions related to the storage of defective fuel or fuel debris
  - Establish/update a country-by-country data base
- **Magnox and AGR fuel**
  - Consequences of increased burnup on AGR fuel sensitization
  - The influence of improved water chemistry on failure rate reduction
- **Construction materials**
  - Behaviour of different pool structure materials (e.g., different SS, epoxies, etc.) during extended operation periods up to 100 years
  - Long term behaviour of dry storage construction materials at elevated temperatures and under irradiation for extended storage

SPAR-III

- Participants: Argentina, European Union, France, Germany, Hungary, Japan (2), Korea - Republic of, Slovakia, Spain, United States of America (2)
- Observers: Sweden, Switzerland, UK
- First RCM: November 2010, Tokyo, Japan

Overview of research subjects

Long-term Behaviour	B-I	B-II	B-III	SPAR	SPAR-II	Surveillance	B-I	B-II	B-III	SPAR	SPAR-II	Facilities & Operation	B-I	B-II	B-III	SPAR	SPAR-II
Material aspect (cladding & components)	X			X	X	Monitoring; Wet + Dry -Environment - Components - Fuel assemblies - Workers' dose rate			X	X	X	Capacity enhancement - High density racks - Re-racking - Double tiering - Doped coolant - Rod consolidation		X			
Degradation mechanisms and models	X	X		X	X	Fuel conditions - Operational - Fabrication - Technology - Defected fuel rods and assemblies		X	X	X	X	Changing modes Wet – Dry		X	X	X	X
Validation **- experiment** **- experience**		X	X	X	X	Different reactor types		X	X	X	X	Handling of heavily damaged fuel		X	X		X
												System performance	X	X	X	X	X

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Conclusions, wet storage

- For undamaged zirconium-alloy clad fuel, all known failure mechanisms, such as oxidation, stress corrosion cracking, pitting, crevice corrosion, hydriding, galvanic effects, fission product attack, water logging, etc., could be excluded under proper storage conditions
- Fuel and the environment were monitored by using both conventional and special methods. Development work on experimental procedures, such as corrosion monitoring, was undertaken by some participants
- Adherence to the specified pool water chemistry was essential to prevent fuel degradation during pool storage for all types of spent fuel

Conclusions, wet storage

- Defected fuel, in some cases, was stored in canisters; however, no cladding deterioration or significant fuel losses or changes in defects were detected
- Experience with liner and rack materials indicated no deterioration under proper water chemistry conditions in pool components

Conclusions, dry storage

- The storage of zirconium-alloy-clad spent LWR fuel in an inert-gas atmosphere (preferably He) is a proven technology
- Positive experience with dry storage is available for storage periods of more than 25 years
- Degradation of fuel assemblies due to storage is unlikely; in all operational applications, no significant fuel degradation in storage has been observed

General Conclusions

- The fundamental R&D questions have been answered
- There is no need for major efforts to solve the basic questions of material science - spent fuel storage is a mature and safe technology
  - the technology itself is simple and good engineering solutions have been selected
  - irregularities that could lead to problems during storage could be solved through international cooperation
- The experience recorded in the SPAR publications can be useful for all countries who have limited nuclear programmes or fuel types for which there is now wide database

THANK YOU FOR YOUR ATTENTION

QUESTIONS?