Research Reactor Fuel Cycle Issues

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Topics

- Conversion of the reactors from HEU to LEU
- Repatriation of SNF to the country of origin
- Spent fuel storage
- Final stage of the fuel cycle

Conversion of the reactors from HEU to LEU

According the information to the RRFM08

- 208 research reactors in the world are concerned in the conversion problem.
- 56 have already been converted,
- 78 are beyond scope,
- 46 are planned for conversion with existing LEU fuel.
- 28 are high performance reactors, also planned for conversion but these will need fuel of a uranium high density

The information about the current status of HEU-reactors should be upgrade periodically on the base of questionnaires

Conversion of the reactors from HEU to LEU

- Several reactors were converted during last year but the problem is still important.
- For small and medium neutron flux reactors the problem is mainly political and financial problem - it requires only corresponding official decision and adequate funding. The qualified and suitable fuel is available

For further successful realization of the conversion it is necessary to support the efforts of small countries or countries with small nuclear activity.

Conversion of the reactors from HEU to LEU

- Now all countries announced about their intensions to reduce enrichment not only in foreign reactors but in domestic reactors too.
- But for more important high-flux reactors the process is only at the feasibility study.

Conversion of the reactors from HEU to LEU

The conversion of high or near high flux reactors is the serious problem till now. Such reactors operate only in several countries: USA, Russian Federation, France, Germany, Belgium, China, Japan.

Conversion of the reactors from HEU to LEU

For the conversion of high or near high flux reactors is necessary to have qualified high-density fuel.

The irradiation tests of U-Mo fuel are in progress. In particularly these tests in the reactor MIR in RIAR will finished and postirradiation tests will carry out.

Russian goal is to have the qualified U-Mo fuel in 2011

HIGH FLUX REACTORS USING HEU OR PLUTONIUM FUEL

1	**Belgium**	**BR-2**
2	**France**	**HFR**
3	**France**	**ORPHEE**
4	**Germany**	**FRM II**
5	**U.S.A.**	**ATR**
6	**U.S.A.**	**HFIR**
7	**U.S.A.**	**NBSR**
8	**U.S.A.**	**MITR-II MASS. INST. TECH.**
9	**U.S.A.**	**MURR UNIV. OF MISSOURI**
10	**China**	**HFETR**
11	**Russia**	**BOR-60 (+Pu)**
12	**Russia**	**IR-8**
13	**Russia**	**IVV-2M**
14	**Russia**	**MIR.M1**
15	**Russia**	**SM**
16	**Russia**	**WWR-M**
17	**Japan**	**JOYO (Pu)**

REACTORS UNDER CONSTRUCTION OR PLANNING TO USE HEU OR PLUTONIUM FUEL

1	China	CEFR
2	Russia	PIK
3	France	RJH
4	Russia	MBIR

Conversion of the reactors from HEU to LEU

- Unfortunately the development of high-density U-Mo fuel delays due to recent fuel element failures in elements using this fuel. It produces some problems for the conversion of high flux reactors
- For some reactors (for example FRM-II), the accelerated development of high-density fuel is very important.

Conversion of the reactors from HEU to LEU

- There is a one relatively new problem. It deals with the use of **plutonium** in research and test reactors.
- This year the fast research reactor - CEFR in China will be commissioned. Russia have begun the preliminary work for the development of the of new fast research reactor – MBIR.
- Several critical assemblies and pulse type reactors now use the plutonium or MOX-fuel

  There are no plans for the conversion of these facilities!
- The use of plutonium in research reactors will increase and it means that the conversion of several research fast research reactors from plutonium fuel is impossible in principle.

Repatriation of SNF to the country of origin

- During many years the programs of the research reactors SNF repatriation to the country of origin are very important programs.
- In July 2008 the Technical Document of the Agency was published: IAEA-TECDOC-1593, Return of Research Reactor Spent Fuel to the Country of Origin: Requirements for Technical and Administrative Preparations and National Experiences.

Repatriation of SNF to the country of origin

- International activities in the back-end of the research reaactors nuclear fuel cycle are at present dominated by the research reactors SNF take back programmes, the United States of America Foreign Research Reactor Spent Nuclear Fuel (FRRSNF) acceptance programme and the Russian Research Reactor Fuel Return (RRRFR) programme.
- The major goal of the separate take-back programmes for USA and Russian origin fuels is to eliminate inventories of Highly Enriched Uranium (HEU) by returning RR spent nuclear fuel to the country where the fuel was originally enriched.

Repatriation of SNF to the country of origin

- The TECDOC-1593 considers practically only the problems of the repatriation of US origin fuel. Only one report considers the problem of the repatriation of SNF from Uzbekistan to Russia.
- In 2008 RRRFR program continue to realize. The next table presents current status and future plans of the Russian-origin fuel repatriation to Russia.

- It seems that now there is the time to discuss the problem of the repatriation of all SNF fuel to the coutry of origin, not only US and Russian fuel

History of the repatriation of the HEU Russian-origin fuel

Country	Year	Fuel		Reactor status
		Fresh	Irradiated	
Serbia	2002	+		Shutdown
Romania	2003	+		Shutdown
Bulgaria	2003	+		Under reconstruction
Libya	2004,2006	+		Operation
Uzbekistan	2004	+		Operation
Czech Republic	2004,2005	+		Operation
Latvia	2005	+		Shutdown
Uzbekistan	2006		+	Operation
Poland	2006	+		Operation
Germany	2006	+		Shutdown
Poland	2007	+		Operation
Vietnam	2007	+		Operation
Czech Republic	2007		+	Operation
Latvia	2008		+	Shutdown
Bulgaria	2008		+	Under reconstruction
Hungary	2008		+	Operation

Plans of the repatriation of the HEU Russian-origin fuel

Country	Year	Fuel		Reactor status
		Fresh	Irradiated	
Ukraine	2009		+	Operation
Poland	2009		+	Operation
Belarus	2009		+	Shutdown
Romania	2009		+	Shutdown
Libya	2009		+	Operation
Kazakhstan			+	Operation
Serbia			+	Shutdown
Vietnam			+	Operation
DPRK		+	+	Operation (?)

Spent fuel storage

- The programs of the repatriation of SNF to the country of origin pay attention practically only to HEU-fuel.
- On the other side a big amount of LEU-fuel continue to storage at sites of research reactors.

What is the future of this fuel?

Spent fuel storage

- The situation with the fuel storage is dynamic and many countries can need a help owing the fuel corrosion during storage, failure of the surface of storage pool, insufficient capacity of storage pool etc.
- This problem is very important for countries with low nuclear activity, weak or absence adequate nuclear infrastructure in the country and by this reason they need a help of the Agency.
- The Agency must explore incentives to encourage facilities storing spent fuel in degraded or corroded conditions to return the fuel to the country of origin to reduce the current radiological risk and future decommissioning costs.

Spent fuel storage

- It is an important to have the prognosis of the situation in the storages of SNF and the adequate database on SNF developed by the IAEA can be very helpful
- Another possible task is the preparation of a technical document on good practice for the management and storage of research reactor SNF

Final stage of the fuel cycle

- An important question of this subject is reprocessing of the SNF. According to the technical policy of several countries the SNF shall be reprocess and it means that the adequate technology shall be ready to the moment of the implementation of new high density fuel.

Final stage of the fuel cycle

- By this reason development of reprocessing technology for the high density dispersion or monolithic U-Mo fuel can be a serious problem owing the addition of Si either in the Al matrix or in the U-Mo itself.
- This addition seems can play the positive role of Si on the fuel behavior under irradiation. But it can play a negative role in reprocessing technology because in the past only the bad behavior of Si in reprocessing processes was one of the main reasons that prevented the use of silicide fuel for conversion of many reactors.