1. IDENTIFICATION DPP No. 2018_D27_127

Provisional Title	Impact of Fuel Density on the Performance and Economy of Research Reactors

2. RATIONALE

Research reactor fuel technology continues to evolve, driven in part by the international efforts to develop high density fuels to enable the conversion of more reactors from HEU to LEU fuels. These high density fuels, e.g. U-Mo, may offer economic benefits for other reactors, despite being more expensive initially, because they offer the prospect of higher per-assembly burnup, thus reducing the number of assemblies that must be procured, and more flexibility in spent fuel management compared to the currently qualified and commercially available LEU silicide fuels. These high density fuels are still under development and are expected to be commercially available in the near future.

Increasing the uranium loading (by increasing fuel density) generally results in the ability of the fuel to be resident in the reactor for a longer period of time while maintaining performance. However, there are certain limits to the benefits that can be achieved; an issue that needs to be further studied.

The use of increased density fuel also has some potential problems, particularly the limitations of being able to remove the extra heat from the core and the capacity of the control rods to achieve sub-criticality or indeed control the reactor. If these limits are reached with the higher density fuel available there are ways to deal with this problem. One example is the introduction of burnable poisons, but it has to be quantitatively evaluated. In addition, although non-silicide high density fuels may feature more flexible spent fuel management options, comprehensive comparative studies on the reprocessing of U_3Si_2 and U-Mo fuels have not been performed yet.

Because of the complex character of multiple overarching factors of the fuel cycle, it is difficult for potential users of the high density fuel to clearly understand what benefits are expected, for example, if U-Mo fuel with a uranium density higher than 4.8 gU/cc is used instead of U_3Si_2 fuel.

3. OBJECTIVE

The objective of this publication is to make available to the research reactor community a comprehensive, high quality study on the impact of fuel density on the performance and economy of the research reactor nuclear fuel cycle, in view of the above mentioned potential economic advantages of using higher density fuels in research reactors.

4. SCOPE

This document will address the impact of fuel density on the performance and economy of the research reactor nuclear fuel cycle, discuss the potential economic advantages of using higher density fuels in research reactors and elaborate on the possible problems that may result from the use of increased density fuel.

The document will concentrate on high density fuels of the type used in most research and test reactors, i.e., a fuel consisting of a fuel meat contained within a metallic cladding. The scope

of the publication will include fuels that are either available or are still under development and are expected to be commercially available in the future, specifically U-Mo fuels.

This publication will:

- Identify significant fuel cycle factors affected by adopting higher uranium density LEU fuel in research reactors;
- Address potential problems that may result from the use of increased density fuel and the different approaches to deal with these issues;
- Present and discuss studies, carried out on research reactor of different type and power, on the impact of uranium density LEU fuel on the economy of research reactor nuclear fuel cycle; and
- Discuss considerations, related to nuclear fuel density in connection with the economy of the fuel cycle, to be made by research reactor newcomer countries and/or organizations at the time of selecting/designing their new facility.

5. USERS

Potential users of this document include research reactor managers and operators, managers of new research reactor projects, fuel developers, regulatory bodies, and decision makers in Member States and/or organizations operating research reactors.

6. RELATED IAEA PUBLICATIONS

Related publications are:

IAEA NES NF-T-5.2	Good Practices for Qualification of High Density Low Enriched Uranium Research Reactor Fuels (2009)
IAEA NES NG-T-4.3	Cost Aspects of the Research Reactor Fuel Cycle (2010)

7. INTERFACES

Internal within IAEA:

- NSNI / Research Reactors Safety Section

External to IAEA:

- Research reactor community
- RERTR Programme
- Managers of new research reactor projects

8. PRODUCTION

Document Preparation Proposal	August 2013
Meetings held	CM: Q2, 2013; CM: Q4, 2013
First draft for DCT review	July 2015
Planned meetings	NA
Submission final draft to DCT	December 2018

9. OTHER RELEVANT ISSUES

None