Consultancy to
"Perform an Assessment of Accelerator Driven Systems (ADS) Dynamics and Safety Physics"

Terms of Reference

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Background: Different strategies for dealing with nuclear waste are being followed by various countries because of their geologic situations and their views on nuclear energy, reprocessing and non-proliferation. Partitioning and Transmutation (P&T) offers potential alternative paths that would, if successful, essentially eliminate plutonium, higher actinides, and environmentally hazardous long-lived fission products from the waste stream destined for permanent storage. P&T enhances the viability of permanent waste repositories. As such, P&T has increasingly become of worldwide interest and could be an important component of strategies to deal with the waste management challenges.

One possibility, for which renewed interest has been triggered by proposals made around 1994 by C. Rubbia at CERN (*Energy Amplifier (EA)* concept), to implement P&T is linked to the development of sub-critical hybrid systems that combine a powerful proton accelerator to produce spallation neutrons with a sub-critical core driven by this source to a relatively high fission power. Accelerator Driven Systems (ADS) can also be envisaged for power production.

The fast spectrum ADS is supposed to be the most efficient device for transmutation and incineration of Minor Actinides, nevertheless critical reactors will be included into the investigations.

A further option for transmutation and incineration is represented by Molten Salt Reactors, to be realized as critical and sub-critical accelerator driven versions.

The efficiency of both critical reactors and ADS for the transmutation and incineration of nuclear waste is strongly related to the utilization of so-called dedicated fuels (solid fuelled reactors). In the ideal case, these fuels should consist of pure TRUs without fertile materials, such as ^{238}U or ^{232}Th, to achieve highest incineration/transmutation rates. These fertile-free fuels may suffer from deteriorated thermal or thermo-mechanical properties, e.g., reduced melting point, reduced thermal conductivity or even thermal instability. In addition, analyses have shown that the use of "dedicated" fuels may lead to a strong deterioration of the safety parameters of the reactor core as, e.g., the void worth, the Doppler, and the kinetics parameters (neutron generation time, and $ß_{eff}$). A dedicated core may also contain multiple "critical" fuel masses, resulting in a considerable re-criticality potential. ADS, due to the sub-criticality of the system, should be able to cope with the poor safety features of such fuels. However, detailed analyses have to prove the safety case for these dedicated transmuters.

To meet expressed Member States' needs, the IAEA has initiated a Coordinated Research Project (CRP) on "Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste". The final goal of the CRP is to deepen the understanding

of the dynamics of transmutation systems, e.g., the accelerator driven system, especially systems with deteriorated safety parameters, qualify the available methods, specify the range of validity of methods, and formulate requirements for future theoretical developments. Should transient experiments be available, the CRP will pursue experimental benchmarking work. In any case, based on the results, the CRP will conclude on the potential need of transient experiments and make appropriate proposals for experimental programs.

Action Plan: The specific objective of the proposed CS is to finalize the definition of the design and safety parameters of the transmutation concepts being investigated in the ongoing CRP. Moreover, the CS will discuss and agree on the methodologies (data and codes), as well as on the specifications for the various protected and unprotected transients to be analysed. Last but not least, the CS will allow all those participants who have joined the CRP after the first RCM (or were not able to attend the first RCM) to review and discuss the specifications of the analytical benchmark models, the methodologies to be applied, and the sequence of the benchmark exercises.

Expected Outcome or Products: Final agreement on the specifications of the benchmark exercises, their sequence, and the methodologies (data and codes) to be applied in the CRP on "Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste".