EXECUTIVE SUMMARY

The Partitioning and Transmutation (P&T) option as an alternative Waste Management Strategy is examined in this report along different lines.

The first approach is a global analysis of the present situation in the backend of the fuel cycle where it appears that two opposite concepts (direct disposal versus reprocessing and Pu reuse) are equally important on the worldscene. In order to allow P&T to be fully developed a doubling of the present conventional reprocessing capacity is required. The radioactive source term with long term implications is discussed and the relative importance of each of the long lived nuclides is quantified on the basis of their hazard index and its evaluation as a function of cooling time.

The radiochemical and nuclear engineering data of Minor Actinides (MA) and Long Lived Fission Products (LLFP) show that, on the basis of their radiotoxicity indexes, the Pu 241 - Am 241 - Np 237 sequence has the greatest radiological impact followed by Am 243 as a precursor of Pu 239. In order to reduce HLLW to an actinide concentration level which is compatible with surface storage, very high DF's are to be obtained. However a more reasonable approach is to reduce the concentration of MA and LLFP in a waste repository with a factor between 10 and 100 depending on the critical nuclide and on the prevailing hydrogeologic conditions. The reduction of the nuclide inventory will decrease the potential risk in the 1000 to 10.000 years period and reduce the time interval during which the proportionally decreased source term will determine the radiological impact of the repository on the geosphere.

The second field influencing the P&T option is the partitioning feasibility. Though extensive studies have been published on the partitioning of MA and LLFP an important effort will have to be accomplished in order to make the P&T option technologically valid.

In the context of improved reprocessing the Np extraction deserves the first attention in order to quantitatively reroute this nuclide in one waste- or product stream, where it can be used as a starting point for transmutation operations. The extraction of Am - Cm from HLLW is still in

the laboratory development stage but it appears that the coupling of an improved PUREX process flowsheet with the TRUEX process is capable of achieving a significant decontamination. The main issue to be resolved is the Am Cm / Rare Earth separation for which no fully satisfactory method is available.

Among the LLFP, I 129 and Tc 99 are the most important ones and methods exist to transform them into a target for eventual transmutation. Other LLFP have only a limited radiological impact or cannot be separated unless isotopic separation is performed.

The third aspect of P&T is conditioning and fuel fabrication of MA which are the critical steps before transmutation can be envisaged. Np 237 can be homogeneously mixed with MOX fuel and submitted to irradiation in LWR and/or FBR's, but the subsequent recycle operations will have to take into account increased Pu 238 concentration. Am - Cm recycle undoubtedly is the most difficult step since the separation from Rare Earths has not yet been accomplished on pilot scale and that a completely new remote handling technology has to be developed for that purpose.

Pyrometallurgical processing of spent fuel to transform the MA into a new metal-alloy-type fuel is a new venture which needs a very large R&D effort to become comparable in confidence level with aqueous recycle methods.

The last and most important aspect of P&T is transmutation, which covers two distinct concepts : transmutation to a short lived actinide and/or incineration to fission products. Transmutation in LWR's and HFR's involves the transformation of Np 237 into Pu 238 and a buildup of a heavier isotope fraction of Am-Cm. Homogeneous recycling of MA in FBR's is from reactor physics point of view feasible and the output of 6 LWR's can be transmuted in one FBR of the same power. Heterogeneous recycle in FBR's has principle advantages from fuel fabrication point of view but critical thermohydraulic problems have been encountered in the fuel assembly design.

LMR's and particularly ABR's are the most suitable answers to the transmutation issue since their “incineration” potential is by far the highest

among the fast reactors. The transmutation yield is yet limited to about 10 % per year which implies long transmutation periods for a given MA inventory.

Accelerator driven transmutation is the most challenging option which will require very long R&D efforts to upgrade the high energy physics machines to production tools which can be operated in conjunction with a large nuclear inventory of MA arranged as a subcritical reactor vessel surrounding the proton beam inlet. The extreme high neutron fluxes attainable in such facilities provide a new outcome for long lived fission product transmutation.