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POSSIBLE IMPROVEMENTS TO THE REFERENCE PLUTONIUM FUEL CYCLE

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1. INTRODUCTION

In the frame of the International Nuclear Fuel Cycle Evaluation (INFCE) a document "Mixed Oxide Fuel Fabrication Facility" which is dealing with the general description and the operating conditions of a reference commercial LWR plutonium fuel fabrication plant, has been written. (Co-chairman WG.4/1B - March 1978 - Belgium). As a base case, the main activities of the described plutonium fuel fabrication plant, isolated from any spent fuel reprocessing plant were :

- to produce UO_2-PuO_2 pellets, rods and fuel assemblies, starting from PuO_2 powder, natural or depleted UO_2 and structural materials;
- to recover the maximum Pu quantities from scraps and wastes and to process with those up to products which either may be recycled or may be shipped for ultimate disposal.

Starting from the described reference case, the goal of this note is to define various improvements or different plutonium fuel cycle concepts which could reduce the overall risks and ameliorate the economy of the plutonium industry.

2. CRITERIA FOR NEW Pu FUEL CYCLE CONCEPTS

Starting from the reference case, three main criteria have been taken into account to define sequences of possible improvements.

2.1. Any improvement may be applied if it ameliorates not only the level of non proliferation of atomic weapons but also all the other safety problems associated with the Plutonium Technology. (Pu effluents, radiation doses, potential risks in case of major incidents etc.).

2.2. To assure the reliability of its performance, any improvement has to be progressively applied starting from realistic data made available by the existing industrial units and/or technological development programmes.

2.3. The time delay associated with the industrial application of any proposed improvement has to be compared with the time delay made available to economically fulfil the energy requirements.

3. POSSIBLE IMPROVEMENTS

3.1. Colocation (Institutional arrangement)

The location on the same site of the spent fuel reprocessing plant, the mixed oxide fuel fabrication plant and the waste treatment facilities would be beneficial for the environment. As a matter of fact such a colocation would reduce the plutonium bearing material treatment facilities (waste treatment, plutonium analytical laboratories, etc), the waste volumes, the nuclear material transports, the proliferation level and the area where occasional accidents could occur.

Furthermore such an arrangement would reduce the overall operating costs when avoiding duplication of peripherical services such as the general workshop, the site physical protection, the nuclear material accountancy systems, the health physics, etc. Various work performed in this field (AIEA and CEC) confirm the advantages of the integrated site including the reprocessing plant and the plutonium fuel fabrication plant.

3.2. Coconversion (Alternative Technology)

At present time, most of the pilot and industrial reprocessing plants separate the plutonium from the uranium (Purex Process). The plutonium nitrate is converted into PuO_2 powder which is used as feed powder for the plutonium fuel fabrication. To avoid the presence of pure PuO_2 powder in the fuel fabrication plant and therefore to reduce the level of proliferation, the uranium nitrates and the plutonium nitrates could be blended and subsequently coconverted into mixed oxide powders which could then be used as master blends for the plutonium fuel fabrication.

Such a philosophy would reduce the proliferation level, the plutonium bearing material treatment facilities (only one facility for mixed nitrate dissolution), the personnel radiation exposure, the potential risks in case of accidental events and the Pu contents in the wastes. Furthermore it would reduce the fabrication costs by limiting to maximum two the number of feed powder types (UO_2 and coconverted mixed oxide powders) and by reducing the number of powder processing steps which generate dusts and wastes with relatively high Pu contents.

Experience has shown that plutonium-bearing powders are not readily contained by the process equipment and that the dust deposits are the causes of contamination of the materials inside the process enclosures and of radiation exposure to the operators. Furthermore, the risks for the environment in case of accidental events are mainly due to the presence of plutonium-bearing powders and subsequent dusts. For public acceptance reasons and for the benefit of the Pu industry it would therefore be recommended to apply Pu fuel fabrication processes using coconverted mixed powders which limit dry powder handling. As an example, the SOL-GEL type processes which omit dry powder handling and possess the potential to be developed to fully remote operations could be succesfully applied to fabricate pellets or vibratory compacted fuels.

It has to be added that the use of coconverted mixed oxide powders would increase the fuel dissolubility without any powder milling operation.

3.3. Coprocessing (Alternative Technology)

As previously reported, mixed oxide materials could be produced from U-Pu mixed nitrates so that Pu-nitrate arising from the reprocessing plant could be used without conversion into pure PuO_2 powder. However, to reduce the level of proliferation, it could be preferable to only partially separate uranium from plutonium and convert the mixed nitrate directly into the fuels. According to such a technique, Pu-nitrate undiluted by uranium nitrate would never exist. It is obvious that the coprocessing takes advantages of all the improvements previously observed for the coconversion.

4. TIME DELAY FOR APPLICATION

From present knowledge and experience it can now be expected that the colocation and the coconversion could be successfully applied in the medium term on an industrial scale. In that case the unaccessibility to pure plutonium compound process steps should reduce the proliferation level. It is obvious that the colocation could be applied with or without the coconversion and vice versa.

The application of the coprocessing seems to only depend on the time delay required to get the data to be made available by the development programmes.