other radioisotopes to the list to be removed. He noted the suggestion that accelerators have no advantages over reactors for transmuting actinides but may have with regard to fission products.

Dr. Kiselev presented the case for using "electro-nuclear facilities" to transmute actinides and other waste radioisotopes, and drew attention to the wide range of Russian research institutes that were engaged in studies on them. The existence of this body of knowledge could be useful in setting out future directions for international co-operation. A number of modes of operation of ENFs were outlined, including the use of fuels in liquid form for which technology would still need to be developed. MINATOM was said to consider fast reactors as the primary means for actinide burning with accelerators as a back-up technology. They were also capable of increasing the usable energy resource base in bringing plutonium and thorium into play.

Dr. Salvatores had indicated an impressive coherence of views about goals when presenting the joint paper by CEA and PNC. This closeness of view boded well for the future of collaboration.

The presentation by EFFTRA had shown that great progress had been made in setting up a collaboration with an impressive programme, making use of a variety of European reactors in appropriate ways. The spirit of compromise and co-operation was itself a lesson for all participants in P&T activities.

SYSTEMS STUDIES
Chairman: J. Lefèvre

Noted that system studies form, at the present state of P&T, the main focus of the meeting.

What is it possible to make, what limits are we capable to reach, what are the best routes to follow and at what financial and safety costs are we able to achieve P&T goals? These are the principal questions that need to be considered, even if they cannot be answered completely at this moment.

During this session, six presentations were made. Unfortunately, maybe because the term "system studies" was not sufficiently precised, only three of the presentations were really centered on the subject.

CEC study

Different strategies were considered:

- reference case: without reprocessing (R1).
- two scenarios with reprocessing (losses 0.3% U and 0.5% Pu) and reactor park burning UO_2 and MOX fuel (R2) and another reactor park including fast reactors (R3).

These scenarios without minor actinides (MA) separation and transmutation were compared with the following scenarios including MA partitioning and transmutation.

- RP1-1 compared to the R2 scenario, characterised essentially by transmutation in PWR for Np and Am with losses at recycling of O.3% U, O.5% Pu, 5% Np and Am and 100% Cm.
- RP1-2 compared to the R3 scenario, characterised essentially by transmutation in fast reactor with the same losses for MA.

At least the RP2 scenario take into account CAPRA type fast reactors and best reprocessing performances including Cm which was stored.

The results were important because all the hypotheses made were realistic and, therefore, even quantitatively were applicable.

The final estimation of extra cost was in the range of 20% to 55% for the PWR scenario and 10% to 50% for the fast reactor scenario.

The gain on radiotoxicity was in the range of 10 to 100 factor compared to reference scenario. The scenario RP2 (with CAPRA) gave the most interesting result.

These results of this system studies could be considered as the minimum that could be reached today. Further improvements could be expected in the future.

JAERI study

The main aspect of the concept was to consider a P&T cycle separated completely from the conventional commercial fuel cycle for power reactors; this concept was named "double stratum fuel cycle".

Partitioning allow to separate HLW elements in four groups: TRU, Tc+platinum group metals, Sr+Cs and other elements.

The transmutation was performed in dedicated transmutation system:

- Actinide Burner fast Reactor (ABR) with 2 types:
  - L-ABR = Pb-cooled ABR
  - P-ABR = He-cooled ABR

- two types of accelerator-based transmutation system:
  - solid system
  - molten salt system.

The fuel was nitride for the ABR systems and the fuel fabrication was described by the carbothermic reduction process. The reprocessing of nitride fuel was proposed by a pyrochemical process with the molten-salt electro-refining.

JAERI also defined a priority for nuclides to be considered with the separation objectives.

The economic part was considered to be premature since all processes were not at the industrial stage. In general, the estimations were always very optimistic.

If the preliminary economic estimates made were considered, it could be concluded that:

- MA partitioning facilities: 1% to 2.5% of costs of investment and operation of actual reprocessing.
- ABR: 2.5 to 5% of thermal power by commercial reactors.
- Accelerator: +50 to 100% of the total cost.

It would be interesting to follow this system study in the future.

PNC study

As the definition of a "systems study" was not made sufficiently clear, this presentation did not answer related questions.

There was no doubt that PNC was working on "systems studies". It would be interesting at a next meeting to have a presentation on this type of work.

CRIEPI study

As for PNC, the presentation was a description of a technical system and considered only the conceptual part of the system study. There was no economic estimation, perhaps also because the CRIEPI system was based on futuristic systems.

Presentation by V.V. Orlov

This presentation addressed essentially liquid lead-cooled fast reactors and their application to burn actinides and to transmute long-lived fission products.

The performances mentioned were interesting, but as for the preceding two presentations it was not really a system study.

Consumption of actinides in ALMR by M.L. Thompson

The same remark as for the preceding presentation could be made. Unfortunately, a presentation of the complementary paper, which was only distributed, "Economics of ALMR Deployment in the United States" by ORNL was not made. In fact, the content of that paper was more in the frame of a "systems study".

Conclusions

In conclusion, it was noted that, even if definition of the subject was not made sufficiently clear, it was very important to have had the first estimations on the whole P&T systems: technical concepts, investments and operational costs and radiotoxicity reducing performance. These types of systems studies would be essential for a proper appreciation of P&T efforts in different countries.