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# 2008 PROGRESS REPORT ON RERTR ACTIVITIES IN ARGENTINA

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## ABSTRACT

Since last RERTR meeting, CNEA has deployed several tasks involving RERTR activities. Main goals achieved were exportation campaign of 42 HEU SNF to USA, the conversion of our RA-6 reactor core from HEU to a new LEU one, the optimization of the technology to recover U from fuel elements fabrication silicide scrap and the favorable outcome of the study on the comparative economics of HEU to LEU conversion technology for fission RI production.
Besides, CNEA also continued deploying an intense R&D activity to get a comprehensive understanding of U-Mo/Al compounds phase formation in dispersed and monolithic fuels, to develop possible solutions to VHD dispersed and monolithic fuels technical problems and to improve the diffusion of LEU target and radiochemical technology for radioisotope production.
Future plans include

- Completion of the core loading and start-up of the RA-6 reactor
- Development of a LEU dispersed U-Mo fuel prototype, to be irradiated in a high flux reactor in the frame of the ARG/4/092 IAEA's Technical Cooperation project
- Very high density monolithic U-Mo miniplates and plates using MEU and LEU fuel with Zry-4 cladding fabrication to be irradiated as a part of the RERTR program.
- Irradiation of miniplates and full scale fuel assembly at RA-3 reactor and plans to perform irradiation on higher power and temperature regime reactors.
- Optimization of LEU target and radiochemical techniques for radioisotope production.

## 1. Main goals achieved since Prague RERTR meeting:

a. RA-6 reactor core conversion

Although designed to operate with LEU core, since start-up in 1983 until June 30th, 2007 the reactor used HEU cores. As part of the support to the GTR Initiative, Argentina decided to convert the RA-6 reactor core from HEU to LEU. On October 30th, 2005 two contracts between CNEA and NNSA-DoE were signed, enabling the core conversion, the minimization of HEU uses in civilian applications in Argentina and to take part of the FRRSNF program to return SNF US origin to USA. It was already achieved:

- Swapping of HEU-LEU inventories: achieved on August 4th, 2006: This operation enabled the production of LEU U3Si2 for the replacement core.
- Removal of last HEU core: achieved on June 30th, 2007. HEU fuel assemblies were temporarily stored in the auxiliary pool, to be conditioned for the transport campaign.

o Fabrication of the replacement new LE U3Si2 based core (4.8 g/cc density in meat, Cd wire for neutronic absorption) and graphite based neutronic reflectors. Initial core fabrication achieved on August 23th, 2007

o Fabrication of interim storage casks and allocation in the reactor building to contain LL and ML wastes produced during the fuel conditioning process, achieved on July 16th, 2007. Achieved since Prague RERTR meeting:

o Export campaign of 42 HEU SNF: fuel conditioning, casks loading, inland transportation, cargo loading and departure (Nov. 7th, 2007)[i].

Conclusions:

o No HEU fuel or target (fresh or spent) remaining inventory

o USDoE-CNEA agreement to process in Argentina remnant fresh and spent HEU (production scraps and HEU used in target for fission RI production), recover U and downblend to LEU, separate Cs 137 and Sr90 for NM applications.

o All Argentine test reactor cores are converted to LEU as well as Mo99 and fission RI production.

b. The chemical technology for recovering U from silicide in fabrication scraps.

The increasing amount of silicide fabrication scraps, triggered the decision to develop this technology, performed at lab scale (full size plate DU silicide Al dispersed).

o Three steps: acid dissolution, extraction and de-extraction.

o Using mixer-settlers, air stirring and forced circulation of aqueous phase.

o 7 steps in extraction, 9 steps in de-extraction

o Full visibility (special glass used in mixers-settlers)

o After hours of process no obstruction due to Si deposition in settlers was observed.

o The recovered material fulfilled requested U purity specs.

This technology is ready to be implemented in recovery pilot plant (LTA facility) to recycle silicide production scraps.

c. The favorable outcome of the study on the comparative economics of HEU to LEU conversion technology for fission radioisotope production

The final restriction in 2001 of HEU supply for irradiation target prompted the decision of CNEA to find a LEU technology for fission Mo99 and other RI production. We successfully achieved an adequate replacement meat for targets, suitable to the alkaline digestion process used in the production plant. Our LEU technology satisfies the most stringent requirements of international quality for radiopharmaceutical products. HEU-LEU production comparative studies showed a better quality in LEU products: quality is out of discussion. In September 2005, CNEA began the regular production of high quality fission I-131, a by-product of Mo-99 production, meeting international quality standards.

New findings are that the comparative costs of converting to LEU technology the fission RI production, turns out to be practically insensitive[ii].

## 2. Ongoing works and future plans

a. OPAL event: diagnosis and corrective actions

After the 5th Cycle of the OPAL Reactor, 13 plates belonging to 5 peripheral fuel assemblies projected partially outside were detected. The affected fuel plates as well as all the fuel assemblies (FA) had been manufactured at the ECRI facility of the CNEA. Although these plate displacements did not produce release of radioactivity or any other abnormal situation in the reactor it gave place to ARPANSA's decision to stop the reactor for core change. Several investigations were performed to understand this unexpected behavior including fuel fabrication, operating conditions, primary coolant operation, power distributions, clamping conditions and vibrations. Others, like oxide layer thickness measurement on irradiated plates remain to be done. Although the swaging process complied international standards specs, it failed to hold plates in place. The absence in the design of a comb or stopper at the top of the FA disabled the action of a defense in deep mechanism. Because of the prototypical framework of the reactor and FA, the main reasons for this behavior are not still fully understood.

However, while the investigation activities are deploying, including the FE modeling of a FA under actual power, thermal-hydraulic and vibrational history, several corrective action are being taken. Hydraulic loop tests done on a dummy FA provided of stoppers at the upper part undergoing a tougher hydraulic regime than OPAL's revealed that this device avoided plate displacement (14 free plates).A new loop test including electro-thermal stripes on plates is planned for the near future. As a result of a careful revision of the fabrication process some improvements to the swaging process were already implemented for the RA-6 replacement core fabrication and further improvements are under development. CNEA is making a full revision of the engineering to adequate the FA design to actual demands of the OPAL reactor, regarding power, thermal – hydraulic and vibrational regimes.

b. MARIA reactor LEU replacement fuel

As a part of the international effort to convert test reactor to LEU cores, INVAP and CNEA participated and won the international bid organized by IAEA to provide the MARIA reactor LTA LEU fuels to test them for further conversion to LEU MARIA's core. An amendment requested by the client of the original contract is being signed.

c. Target supply to ANSTO and EAEA

Our LEU technology for Mo99 and other fission RI production was sold by INVAP to ANSTO (Australia) and EAEA (Egypt). Targets supply for both agencies are scheduled.

d. Very High Density Fuel Development

Since 1998 CNEA is carrying on R&D activities on VHD fuels to reduce fuel cycle lengths, release core positions for irradiation devices, to contribute to the international effort on non-proliferation and recently to support the GTRI.

CMAD (VHD fuels), is a special project who seeks the increase of knowledge in the research and development fields:

Our research work is focused on U-Mo properties through out of pile and in pile tests and in the alternative fuel UZrNb. Our development work is focused on irradiation tests of prototypical FA and miniplates /plates based on U-Mo dispersed in Al-Si matrix and in monolithic U-Mo in Zry-4 cladding[iii].

5. HEU recovery and downblending to LEU is one of the agreements between CNEA and NNSA-DoE. It will be performed in the LTA facility which was fully refurbished to satisfy demands of the ARN (national regulatory body). Documentation of the LTA plant and procedures are being studied by the ARN. It is expected that the operational license will be granted this year.

## 3. Conclusions

CNEA has collaborated in the frame of the RERTR program since its very beginning. Today is deploying an intensive and concrete R&D activity on LEU solutions.

- Concerning HEU minimization, CNEA achieved this goal in our country.
- Concerning core conversions to LEU, CNEA also achieved this goal in the RA-6 reactor and participates internationally with INVAP to provide solutions and the experience of the Argentine nuclear sector to the reactor community.
- Concerning VHD fuels, we focused our work on some promissory lines for technological solutions both on dispersed and monolithic fuels in 8-16 gU/cc range.
- Concerning LEU technologies for radioisotope production, we are deeply involved on its development and the diffusion of the advantages of this technology.

[i] "Exportation campaign of SNF from the RA-6 reactor", Novara. O et al. 30th RERTR meeting
[ii] "HEU and LEU cost comparison in the production of Mo99" Cestau, D et al. 30th RERTR meeting
[iii] "Research and Development of Very High Density Fuels" López, M et al. 30th RERTR meeting