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# FORSCHUNG UND INDUSTRIELLE ENTWICKLUNGEN FÜR KERNBRENNSTOFFE IN ITALIEN

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# Research and industrial progress in the nuclear fuel field in Italy

Abstract of the article by U. L. Businaro

A survey on the nuclear Italy today will show no large plant for the manufacture of fuel elements in operation. With three nuclear power reactors in operation this might seem a contradictory aspect of nuclear energy in Italy. A closer examination of the nuclear history in Italy and the different path of its development with respect to other European countries will show that there is no such contradiction. It will also show that the lack of industrial fuel manufacturing plant in operation today does not mean lack of interest on nuclear fuel development and manufacturing. On the contrary in the last decade many research and development activities have been growing in Italy to build up a large and diversified program of today dealing with:

- research on fuel and structural materials
- manufacturing technology development
- reactor core performance evaluation
- fuel reprocessing pilot plant
- plutonium fuel development
- integrated pilot plant for reprocessing and remote refabrication of active fuel elements
- launching of commercial fuel fabrication activities.

The following well equipped laboratories with trained staff are operating in the nuclear fuel field:

- CNEN fuel elements fabrication and control laboratories at Saluggia (Vercelli)
- CNEN chemistry laboratories at Casaccia (Roma)
- CNEN ceramic fuel technology laboratories at Casaccia
- CNEN metallurgy laboratories at Casaccia
- CNEN hot cell laboratories at Casaccia
- CNEN EUREX pilot fuel processing plant at Saluggia
- CNEN PCUT thorium-uranium fuel reprocessing and remote refabrication plant at Rotondella (Matera)
- CISE technology development laboratory at Segrate (Milan)
- SORIN cold and hot metallurgical laboratories at Saluggia
- CAMEN materials technology laboratories at S. Piero a Grado (Pisa)
- SNAM Progetti-LR-SR at S. Donato (Milan)
- FIAT-Nuclear Energy Section at Turin.

In the field of research on fuel and structural materials investigations and studies have been done on ceramic fuel materials, cermet fuel materials especially  $UO_2$  cermets with Nb, Cr and Fe and metallic fuel especially binary and ternary uranium alloys. For structural materials a program is undertaken to develop corrosion resistant zirconium alloys. To study the irradiation behaviour of binary uranium alloys a program has been done in cooperation between CNEN, SNAM and the British consortium TNPG. In connection with the fast reactor developments an extensive program is carried through to irradiate fuel pins in the fast reactor Enrico Fermi in the USA.

For the development of manufacturing technology various groups are working on  $UO_2$  and  $UO_2-ThO_2$  sintering technology, technology to produce dense  $UO_2$ , technology for cladding materials especially a large program for cladding SAP and mechanically compacted fuel rods with a vibro-swaging compaction process. Prototype fuel elements of the Latina type and research reactor fuel elements of the MTR type have been fabricated.

A programme under ENEL-Euratom contract is underway to evaluate the data obtained by the operation of the Trino Vercellese pressurized water power plant. FIAT is working on an adjoint contract to develop informations from design and calculations which will be used to integrate the experimental information coming from the reactor. Furthermore as a part of the work FIAT will predict future core behaviour with respect to power distributions, reactivity effects, and transient behaviour. Hot laboratories for examination of irradiated fuel are already available at CNEN-Casaccia, at SORIN-Saluggia and at CAMEN. CNEN plans to enlarge its present hot facility in connection with the fuel development and evaluation of its fast reactor program.

At Saluggia CNEN has in an advanced stage of construction the EUREX fuel reprocessing pilot plant. Euratom is financially participating in the project, and it is foreseen that the plant will begin operation in early 1968. The plant is designed as a flexible facility of a scale large enough to get useful information in extrapolating to industrial operation, but sufficiently small to permit at reasonable cost to experiment variations in the processing scheme. In the early phase of operation EUREX will process MTR type highly enriched fuel elements with a reprocessing capacity 30 kg/day. Subsequently the plant will operate only part of the time to reprocess highly enriched fuel, while for the rest it will be operated as an experimental facility to develop the aqueous reprocessing method for slightly enriched fuel elements for power reactors.

Since February 66 CNEN has begun what is considered a crash program to develop in four years the base technology for plutonium fuel production. Plutonium laboratories to a total of 1800 m<sup>2</sup> (including 900 m<sup>2</sup> for services) are being built at Casaccia which will begin operation in early 1968. The laboratory will have approximately 50 glove boxes equipped to produce fuel rods up to 3 m length, using the sintering process and the vibratory compaction technique.

At Rotondella on the heel of the Italian booth CNEN is building the PCUT plant, which has been conceived as an integrated fuel reprocessing and remote refabrication facilities, to be used for the development of the Th-U fuel cycle. Expected to be in operation before the end of 1967, the PCUT plant will start by reprocessing and refabricating 1/3 of the core for the Elk River reactor under an USAEC contract. The production capacity of the plant is approximately 15 kg/day of fuel materials. PCUT will in general add information on the problems of running reprocessing plants. In particular it should contribute to assess the economics of the Th-U fuel cycle.

The first request for a bid for fuel element manufacturing has been placed during last summer by ENEL for the partial refueling of the Trino Vercellese plant. For the Garigliano reactor the first request for bids for partial refueling is expected during 1967. For the Latina gas-cooled reactor the British UKAEA has still a contract to supply ENEL with fuel elements. Things are changing quite rapidly due to both the possibility of supplying fuel elements for recycling the ENEL operating reactors, and the reactor prototype development program launched by CNEN, namely the CIRENE 100 MW thermal reactor and the PEC fast fuel element testing reactor. The work done up to now in developing technology, and training staff, should permit Italian industries to rapidly set up a commercial activity for fuel manufacturing.