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ADVANCES IN THE APPLICATION OF NUCLEAR  
ENERGY FOR PEACEFUL PURPOSES

Information transmitted by Italy

Note by the Director General

On 4 September the Director General received from Italy material on the advances made in the year 1973-74 in applying nuclear energy for peaceful purposes. The material in question is reproduced below for the information of the General Conference.

INTRODUCTION

1. Italy, probably more than any other European country, has been conscious of the risks resulting from the shortage of oil supplies and the impact of the high rise in oil prices. In 1973, Italy depended on imports for 75% of its oil requirements, whereas for the other OECD countries as a whole the dependence was of the order of 51%.
2. As a result, Italy, more than anywhere else, has felt the need to devote greater attention to the role of nuclear energy - the only national source that can to some extent replace oil. The reappraisal has given place to a still continuing process of acceleration of the nuclear power programme, rationalization of industrial capacity, revision of research options, and definition of the bodies co-ordinating the different sectors operating in the nuclear power domain.
3. The first important results of the new approach adopted in national power policy are reflected in the decision to order four new power stations with a total capacity of approximately 4000 MW(e); in the impetus given to nuclear research

activities by the approval, last July by the Interministerial Committee for Economic Programming (CIPE), of the third five-year plan (1974-1978) for the Italian National Nuclear Energy Committee (CNEN) and in the decision to collaborate in the Eurodif project for the construction of the first industrial plant in Europe producing enriched uranium.

#### NUCLEAR PROGRAMME

4. In December 1973, ENEL (the Italian national electricity authority) placed an order for two new nuclear power plants: the first, which is to have a pressurized water reactor (952 MW(e)), from Elettronucleare Italiana, and the second, of the boiling water type (982 MW(e)), from Ansaldo Meccanico Nucleare (AMN). In July 1974, the Administrative Board of ENEL decided to commission two more nuclear power plants of the same type. As a result of these orders, the nuclear power programme, as it stands on 1 September 1974, provides for an installed capacity of 612 MW(e) (3 units) and a capacity of 4708 MW(e) (5 units) under construction, i.e. a total of 5320 MW(e) (8 units). On 1 July 1974, Italy was producing approximately 33 000 million kW(e), from nuclear stations, thus occupying a leading place among the countries most experienced in the actual production of nuclear electrical power.

5. Plans for the development of nuclear power in Italy have recently been revised, and it is now envisaged that, from next year onwards, practically all new power generating units ordered in Italy will be nuclear. The installed nuclear capacity will amount to 6500 MW(e) by 1980, to 20-26 000 MW(e) by 1985, and 47-62 000 MW(e) by 1990. An output of that level should account for 15% of the total electricity production in 1980, 38-40% of it in 1985, and 70-75% in 1990.

6. Among the activities of ENEL in the nuclear field, one should also recall the negotiation of contracts for the construction, in collaboration with the French (EDF) and German (RWE) electricity producers, of two demonstration power stations equipped with fast reactors, and the start-up, in France, of the first of these two plants, with an output of approximately 1200 MW(e). According to plans, ENEL is scheduled for 33% participation in these two projects, and will be guided by the directives of CIPE, which stipulate that ENEL's position in the negotiation and implementation of the contracts should be based on agreement between ENEL, CNEN and the domestic firms concerned.

## INDUSTRIAL ACTIVITIES

7. In the industrial sector a considerable effort was made in 1973 and 1974 to rationalize and to centralize the various operational units involved in order to achieve a competitive production capacity and to gear industry to both the internal and the world markets.

8. The IRI-Finmeccanica Group has begun concentrated activities for the purpose of evaluating, integrating and intensifying the production capacities of the companies in the Group. Accordingly, this has led to the establishment of the thermo-electro-mechanical-nuclear sector (TEN), which is to co-ordinate the activities of numerous companies in the nuclear power field, more particularly AMN, ASGEN, SAIGE, Fabbricazioni Nucleari PMN, Breda Termomeccanica and NIRA.

9. As regards the operational activities of companies associated with the Finmeccanica Group, AMN has made considerable headway with the construction of the Caorso power station (840 MW(e)), which is due for incorporation into the grid in 1975. Furthermore, as already mentioned, at the end of 1973, AMN received an order from ENEL for a boiling water reactor plant (982 MW(e)), which is due for start-up in 1979. A further order for a plant of the same type has recently been placed.

10. The firm Fabbricazioni Nucleari (FN), some of the activities of which were made over to Agip Nucleare in 1973 - has completed the facility at Bosco Marengo; a series of prototype tests is at present under way prior to commencement, towards the middle of the present year, of the first run for the production of fuel intended for reloading the Garigliano reactor. The company will then start production of the first core for the Caorso power plant. The FN facility is designed for an output of 600-700 t/yr, depending on the market predictions. It is in a position to cope with all the fabrication and inspection phases - from delivery of  $UO_2$  powder to dispatch of the finished fuel element.

11. The NIRA Company, set up in 1973, on a basis of parity, by AMN and Agip Nucleare, has geared its activities to the following three aims:

- (a) Construction, under contract with CNEN, of the PEC fast reactor (130 MW(th));
- (b) Construction, likewise under contract with CNEN, of the CIRENE prototype (40 MW(e)); and
- (c) Participation, as representative of the Italian building industry, in the construction of the first power plant, with an approximate

capacity of 1200 MW(e), equipped with a fast breeder reactor, at Melville in France, as part of the Franco-Italo-German initiative already referred to.

12. Italmimpianti, the company engaged in project studies for facilities owned by the Istituto per la Ricostruzione Industriale (IRI), and which is licensed by Atomic Energy of Canada Ltd. (AECL) for the building of heavy water reactors, has become well established on an international plane. During 1973, for example, the Argentine National Atomic Energy Commission, following a contest in which the main American construction firms took part, commissioned a consortium formed, on a basis of parity, by Italmimpianti and AECL to build a second nuclear power plant in Argentina (600 MW(e)). Italmimpianti will not only play a significant part in providing the equipment required for the construction of the plant, but will also head the consortium and, as such, be responsible for co-ordinating the project as a whole.

13. Breda Termomeccanica, acquired by Finmeccanica in 1973, has reaffirmed its leading position on the home market as well as abroad. As due reward for its capabilities, Breda signed an agreement in 1973, by which it would provide technical assistance for a consortium formed by four important Spanish companies for the construction of a facility for the manufacture of nuclear components. Furthermore, it will provide the consortium with the necessary know-how for the production of the main components of light water reactors.

14. Moving on to the nuclear activities of the companies in the ENI Group, we see that in 1973 and 1974, Agip Nucleare gained recognition in, among others, the nuclear fuel cycle sector. There has already been reference to the part played by Agip Nucleare in the activities of Fabbricazioni Nucleari and NIRA. Leaving aside Agip Nucleare's operations in the field of uranium prospecting, it would be relevant to mention its participation, together with CNEEN, in what is in many respects the most important international project of the current year, i.e. the Eurodif project. Finally, mention should likewise be made of the decision by Agip Nucleare to set up a facility for producing enriched uranium oxide; the design of a facility for plutonium fuel fabrication; development activities aimed at setting up an industrial reprocessing plant; and, its important contribution to adoption of a policy of diversification in the enriched uranium field.

15. As far as FIAT's activities are concerned, it is operating either autonomously, or else as an associate of the Elettronucleare Italiana and COREN companies. The former, more particularly, which was set up in 1973, acts as a focus for the capabilities of the three companies - FIAT, Breda Termomeccanica, and Franco Tosi - whose technological capacities and production services are complementary to the extent that complete nuclear power plants can be constructed. FIAT, for example, possesses thorough experience in the design and construction of nuclear components and systems, while Breda Termomeccanica has shown itself, as already mentioned, to be one of the major European constructors of components for the primary reactor circuit; Franco Tosi is in a position, as an electrical engineering firm, to complete the range of more conventional equipment required for nuclear power plants. A subsidiary of Elettronucleare Italiana, COREN, was set up by FIAT and Breda Termomeccanica in 1969 for fuel fabrication. The first major success achieved by Elettronucleare Italiana was the order placed by ENEL in 1973 for a power plant equipped with a pressurized water reactor (952 MW(e)), to be completed by 1979. A second power plant of similar output has recently been ordered from the same company.

#### RESEARCH ACTIVITIES

16. In July 1974, as already mentioned, CIPE approved CNEN's third five-year plan (for 1974-78), which involves expenditures amounting to 500 000 million lire (about \$770 million). Moreover, CNEN already took this five-year plan into account in its research and development activities for 1973 and 1974. The following brief account is given in respect of work already done and the forecasts contained in the third five-year plan.

#### Proven reactors

17. The experience and expertise available at CNEN relate to the design and evaluation of components for proven water-cooled and/or -moderated core types and, in some measure, of control and other systems and to the design and fabrication of fuel elements (based both on uranium oxide and on mixed uranium and plutonium oxides), especially for boiling-water reactors. By the end of 1973, CNEN had spent about 12 500 million lire (about \$19.2 million) in this area. Future activities in the field of light-water reactors are to be oriented towards the two following basic objectives, which are to be achieved successively:

- (a) The acquisition by Italy's nuclear industry of the ability to exploit the foreign licences which it already holds or which it may obtain in the future; and

- (b) The gradual acquisition by Italy's nuclear industry of commercial autonomy as regards core and other components, with a view to dissociating the general system of guarantees on the plant as a whole from the system applying to the individual components, including in particular the fresh fuel charges.

The expenditures envisaged for the period 1974-78 amount to about 25 000 million lire (about \$38.5 million).

#### Advanced breeders

18. In 1973, the heavy-water reactor research and development programme, which has been in existence for some ten years, led to the start of work on the 40 MW(e) CIRENE prototype as part of a joint CNEN-ENEL project. This is a heavy-water-moderated reactor cooled by light water and fuelled with natural uranium. By the end of 1973, expenditures of about 27 000 million lire (about \$41.5 million) had been incurred. The short-term objective is to complete work on the CIRENE prototype. The medium-term objective is to acquire the knowledge and expertise necessary for the future development of the CIRENE reactor type. The expenditures envisaged for 1974-78 in connection with this programme amount to about 73 000 million lire (about \$120 million).

#### Fuel fabrication

19. In the field of fuel element development, CNEN will - besides supporting Italy's nuclear industry and continuing its activities relating to fuel for proven power reactors - concentrate on the needs of the CIRENE and PEC reactor types.

#### Uranium enrichment

20. This is the part of the fuel cycle with respect to which the most important decisions were taken during 1973 - in particular the decision to build the Eurodif plant. Italy is participating in this project to the extent of 22.5%, shared equally between CNEN and Agip Nucleare. It is expected that the project will bring to fruition the research and development activities which CNEN has - since 1963 - been co-ordinating and conducting in conjunction with Italy's main industrial groups (Finmeccanica, ENI, EFIM, SNIA Viscosa, FIAT, Montedison) in an effort to develop the principal components of a gaseous diffusion plant. At the same time CNEN, various branches of industry and a number of national institutes are continuing work on the development of centrifuging - the other method of uranium enrichment being investigated in the

principal industrial countries. Through CNEN and Agip Nucleare, Italy has joined the Association for Centrifuge Enrichment (ACE), established by the countries party to the Almelo agreement. The expenditures envisaged for 1974-78 in this connection amount to about 21 000 million lire (about \$32.3 million), not counting the cost of participation in Eurodif.

#### Fast reactors

21. CNEN began work on fast reactors in 1962. In 1964, the initial programme of basic research was converted into an industrial promotion programme, the aim being to develop a fuel element and the main components of the sodium circuit (in particular the steam generation and the sodium-sodium heat exchanger). By the end of 1973, CNEN had spent over 60 000 million lire (about \$92.3 million) on this programme.

22. The future objectives of the programme are:

- (a) the development of the PEC reactor, which will have a capacity of about 130 MW(th) and will be used for testing fuel elements (work on this has already started);
- (b) the development of the prototypes of fuel elements for fast power reactors (to be tested in the PEC reactor); and
- (c) the development of sodium circuit components for fast power reactors.

23. The expenditures envisaged for 1974-78 amount to about 196 000 million lire (about \$301.5 million). During May 1974, a general agreement for collaboration in the fast reactor field was signed by CNEN and the French Commissariat à l'énergie atomique (CEA). This agreement will be supplemented by similar agreements between Italy's nuclear enterprises on one hand and CEA and France's nuclear enterprises on the other.

#### Fuel reprocessing

24. In this field, CNEN has been concentrating on:

- (a) the development of reprocessing techniques for enriched uranium fuel and the construction of the EUREX experimental facility (100 kg/day);
- (b) the development of reprocessing techniques for uranium-thorium fuel and the construction of the ITREC experimental facility; and
- (c) its participation in EUROCHEMIC (since 1957).

25. By the end of 1973, CNEN had spent about 35 000 million lire (about \$53.8 million) on activities within Italy and about 2500 million lire (about \$3.8 million) in connection with its participation in EUROCHEMIC. CNEN is looking forward to establishing, in conjunction with industry (possibly within the framework of international agreements), a joint enterprise for creating a facility which will permit the exploitation of the available know-how. The expenditures envisaged for 1974-78 amount to about 22 000 million lire (about \$33.8 million).

#### Radioactive waste management

26. CNEN's knowledge and experience relate to:

- (a) the development of processes for the treatment of liquid radioactive waste of low and intermediate activity;
- (b) the development of the technology for incorporating solid radioactive waste of low and intermediate activity in cement, in accordance with international specifications; and
- (c) research and development in connection with procedures for the vitrification of liquid waste of very high activity from fuel reprocessing plants.

27. By the end of 1973, CNEN's expenditures in this area amounted to about 1020 million lire (about \$1.6 million). There are plans for CNEN to embark upon pilot trials with waste treatment and processing techniques developed in the laboratory - an essential stage in the establishment of a national organization for the collection, transport, treatment and controlled storage of radioactive waste. The expenditures envisaged for 1974-78 amount to about 17 000 million lire (about \$26.2 million).

#### Thermonuclear fusion

28. Work in this field has been conducted since 1960, in Italy as in the other countries belonging to the European Community, in contractual collaboration with EURATOM. The capability and knowledge gained by CNEN in the course of about 13 years are the result of theoretical and experimental work aimed at obtaining a thermonuclear plasma either by magnetic confinement (orthogonal compression and stable plasmas) or by inertial confinement (magnetic implosion, heating by means of lasers, and chemical implosion).



29. For this purpose many advanced forms of technology have had to be developed, including those related to intense magnetic fields, ultra-high vacuums, high temperatures, high voltages and currents, and lasers. By the end of 1973, CNEN had spent over 17 000 million lire (about \$26.2 million) on such activities.

30. It is expected that CNEN's activities in this area will continue to be conducted on a collaborative basis within the framework of the European Community. CNEN's research efforts are directed mainly towards magnetic confinement and the development of a Tokamak-type toroidal device of intermediate size with a strong magnetic field and a high current. The device, which involves advanced forms of technology (especially in the mechanical and electrotechnical areas) and the development of optical and electrical diagnostic techniques, is scheduled for completion in 1975.

31. In conclusion, it should be mentioned that in 1973 CNEN spent about 53 000 million lire (about \$31.5 million) on various activities which were undertaken in the light of the third five-year plan, which provides for total expenditures of 500 000 million lire (about \$770 million) during the period 1974-78. It should also be mentioned that, during the period 1968-72, CNEN's total expenditures amounted to 214 000 million lire (about \$329 million). Lastly, it may be worth noting that the staff of CNEN is expected to increase from 3516 to 4000 in the course of the third five-year plan.

