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ABSTRACT

The United States Atomic Energy Commission program of assistance to the European Company for the Chemical Processing of Irradiated Fuels ("Eurochemic"), Mol, Belgium, is presented. Included are the background, formation, purpose, and structure of the Company; basic design considerations and a brief description of the proposed plant; present status of the design; the AEC assistance authority and procedure; tabulation of the assistance required by Eurochemic; and a list of participating organizations and members.

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UNITED STATES ATOMIC ENERGY COMMISSION ASSISTANCE PROGRAM
TO THE EUROCHEMIC COMPANY, MOL, BELGIUM

1.0 INTRODUCTION

The United States Atomic Energy Commission has entered into a program of assistance to "The European Company for the Chemical Processing of Irradiated Fuels (Eurochemic)." Assistance will take two principal forms: the loan of one to five technical people for periods of several weeks to several years and the exchange of technical and engineering data pertinent to the radiochemical reprocessing of irradiated fuels. The purpose of this report is to outline as far as possible the status of the USAEC assistance program for Eurochemic.

2.0 EUROCHEMIC PROGRAM

A detailed description of the European Nuclear Energy Agency and the Eurochemic Company is given in "The European Nuclear Energy Agency and the Eurochemic Company, First Report of the Steering Committee for Nuclear Energy to the O.E.E.C.* Council," dated March, 1958. The report contains information on the following subjects (a detailed outline of report is given in Appendix III):

1. plant for the chemical processing of irradiated fuels;
2. experimental reactors: proposals for their co-operative development in Europe;
3. nuclear power stations: proposals for their co-operative development in Europe;
4. European Nuclear Energy Agency;
5. list of members of the Steering Committee and of the Study and Working Groups.

2.1 Formation, Purpose, and Structure of Eurochemic

Formation. The Organization for European Economic Co-operation (O.E.E.C.) consists of 17 member countries (Appendix I) and was established in 1948. The O.E.E.C. was formed by economically interdependent European nations, "to combine their economic strength, to join together to make the fullest collective use of their individual capacities and potentialities, to increase their production, develop and modernize their industrial and agricultural equipment, expand their commerce, reduce progressively barriers to trade among themselves, promote full employment and restore or maintain the stability of their economies and general confidence in their national currencies."⁽¹⁾ The Council of Ministers for the O.E.E.C. established a permanent Steering Committee for Nuclear Energy to be responsible both for implementing earlier decisions and for submitting proposals regarding the creation of a European Nuclear Energy Agency (ENEA) to pursue the joint action of the European countries. The

* Organization for European Economic Co-operation.

(1) Quoted from the reference above.

Steering Committee is composed of officials in charge of nuclear energy development programs in O.E.E.C. countries. The Statute of the ENEA was adopted by the Council in September, 1957.

Purpose. The Steering Committee established a Study Group for the chemical processing of irradiated fuels among fourteen O.E.E.C. countries in September, 1956. The general purpose of the plant would be twofold: (1) it would be used to process the various types of fuels coming from research and test reactors, and (2) it would serve as a pilot plant for the construction, possibly on a joint basis, of the larger plants that will become necessary later (after 1965). The Study Group examined the needs for chemical processing in member countries and proposed the constitution of an international company which would permit the simultaneous participation of governments in its financing and administration; the company would be effectively constituted on ratification by the governments representing 80% of its capital. The Study Group concluded that it would be desirable and possible to construct and operate a chemical processing plant on the basis of the following main specifications and estimates:

1. The plant should have sufficient versatility to be able to handle a variety of natural and slightly enriched uranium fuel elements.
2. The plant, as well as auxiliary and supporting facilities, should be designed for 100 tons/year capacity. (This was based on a projected maximum necessary capacity through 1964.)
3. The company should have ample research facilities at its disposal.
4. The cost of the plant is estimated at \$12 million.
5. The net operating cost, exclusive of capital charges, is \$7 million for the four years. The estimated annual operating cost is \$3 million, with an annual earning of \$1.5 million during periods of full operation.
6. The scheduled start-up date is 1961.
7. The staff would consist of 400-450 people.
8. The location would be at Mol, Belgium near the research establishment of the Centre d'Etudes Nucleaires (CEN). Four sites -- in Belgium, Denmark, Italy, and Norway -- were considered.

Structure. Eurochemic is a joint stock company governed by the International Convention on the Constitution for Eurochemic, by the present statute, and, residually, by the law of Belgium. The Company reports each year to the Governments involved by submitting the reports to a Special Group of the Steering Committee of the ENEA. The Special Group has a "watch-dog" function: to consider any mutually interesting problem and to resolve difficulties arising in connection with the processing of fuel consigned, the allocation of products recovered, the use of the Company's resources

for development or research, and the communication of the results of research. In addition, the Special Group's approval is required for certain statute amendments, the extension of the life of the Company, the conclusion of contracts with non-participating countries for fuel processing or product delivery, and the expansion of the Company's plant either in the existing location or to a new site. In general, all problems which cannot be resolved by the General Assembly of the Company are referred to the Special Group.

The Company's headquarters is Mol, Belgium, and is established for fifteen years with an automatic five-year extension if the Company still exists. Plant operation is scheduled for 1961. In addition, the Company is to ensure development of techniques and the training of specialists and to examine means of meeting any excess demands from O.E.E.C. countries. The authorized capital of the Company is 20 million European Payment Union units of account (dollars), divided into 400 shares, each valued at \$50,000. The shares of the countries involved are tabulated in Appendix I.

A General Assembly, composed of all shareholders, is the ruling body of the Company. A representative each from the ENEA and the Euratom (European Atomic Energy Community) are advisory members of the General Assembly. The Board of Directors, appointed by the General Assembly, consists of 15 Directors, plus a representative each from the ENEA and the Euratom.

2.2 Company Status

The ratification of the Convention has not been completed and is not expected before March, 1959. The Study Group proposed the following measures for the interim period.

1. When the Convention is signed the Study Group should be reorganized, with functions similar to the future General Assembly, so as to reflect the composition of the Company.
2. The reorganized Study Group should appoint an Interim Board of Directors.
3. The Study Group should initiate work on planning and design, with the cost not to exceed \$500,000 supplied by contributions from the O.E.E.C.

The above recommendations have been put into effect, and planning and design are underway. (Appendix II lists the known personnel involved.)

The interim organization consists of:

1. A Study and Research Office located at Mol, Belgium with Dr. E. Haeffner, Sweden, as Director. Twelve full-time professional people are employed, and this group will probably form the nucleus of the permanent professional staff of the Company.

2. A Management Committee with Y. Sousselier, France, as Chairman. The Committee consists of the chairman and one member from France, the Netherlands, Belgium, Italy, and Switzerland.
3. Interim Board of Directors with Dr. Pohland, Germany, as Chairman. This Board has representation from all participating countries, with voting powers proportional to their scheduled stock ownership. The Interim Board will probably become the Board of the Company.

The Eurochemic Company is planning a significant laboratory development effort in conjunction with their design program. The development effort will cover equipment testing and specification, corrosion studies, instrumentation evaluation, and head-end flowsheet development. The specific areas in which information and assistance are desired from the United States are: radiochemical process data and experience, waste disposal, health physics, equipment design, continuous instrumentation, overall design experience, analytical chemical methods and techniques, criticality control data, and certain engineering cost data.

2.3 Design Basis ⁽²⁾

Uranium. Quantities of natural uranium available for a joint plant were predicted by Germany, Italy, the Netherlands, Norway, Portugal, Sweden, and Switzerland, while slightly enriched uranium was indicated by Belgium, France, Italy, the Netherlands, Norway, and Switzerland. Denmark would probably need reprocessing facilities for considerable amounts of fuel for some date after 1965, but could not at present give any specification as to the type of material. The quantities to be expected increase gradually from a few tens of tons in 1960 to about 100 tons per year by 1964. These quantities exclude the fuels from recently constructed Euratom reactors and all fuels of 20 or higher per cent enrichment.

From 1965 on, a sharp rise in the quantities is indicated, and the yearly amounts to be treated rapidly reach several thousand tons, most probably consisting mainly of natural uranium. Several countries might, by 1970, under these circumstances wish to establish their own processing facilities, and in the view of the Study Group the joint undertaking would not prevent the future realization of national undertakings in this field. The figures given above are to be regarded as very conservative because they are based principally on reactors already operating, under construction, or projected. Changes in national reactor programs, which will most likely take place in many countries during the next few years, might therefore considerably increase these amounts.

The forecast given above deals only with natural and slightly enriched uranium. A number of countries have also indicated the possibility of sending highly enriched uranium to a joint plant. Because this material is at present exclusively supplied under international agreements, its treatment in a joint plant would be subject to the assent of the supplier. However, the

(2) Abstracted from "The European Nuclear Energy Agency and the Eurochemic Company, First Report of the Steering Committee for Nuclear Energy to the O.E.E.C.," and revised to include the most recent information.

United States has agreed that enriched fuels supplied from the U.S. can be processed outside of the U.S. in an approved plant.* It has been difficult for the member countries to give firm indications regarding this enriched uranium fuel and the Study Group, therefore, confined its consideration to the processing of natural and slightly enriched uranium; this decision will probably change. The chemical plant will be built in such a manner as to be able to process highly enriched fuels.* With regard to the natural and slightly enriched uranium, the fuel which might be available for treatment for a joint plant is expected to have a content of uranium-235 (after irradiation) ranging approximately from 0.4 to 3.4 percent. The plutonium content in the material will generally vary from 1 to 2 kilograms per ton but might be higher in special cases.

Thorium. The result of the inquiry indicated that plans for the utilization of thorium as a fuel are not very advanced in most of the member countries. Only one country (France) predicted having substantial quantities of thorium for treatment in a joint plant for the period under consideration.

Joint vs Separate Plants. A striking feature is the great variety of types of fuel elements to be expected for treatment. Differences in geometrical shapes and dimensions, variations in chemical composition (uranium metal, oxide, alloys) and in canning material (aluminum, magnesium, zirconium, stainless steel) will create special problems requiring close attention from the very outset of the technical planning of the plant. In the view of the Study Group, this situation naturally leads to the idea of the creation of a joint undertaking rather than to other possible alternatives.

One alternative to the construction of a joint plant would be that each country as early as possible develop and construct its own reprocessing facilities in order to cover its own needs. This solution has several disadvantages. The results obtained from each of these individual efforts might be rather limited because of the insufficient number of qualified personnel in each country. Furthermore, most of the resulting national processing plants would be extremely uneconomical in operation because of the very small quantities of fuel available for treatment in each country during the first years.

The other main alternative to the joint processing plant would be to entrust the reprocessing of fuel from all the member countries to the few countries which are the most advanced in this field. This alternative is the more plausible, because both the United Kingdom and France have stated that a certain over-capacity in their national reprocessing plants might be made available to other countries. Although this alternative might offer certain immediate advantages the members of the Study Group do not, in general, favor this alternative because it might leave the majority of the countries definitely behind in the development of a new and important technological field.

Compared with the two alternatives mentioned, a joint undertaking would offer vital advantages. First, provided that adequate research facilities are included, such an undertaking would enable the participating countries

*Recently decided.

to take active part in the technical development in the field of fuel re-processing. A larger staff and more complete equipment would, in all probability, give better results than those which could be obtained through isolated efforts on a smaller scale in a number of individual countries. Investigations related to specific national projects might also in many cases be studied with advantage in the laboratories of the joint undertaking. Second, more material would be available for processing in a joint plant, and the unit cost of the processing (which strongly depends on the capacity of the plant) would consequently be reduced. It is not expected that a joint plant will operate with low processing costs during its first years of operation. The pooling of the material to be treated would, however, at an early date permit an extension of the plant's capacity and thus lead to more economical operation. The cost of processing one ton of uranium in a plant treating 500 tons of uranium per year would be only one-third of the cost incurred in a plant treating 50 tons of uranium per year.

Technical cooperation with countries having special experience in this field would be of great value for the realization of a joint project. The Study Group, therefore, attaches great importance to the fact that a number of countries have declared themselves willing to contribute results from research and pilot plant work which they have carried out in their own country. It is especially important that, in addition, the United Kingdom and France would be willing, on certain conditions, to place at the disposal of the joint undertaking technical experience and know-how gained through their operation of large-scale plants. Also, it should be noted that the general declassification of information in the field of fuel reprocessing recently decided upon by the United States Atomic Energy Commission will further enhance the possibility of obtaining technical information for the construction of the plant.

Choice of Extraction Process. The principal factors considered for the choice of the most suitable process were:

- a. the amounts and types of materials to be treated;
- b. the final products desired and the requirements as to their technical specifications;
- c. the availability of technical information and experience related to the process chosen.

Because of the diversity of the fuel to be treated, the method chosen should make it possible to keep fuel batches of different origin separate. The Study Group has assumed that the final products of the plant should be uranium in the form of a salt or oxide and plutonium in the form of a salt (such as fluoride or oxalate). It should be noted that these products could not directly serve in a reactor but would have to be fed into the fabrication processes for fuel elements at an appropriate stage.

The Study Group took the view that the separation process chosen should provide sufficient fission product decontamination to permit unshielded metallurgical fabrication of new fuel elements from most of the products emerging from the plant. The reason for this is that techniques for "remote metallurgy" are at present relatively undeveloped and would present very great difficulties,

especially when it comes to the re-fabrication of more complicated types of fuel elements. This requirement means that the process chosen should be able to give a decontamination factor of 10^7 for the fission products. It also implies that the storage time of the irradiated fuel either before or after processing should be long enough to allow for sufficient decay of uranium-237. This gamma-radioactive isotope, which is formed from uranium-235 during the irradiation, will pass through the processing together with the uranium recovered. Problems arising from the irradiation level of plutonium are recognized.

The Study Group considered it of fundamental importance that at the moment all processes in use are based upon solvent extraction, i.e., extraction by an organic solvent of uranium and plutonium from aqueous nitrate systems. The choice of such a process would contribute greatly to a speedy realization of a joint undertaking and the Study Group therefore confined its more detailed study to this process.

Choice of Solvent. Three solvents have been reported as used in full-scale plants, namely hexone, dibutylcarbitol (DBC) and tributyl phosphate (TBP). The Study Group is in favor of recommending the use of TBP. The reasons for this are briefly the following. The solvent hexone requires a salting agent such as aluminum nitrate which complicates concentration and storage of the radioactive waste. TBP and DBC require only nitric acid as a salting agent. Of the latter two solvents, TBP reacts least with concentrated nitric acid, but its decomposition under intense irradiation might adversely affect the separation process. Dibutylcarbitol is believed to be damaged less by irradiation, but seems likely to give somewhat lower decontamination factors than TBP, and TBP has therefore been chosen.

The Study Group took the view that the design of the extraction equipment (see p. 37, O.E.E.C. Brochure) should allow the utilization, as far as possible, of well-known chemical industrial techniques. The equipment should, therefore, preferably be designed and constructed for direct maintenance, which means that maintenance work could be done directly on the equipment after its decontamination. In order to limit the number of shut-downs for such decontamination, equipment which is extremely reliable in function should be selected.

Criticality. The Study Group recommended that heavy emphasis should be put on the criticality considerations when making the final choice of process and equipment: that the plant design should be of the so-called "ever-safe" type. This means that once the maximum content of fissionable material in the fuel which will be accepted for processing has been laid down, the design of the plant will be such that criticality cannot occur under any conditions. However, as the study proceeded, the same compromises with always-safe design familiar to highly enriched U.S. plants have been made, i.e., using concentration and batch control.

Choice of Types of Equipment. Three types of extraction equipment have been reported to be in use in full-scale or pilot reprocessing plants, namely, mixer settlers, packed columns, and pulsed columns. Mixer settlers are efficient in use and are readily adapted for remote control. It should be noted,

however, that their shape is not "always safe" for the processing of fissionable material. Another disadvantage is that the large hold-up volumes and the large installation area needed for this involve extensive shielding construction. Packed columns are being used with good results in the United Kingdom Windscale Plant, the Idaho Chemical Processing Plant, and the Hanford Redox Plant. They are reliable in function, but their efficiency is comparatively low, so that very high columns are necessary. Pulsed columns seem to offer many advantages. The most important is probably the reduction in column height in comparison with the conventionally operated packed columns. Not all types of pulsed columns can, however, be used for radioactive solutions because of the risk of contamination. It is believed, however, that a suitable type of pulsed column will be the final choice for the plant, although other types of contacting equipment might be used for certain purposes.

"Head-End" Treatments. The choice of method for the first stages in the processing, namely, the decanning and dissolution of the fuel, as well as adjustment of the solution before solvent extraction, represents a special problem. Here the final choice will consist not of one single method but of a number of parallel methods depending on the types of fuel elements which are finally accepted for treatment in the plant. A number of "head-ends", (that is, processing lines converting the fuel elements to nitric acid solutions suitable for the extraction process) might be considerable.

Purification of Plutonium. The Study Group also considered the choice of method for the final purification of the plutonium. Little information has been published so far on this part of the treatment of irradiated fuel. A number of methods are possible; one of these, applied in France, consists in a second plutonium cycle using TBP, the use of three different ion exchange purifications, and final precipitation of the plutonium as fluoride. Alternative methods are the use of solvent extraction only or of resin columns only. It must be borne in mind, however, that the scale of this part of the plant will be rather small. Only a few hundred liters of solution containing some hundred grams of plutonium will have to be treated per day at the final purification stage. The size of the final purification equipment will, therefore, be small and its cost will be slight compared with other parts of the plant. Changes in this equipment will not substantially affect the rest of the plant. The scarcity of published data combined with the fact that some processes have not been proved by operation on a large scale and over long periods seems to suggest that it would be advisable to postpone the final choice of the method for this part of the process. At present, it appears that anion exchange from 7 N HNO_3 will be used.

Special Materials and Equipment. The Study Group also considered the availability of special materials and equipment needed. It is essential that the material chosen for vessels, pipes and columns should not suffer from corrosion during the life of the plant. A fully austenitic stainless steel with extremely low carbon content or stabilized with niobium will probably meet these conditions. Careful analytical and metallurgical control of the steel used will be necessary. The final orders for steel must be placed by the middle of 1958. Moreover, as the plant should be free from any possibility of leakage and should require a minimum of maintenance, an all-welded construction is likely to give the best

result. This, however, would require special welding methods and a gamma-ray inspection of every weld will be necessary. Welding specialists must be recruited and trained at an early stage. The extraction columns and their auxiliary equipment, such as feeder pumps and pulsing units, may be commercially available, but at least a part of this equipment would probably have to be specially constructed for the plant. As to the instrumentation, part of the instruments would be of conventional types while some might have to be of special design. Conventional types for measuring pressure, temperature, flow rates, acid concentration, etc., can be used while, for instance, the continuous control of the alpha radioactivity in a liquid flow will necessitate development of special monitors.

Plant Buildings. The proposed plant will consist of about twenty different buildings.

PROCESSING SECTION

1. main processing building, for the decanning and dissolution of the irradiated fuel and its primary separation into solutions of uranium, plutonium, and fission products;
2. uranium purification facilities, for the final decontamination and purification of the uranium solutions and transformation of the uranium salt into uranium oxide;
3. plutonium purification facilities, for the final purification of the plutonium solutions from impurities of iron, uranium, and fission products;
4. tank farm, for the separation and storage of inactive process solutions and decontamination solutions;
5. analytical laboratory, for production control;
6. building for fission product treatment, for the evaporation of fission product solution down to concentrations suitable for economical storage (this building might also contain facilities for the separation of certain long-lived isotopes for more convenient storage of these radioactive materials);
7. underground storage tanks, for long-term storage of highly radioactive liquid waste;
8. low-active effluent treatment facilities.

RESEARCH FACILITIES

9. radiochemical engineering laboratory;
10. radiochemical research laboratory.

SUPPORTING INSTALLATIONS

11. maintenance workshop and equipment store;
12. equipment decontamination building;
13. steam plant;
14. transformer station with diesel emergency station;
15. water supply station with demineralizer;
16. stack and fan house to disperse the radioactive gases safely into the atmosphere.

GENERAL REQUIREMENTS

17. administration building with 30 offices, library, and lecture hall;
18. health physics facilities.

UTILITIES

19. canteen to serve 200 meals per shift;
20. laundry, bathrooms, fire guard facilities, and medical service station.

Investment. A first estimate of the investment necessary is given below. Its preliminary nature is clear from the fact that it is not based on actual tenders but on volume prices and comparison with similar plants. The estimated costs in millions of dollars are given below for the main buildings and equipment listed above.

	Millions of Dollars
Process building	0.6
Process equipment	3.2
Waste treatment facilities	1.0
Research facilities	1.5
Supporting facilities	0.5
Administration buildings	0.2
Health physics facilities	0.1
Utility installations	0.5
Site and housing estate	1.4
Purchase of technical know-how	1.0
Contingencies	<u>2.0</u>
Total	12.0

A tentative estimate for the schedule of these expenditures gave the following result:

	Millions of Dollars
1957-58	5.2
1959	5.6
1960-61	1.2

The number of employees will be decisive for the running expenses of the undertaking. The original estimate of the Study Group envisaged the employment of about 450 people, of which some 250 would be engaged in the processing itself and the rest in research and development work. It is now possible to compare the estimates for the operating personnel in the processing plant with figures published for similar American plants. The one which is nearest to the type of plant intended by the Study Group is the Idaho Processing Plant, which at present is built for highly enriched fuels but could be converted to processing natural uranium at about 1200 kilograms per day. This plant, which is a self-sustained unit, employs 260 people, and it is indicated that if it were used as a single unit instead of as a multi-purpose plant, it would need 170 to 210 people. Other American plants, such as the Hanford Semi-Hot Works (200 kilograms of natural and slightly enriched uranium per day), the Oak Ridge Metal Recovery Plant (500 kilograms per day) and the Oak Ridge Thorex Plant (400 kilograms per day), all employ substantially fewer people, about 30 to 50, but they are not independent units since they rely extensively on available common facilities. By comparison it seems reasonable to assume that the processing, as such, would not require more than 250 employees. The research and development staff would probably increase during the period considered, but in view of the fact that part of the work will be done by trainees paid by the shareholders, it seems reasonable to conclude that the total staff paid by the undertaking itself would not exceed 400 people by the beginning of the operation period, and that it might increase to 450 by the end of this period. Based on the assumption that each person employed would involve an average expenditure (salaries, maintenance, and equipment, etc.) of \$7,000 per year, the yearly running costs would be from \$2.8 to \$3.2 million, increasing during the 4-year period, 1961-1965.

2.4 Design Status

The principal effort during the past several months has been directed toward developing the chemical and preliminary engineering flowsheets. The solvent extraction and final product treatment flowsheets have been emphasized because of information availability.

The original plant capacity, previously set at 100 metric tons of natural uranium per year, did not specify the operating time or the cleanup and repair time allocations. Times of 100 days/year for cleanup between batches, 100 days/year for maintenance, and 150 days/year for processing have now been specified. The normal throughput will be about 670 kg of uranium per day. The maximum throughput recommended is 1500 kg of uranium per day. The plant will probably be designed geometrically safe for fuel up to 5% U²³⁵. Fuels of higher U²³⁵ content may be processed by a combination of concentration control and geometrically

safe design of specific equipment. A capacity of about 20 kg/day of 20% enriched fuels is probable.

Effort on the head-end flowsheet has been restricted to calculations for preparing feed from chemical dejacketing and dissolution of aluminum-clad uranium metal slugs. Visual inspection and mechanical transfer of dejacketed slugs will not be done. Laboratory-scale work is being done on fumeless dissolution of uranium metal; this procedure appears complicated, and all available design and performance information on fumeless dissolution systems ~~is~~ required as soon as possible.

The flowsheet selected for the plant will have a co-decontamination cycle for uranium and plutonium, a uranium-plutonium partitioning cycle, a final uranium and a final plutonium extraction cycle followed by silica gel treatment for uranium and anion exchange for plutonium. With this much equipment, one extraction cycle may prove unnecessary in the future when the operating group has gained experience and wishes to change to the recently developed two-cycle Purex flowsheet. The co-decontamination cycle will have a very tall extraction column followed by a separate scrubbing column; this will ensure low losses even when extracting enriched feeds ~~with~~ dilute TBP and will permit exhaustive scrubbing in the separate scrub column as well as the optimum temperatures in the extraction and in the scrubbing columns. Bottom interface operation is specified for "A" types and the scrubbing column, with bottom interfaces probably to be specified for "C" columns for capacity reasons. Preliminary information on pulse cartridge selection, column dimensions, etc., will be sent in the near future for review and comments. Uranium and plutonium losses will be recovered by backcycling to the HA column of the partitioning and succeeding cycles' acid evaporator bottoms. An elaborate system for recovery and recycle of all nitric acid and low activity condensates, ~~etc.~~, will be needed to minimize the very difficult waste disposal situation. A maximum of 240 mc of beta activity per month can be discarded to the environment by all operations in this area (including CEN). Flowsheet calculations are being completed for the solvent extraction portion of the plant and will incorporate the backcycling operations and the revised daily capacity of 670 kg of uranium per day.

Solvent recovery will be by turbine mixer ~~settler~~ units. Two alkaline washes (probably one with KMnO_4), a dilute acid wash, and sand filtration will be used. Two solvent systems are to be used.

Preliminary sizing of feed preparation and tanks for the solvent extraction system is being done. Hot-feed pumping will be by air lift with a possibility of Lapp pump backup. Batch transfer of radioactive materials will probably be by steam jetting instead of the vacuum transfer system. The vacuum transfer equipment at Marcoule has become quite contaminated, a possibility not considered in the design, and has caused a certain amount of trouble.

The plans of the inactive, full scale, one-extraction-cycle pilot plant are being revised to conform with the pumping and other equipment planned for the plant. It is intended that a lump sum contractor will do all engineering and install the unit. This project is such a long way from realization that it is unlikely to provide any design information for the plant.

3.0 USAEC PROGRAM

3.1 Authority

Early in 1958 Mr. Huet, Secretariat for the Steering Committee for Nuclear Energy, requested assistance from the USAEC. This request was replied to affirmatively, and the services of 4 or 5 people were offered for an extended period. On August 29, 1958, ORNL was requested to provide one design engineer for assistance to Eurochemic. The assignment was for an initial period extending through March, 1959, with the intent that the assignment would be extended for a total of 12 to 18 months (estimated time required for plant design). A letter of agreement between the USAEC and the O.E.E.C. will be made to cover this assignment and other aspects of the cooperation. On October 6, 1958, ORNL officially agreed to supply the design engineer requested and Mr. E. L. Nicholson was assigned to the Eurochemic group. Mr. E. M. Shank, ORNL, was assigned to accumulating information and coordinating ORNL's efforts in behalf of the Eurochemic group through Mr. Nicholson. At the same time and at the request of the AEC, ORNL agreed to act as a central point for coordinating information from other sites and for obtaining and transmitting Eurochemic information to other sites for consideration.

3.2 Procedure

The procedures used in obtaining and transmitting information to E. L. Nicholson have been developed through discussions with various people at ORNL, ICPP, and HAPO and are subject to change at the request of the various sites or the AEC. These suggested procedures are tentative and differ with the originating site for the information. All information sent to E. L. Nicholson is listed in a letter of transmittal.

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Other AEC-Originated Information. Information is obtained from other AEC sites either from documents or by oral transmission. In the case of unclassified or declassified documents, the site involved will be asked for permission to transmit the documents to E. L. Nicholson (this is to prevent transmittal of site-sensitive or patentable information prematurely). In the case of classified documents, either the site involved will be requested directly to process the document for declassification, or the document will be sent to the ORO AEC for declassification processing. If declassification is obtained by the site, approval for transmittal will be implied. If the declassification is processed through ORO AEC, the site involved will be asked for transmittal permission.

Information obtained orally will be issued as a rough draft (secret or confidential) and submitted to the site for technical, patent, and classification approval and then formally issued as an unclassified ORNL memo, copies of which will be sent to E. L. Nicholson. Information not readily obtained from documents or orally will be requested by letter. The information supplied in writing will be considered approved for transmittal.

Eurochemic-Originated Information. Information obtained from Eurochemic, such as reports, flowsheets, and drawings, will be reproduced in sufficient quantity to provide a minimum of one copy each to Argonne National Laboratory, Brookhaven National Laboratory, Feed Materials Production Center, Hanford Atomic Products Operation, Idaho Chemicals Processing Plant, and Savannah River Plant for perusal and comment. Copies will also be distributed at ORNL for comment. Comments will be compiled and transmitted to E. L. Nicholson.

3.3 Status

Ten transmittals of ORNL-originated documents have been sent to E. L. Nicholson. Reports on trips to Hanford Atomic Products Plant Operation and Idaho Chemical Processing Plant have been issued to the sites for approval. Data is being accumulated on head-end processes, off-gas and waste disposal, equipment design, corrosion, Health Physics, analytical procedures and requirements, in-line instrumentation, flowsheet chemistry and performance, and criticality. An outline of the assistance desired is given in Table 3.1.

Table 3.1. Assistance Desired by Eurochemic

<u>Area</u>	<u>Site</u> ⁽¹⁾						
	<u>ANL</u>	<u>BNL</u>	<u>FMPC</u>	<u>HAPO</u>	<u>ICPP</u>	<u>SRP</u>	<u>ORNL</u>
1.0 Equipment Design and Performance							
1.1 Pulsed Columns							
a. Inverted				*			
b. Design of internals				*			
c. Operating characteristics, limitations, flooding data				*	X		*
d. Auxiliary instrumentation and equipment				*	X		*
1.2 Dissolution							
a. Batch				*	X	X	X
b. Continuous					X	X	X
c. Control				X	X	X	*
d. Jacket removal				*	X	X	*
e. Off-gas				*	*	X	*
1.3 Solvent Recovery							
a. Procedure			X	*	*	X	*
b. Equipment			X	*	*	X	X
c. Efficiency			X	*	X	X	*
1.4 Evaporation							
a. Acid recovery				*	X	X	*
b. De-entrainment				*	X	X	*
c. Organic removal			X	*	X	X	*
d. Products			X	*	X	X	*
1.5 Solution Transfer							
a. Pumps				*	X	X	*
b. Airlifts				X	X	X	*
c. Jets				X	X	X	*
d. Metering				X	X	X	X
e. Valves				*	X	X	*

(1)* Information requested

X Information to be requested

Area	Site ⁽¹⁾						
	<u>ANL</u>	<u>BNL</u>	<u>FMPC</u>	<u>HAPC</u>	<u>ICPP</u>	<u>SRP</u>	<u>ORNL</u>
1.6 Waste Disposal							
a. Liquid	X	X	X	*	*	X	*
b. Gases	X	X	X	*	*	X	*
c. Solid	X	X	X	*	*	X	*
1.7 Corrosion							
a. Evaporators			X	*	X	X	*
b. Waste disposal				*	X	X	*
c. Head-end				X	X	X	X
d. Solvent-extraction (General)				X			
1.8 Instrumentation							
a. Standard				*	X	X	*
b. In-line				*	X	X	*
2.0 Plant Operation							
2.1 Criticality - Philosophy, Design				*	*	X	*
2.2 Decontamination Procedures				*	*	X	*
2.3 Health Physics							
a. Hazards	X	X	X	*	*	X	*
b. Exposure control	X	X	X	*	*	X	*
c. Organization	X	X	X	X	X	X	X
d. Instrumentation	X	X	X	X	*	X	*
2.4 Analytical							
a. Manpower and space vs activity level				X	X	X	*
b. Procedures and equipment				X	X	X	*
c. Schedule - frequency, points, philosophy				X	X	X	*
3.0 Process Performance							
3.1 Purex							
a. Chemical flowsheet - concentration, flowrate flowratio limits and effects				*		X	*

(1)* Information requested

X Information to be requested

Area	Site ⁽¹⁾						
	ANL	BNL	FMPC	HAPO	ICPP	SRP	ORNL
b. Physical data, freezing point, viscosity, distribution coefficient				*		X	*
c. Effects of temperature, backmixing				*		X	*
d. Losses, decontamination factor				*		X	*
e. TBP Stability - chemical and radiation				*		X	*
f. Diluents				*		X	*
g. Concentration profile curves				X		X	X
h. Flow vs HETS vs flooding				X		X	X
3.2 "25" Process							
a. Chemical flowsheet - concentration, flowrate, flowratio limits and effects					X	X	X
b. Physical data - freezing point, viscosity, distribution coefficient					X	X	X
c. Effects of temperature, backmixing					X	X	X
d. Losses, decontamination factor					X	X	X
e. TBP Stability - chemical and radiation					X	X	X
f. Diluents					X	X	X
g. Concentration profile curves					X	X	X
h. Flow vs HETS vs flooding					X	X	X
3.3 Head-end							
a. Flowsheets				X	X	X	*
4.0 Plant Construction							
4.1 Engineering manpower			X	X	X	X	*
4.2 Manpower buildup			X	X	X	X	*
(1)* Information requested							
X Information to be requested							

NOTE: The fact that desired assistance is not indicated in a given area should not deter sites from offering such assistance, if available.

APPENDIX I

EUROPEAN ORGANIZATION MEMBERSHIP

1.0 O.E.E.C. - Organization for European Economic Co-operation

<u>Members</u>	<u>Associate Members</u>	<u>Observer</u>
1. Austria	1. Canada	1. Yugoslavia
2. Belgium	2. United States	
3. Denmark	3. Spain	
4. France		
5. Germany		
6. Greece		
7. Iceland		
8. Ireland		
9. Italy		
10. Luxembourg		
11. the Netherlands		
12. Norway		
13. Portugal		
14. Sweden		
15. Switzerland		
16. Turkey		
17. United Kingdom		

1.1 EPA - European Productivity Agency

1. All O.E.E.C. members
2. Spain

2.0 Eurochemic - European company for the chemical processing of irradiated fuels

<u>Country</u>	<u>Shares</u>	<u>Investment (Dollars)</u>
The Government of the Federal Republic of Germany	68	3,400,000
The Government of the Republic of Austria	20	1,000,000
The Government of the Kingdom of Belgium	44	2,200,000
The Government of the Kingdom of Denmark	22	1,100,000
The Commissariat à l'Energie Atomique in Paris	68	3,400,000
The Comitato Nazionale per le Ricerche Nucleari in Rome	44	2,200,000
The Government of the Kingdom of Norway	20	1,000,000
The Government of the Kingdom of the Netherlands	30	1,500,000
The Junta de Energia Nuclear in Lisbon	6	300,000
Aktiebolaget Atomenergi in Stockholm	32	1,600,000
The Government of the Swiss Confederation	30	1,500,000
The Government of the Turkish Republic	16	800,000

APPENDIX II

EUROPEAN PERSONNEL AND POSITIONS

Interim Board of Directors (partial listing)

Dr. E. Pohland (Germany), Chairman
Mr. E. Svenke (Sweden), Vice Chairman
Dr. Y. Sousselier (France)
Dr. E. Saeland (Norway)
Mr. P. Huet (France), also Director, ENEA
Mr. P. Regnaut (France)

Management Committee

Dr. Y. Sousselier (France), Chairman
Dr. E. Pohland (Germany)
Dr. T. J. Barendregt (Norway)
Mr. M. d'Hont (Belgium)
Dr. E. Saeland (Norway), also Deputy Director, ENEA
Member from Norway

Eurochemic Organization Chart

Director: E. Haeffner (Sweden)

Consultants: M. P. Lung, France
E. L. Nicholson, U.S.A.

Building Section: E. Lüscher 2 draftsmen
W. Schüller

Flowsheet Section: E. Hoffmann (Extraction) 5 technicians
E. Detilleux (Head End) 2 assistant technicians
M. Zifferero (Tail End)

Equipment Section: O. Jenne (Equipment design) 5 draftsmen
A. Redon (Cold Pilot Plant)
R. Winckler (Instruments)

Health Physics Section: Moeken

Development and Analytical
Section: S. Ahrland (Development) 1 technician
K. Samsahl

Administration

Accounting and Purchasing: P. Chauvelier
1 Assistant
1 Secretary

Personnel and Ext. Relations: E. Esling
1 Secretary
1 Porter

Documentation: Miss A. Norstrom

APPENDIX III

OUTLINE OF CONTENTS
OF

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December, 1957

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Convention

Protocol

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LIST OF MEMBERS OF THE STEERING COMMITTEE AND OF THE
STUDY GROUP AND WORKING GROUPS

Study Group, Working Groups and Working Parties of the Steering Committee for
Nuclear Energy

Steering Committee for Nuclear Energy

Participants in the Study Group for the Setting Up of a Joint Undertaking
for the Chemical Processing of Irradiated Fuels

Working Group on Experimental Reactors

Working Group on Nuclear Power Stations

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