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APPENDIX "D"

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON 25, D. C.

February 19, 1960

MEMORANDUM FOR: Mr. Philip J. Farley
Department of State

SUBJECT: CONTROL OF AND COOPERATION IN GAS CENTRIFUGE RESEARCH AND DEVELOPMENT TECHNOLOGY

The attached background paper summarizes the current state of the art both domestically and abroad in the gas centrifuge method of U-235 isotope separation. It notes that as a result of recent developments here and in Germany, the process now shows significant promise of producing U-235 at a cost bracketing the AEC published price schedule. The capital costs, power requirements, and technical skills necessary to build and operate a production scale plant may shortly be within the capabilities of as many as 20 to 30 foreign countries if development meets expectations and the technology remains unclassified. The implications of this on the Nth power problem are obvious. The staff is now preparing recommendations for Commission consideration as to (1) the future scope of our own gas centrifuge program; (2) control of the gas centrifuge process including information in the light of the Nth power problem; and (3) cooperation with the Germans, Dutch, and possibly others in this area.

Because of the complexity and interdependence of the foreign and domestic aspects of this problem, we would appreciate the views of the Department as to the several questions raised in the attached paper.

Members of my staff are, of course, available to discuss this matter in further detail and provide such additional technical background information as may be of assistance to you.

A. A. Wells, Director
Division of International Affairs

ENCLOSURE TO APPENDIX "D"

CONTROL OF AND COOPERATION IN GAS CENTRIFUGE RESEARCH AND DEVELOPMENT TECHNOLOGY

The Commission has for a number of years supported a modest experimental program at the University of Virginia in the separation of U-235 isotopes by the gas centrifuge process. Most of this work has been done on a classified basis and has not been pursued as a matter of priority due principally to the lack of a foreseeable need for expanded United States U-235 production and the relatively high efficiency of our present diffusion plant.

Within Germany a gas centrifuge research and development program has gone forward with groups working at the Universities of Bonn and Kiel, the Max Planck Institute at Aachen, and at DEGUSSA and AEG. All of the German work has been done on an unclassified basis and aimed primarily at developing the process for commercial exploitation. In addition, a Dutch group has been working under the FOM (Society for Fundamental Studies on Matter) at several different sites on a basis which appears to be partially classified. Although the Dutch interest is undoubtedly partly commercial, the possibility of using the process for developing a native U-235 capability for national purposes such as naval propulsion was noted in our recent discussions with the Dutch Naval Group.

Until recently, the state of the art both domestically and abroad did not suggest that the economics of the gas centrifuge process were sufficiently attractive to justify consideration of building a centrifuge plant. As a result of developments in Germany and in the United States, it now appears possible that a gas centrifuge plant could be designed, built, and put into operation within the next five years in the United States that would produce U-235 at a cost roughly equivalent to our published prices. The basis for this assumption is a detailed study that has already been prepared for the Commission by the General Electric Company. It should also be noted that the building of such a plant in Germany is judged by the General Electric study group to be within the capability of the Germans. It does not appear, moreover, that successful conclusion of such a project either in the United States or Germany is dependent upon cooperation since the state of technological advancement is roughly equal in both countries, with the Germans, if anything, enjoying a slight lead.

At the present time, the information which has been published on the German centrifuge effort (the ZG-III model developed by Professor Beyerle of the Aachen Group) if used as the basis of a separations plant, would result, according to our estimates, in the production of U-235 at a cost approximately ten times that of our published price schedule. A refined model of this centrifuge (the ZG-VII) is also unclassified and is currently an article of commerce. (The Commission has issued a license to Thor-Westcliffe to import seven of the ZG-VII centrifuges into the United States. We understand Thor-Westcliffe plans to construct an experimental cascade for purposes of studying the economic potential of the

process.) Complete information, however, has not yet been published on the ZG-VII. According to our estimates, a plant designed around this unit if built could produce U-235 at a cost of two to four times our published price.

The General Electric study referred to above would require a $6 million research and development program to advance present technology to the point where a plant could be built to produce U-235 at a competitive price.

We have reviewed these developments in light of the potential of the gas centrifuge process for contributing to the Nth power problem. Our preliminary conclusion is that this potential is significant and that the process now may, in some circumstances, be equal to or slightly more attractive than the plutonium reactor route. Some of the more significant factors underlying this conclusion as useful to an appreciation of the problem. The hypothetical plant described in the General Electric study would cost from 17 to 24 million dollars, would be capable of producing 500 kgs of U-235 at 95% enrichment annually, and would have a total annual power requirement of approximately one megawatt of electricity. Except for the preparation of feed materials, the skills needed to design and construct such a plant are primarily in the area of mechanical engineering and are available to perhaps some 20-30 countries.

The principal liability of the centrifuge route as against the plutonium reactor route today lies in the fact that centrifuge technology is yet to be proven and the designs of the more advanced centrifuge units have not as yet been published, nor have these units been tested. Because of our concern with the attractiveness of the process to a potential Nth power we are studying what steps might be taken to control centrifuge technology both in this country and abroad. It should be noted that independent of this study, the staff has under consideration a recommended research and development program designed to advance gas centrifuge technology within the United States to a point where it could produce U-235 at a cost competitive with our published price schedule. The principal justification for adopting such a program would be to maintain U.S. leadership in isotope separation technology rather than to fulfill any currently forecast requirement for expanded U.S. production capacity.

In view of the potential of this process for contributing to the Nth power problem, our current intention would be to carry out such a program on a classified basis in order most effectively to safeguard the technology.

Clearly, however, any classification action the Commission might take could be vitiated if the German activities were to proceed on an unclassified basis. It appears to us, therefore, that it is important to determine whether the German Government could and would classify its work in gas centrifuge technology.

We are mindful of several problems in this regard which could make such an action difficult. The German development to date has been undertaken almost exclusively by private parties interested in ultimate commercial exploitation. To the best of our knowledge, the German Atomic Ministry has no classified

programs due in part at least to Germany's commitments under the Brussels Treaties. Any modification of this position could perhaps have serious political repercussions in Germany. It is unclear both from the standpoint of Treaty provisions and policy as to whether Germany could or would take a classification action in this area that would prevent dissemination of the technology to her EURATOM partners, although limitation of the technology to the EURATOM members would obviously constitute a degree of information control substantially greater than a completely unclassified development. The problem as regards the Netherlands is not treated separately here but we would assume that the EURATOM aspects would be similar.

Notwithstanding these problems, we believe that the safeguarding of ultra-centrifuge technology by agreed procedures for the control of this information among the several states in which centrifuge work is being carried out is important and should be explored. It would further appear to us that such exploration should in the first instance be with the German and Dutch Governments.

We believe, moreover, that regardless of whether these governments or EURATOM could control their present and future gas centrifuge information by classification or otherwise agreement should be sought to control the export of gas centrifuges and related equipment and to subject such export to safeguards. It is our impression that agreement on such controls could probably be successfully negotiated, and taken together with the agreed controls we are seeking among uranium supplier nations would mitigate to some extent at least the likelihood of an Nth power exploiting the process.

As a related matter, the Commission staff recognized the technical desirability of cooperating in centrifuge research and development with the Germans and the Dutch. While such cooperation is not essential to achieving the stated objectives of the proposed U.S. developmental program, it is reasonable to assume that it would contribute to the rate and probability of their achievement. In addition it would permit an immediacy of association with the European development which in itself could enhance control. If it proves feasible, therefore, for the Dutch and Germans to establish control over existing and future gas centrifuge information, the possibility of cooperating with those two countries on a classified basis should be examined. We recognize that classified cooperation with the Germans and the Dutch raises certain problems with respect to EURATOM, including the concurrence of the Community in the negotiation of new bilateral instruments and the feasibility of the German and Dutch governments' segregating their work from their EURATOM partners. In this regard the possibility of considering a classified agreement with EURATOM to permit exchange of gas centrifuge information deserves examination as a means for cooperating with the Germans and the Dutch even though we recognize the policy problems that such an Agreement would present to both the Europeans and ourselves.

Finally, if agreement cannot be reached with the Germans and the Dutch to control gas centrifuge information, then there may be serious question as to whether a real purpose would be served in classifying any of our own work. Should we, therefore, as a

result of our inability to secure German and Dutch agreement to control centrifuge information, decide to declassify our own work, it would appear possible to work out an arrangement for unclassified technical exchange with the Germans and Dutch under the ambit of EURATOM if this should prove desirable, and, probably without modification of our existing Agreements for Cooperation either with EURATOM or the member states.

The staff is now preparing recommendations for Commission consideration as to (1) the future scope of our own gas centrifuge program; (2) control of the gas centrifuge process including information in light of the Nth power problem; and (3) cooperation with the Germans, Dutch, and possibly others in this area. Because of the complexity and interdependence of the foreign and domestic aspects of this problem, we would appreciate the views of the Department as to:

a. Whether an approach to the German or Dutch Governments to seek their agreement on classifying or otherwise controlling present and future work is feasible and desirable from an over-all U.S. foreign policy standpoint; and

b. Whether the German Government to your knowledge, could or would, in view of its Treaty and foreign policy commitments, be likely to agree to such an action.

On the basis of your consideration of these questions we would appreciate your views regarding the general desirability of cooperation in this field including your specific comments as to:

a. Whether, if the German and Dutch Governments could agree to the control of gas centrifuge information it would be desirable from a U.S. foreign policy standpoint to cooperate with them bilaterally on a classified basis in a research and development program; and, if not, whether it would be possible or desirable to seek to do so with EURATOM under a classified agreement.

b. Whether, if it is not possible for the Dutch and Germans to agree to control gas centrifuge information it would be desirable from a foreign policy standpoint to cooperate with the Dutch and Germans either bilaterally or through and with EURATOM.