November 23, 1965
Glenn Seaborg, Chairman, Atomic Energy Commission, to National Security Adviser McGeorge, Bundy, enclosing summary of 'Nth Country Evaluation'

Citation:

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Summary:

Summary of Union Carbide’s 1964 study on gas centrifuge technology’s effect on nuclear proliferation. The summary provides Union Carbide’s estimations for how long countries of varying industrial capability would take to develop a nuclear weapon, which was redacted in the original document.

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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

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McGEORGE BUNDY'S OFFICE

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DECLASSIFIED
E.O. 12958, Sec. 3.6
NLJ 10-283
By lal, NARA, Date 8-23-10

Dear Mac:

My letter of July 16, 1964 discussed various aspects of gas centrifuge technology as related to the Nth power problem and transmitted a copy of a report (K-OA-1237) on this subject. The purpose of this letter is to comment further on this problem following discussions which Commissioner Palfrey and I had with you on August 5, 1965.

Our assessment of the feasibility for use of gas centrifuges in clandestine operation for production of weapons material has not changed since preparation of the report previously transmitted. Attached for your information is a brief summary of this report supplemented to indicate the current status of gas centrifuge technology. A re-evaluation of the Nth power problem, based on developments that will be made during the AEC's current three year gas centrifuge development program, is expected to be issued in the latter part of 1966.

A number of steps have been taken to minimize the proliferation problem associated with the gas centrifuge process. Although the AEC is continuing its classified development program in order to improve its ability to properly assess the potential of the process, we do not plan to permit industry to have access to the technology developed by AEC after June 30, 1964. Prior to that date, a limited number of companies had access to AEC information provided each company met the qualifications and criteria established by the AEC for such access. In addition to tightening control of the technology developed by the AEC, it was necessary to consider an approach to minimizing the potential for proliferation of this process as developed in foreign countries.

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Arrangements for controlling dissemination of information on gas centrifuge technology by means of classification have been developed and are in effect with the United Kingdom, West Germany, and the Netherlands. These arrangements have been voluntarily put into effect as a result of discussions among the parties. They are not set forth in any formal agreement. Our discussions have indicated strong resistance, particularly on the part of the Germans, to a formal agreement to classify and control dissemination of information in this area, but we plan to continue to press the point in future consultations with these governments.

The exchange of gas centrifuge information with the United Kingdom was terminated on June 30, 1965 by a declaration that information now being generated in the U.S. development program represented production technology which was not transmissible under the bilateral. This was the only bilateral agreement permitting an exchange of classified information on the process.

The AEC's action of June 30, 1964, removing the Commission's gas centrifuge restricted data from the Access Permit Program, thereby denying further access by domestic private industry to the AEC's gas centrifuge information, strengthened the U.S. position with foreign governments with respect to our determination to prevent the dissemination of this information. AEC has granted permission for General Electric/Allied Chemical and W. R. Grace/Electro-Nucleonics Inc. to continue on a classified basis, privately financed, laboratory scale, research and development programs in the gas centrifuge field. However they do not have access to current data from AEC sponsored work in this field and Grace/Electro-Nucleonics have not had access to any AEC classified gas centrifuge information.

If these approaches do not prevent the construction of production scale gas centrifuge plants in other countries, every effort would have to be made to bring such plants under a safeguards system designed to insure that their output was used solely for peaceful purposes.

It should be noted that the IAEA has not yet had occasion to consider inspection of gas centrifuges or other types of isotope separation plants. However, in the June 25, 1964 Working Paper on Inspection of a Fissionable Material Cutoff tabled by the U.S. Delegation to the Eighteen Nation Disarmament Conference, a scheme was outlined for perimeter inspection of declared

isotope separation plants of nuclear countries producing enriched uranium for peaceful purposes. Such inspection would involve continuous ground access at the perimeter of the process buildings, measurement of electrical input to the plant, and measurement of perimeter uranium input and declared product output and uranium tails. It was envisioned that IAEA or a similar international safeguards group would, through such inspection, be able to estimate U-235 production adequately to assure detection of diversions by nuclear powers, of quantities that would be significant, relative to existing stocks. A satisfactory inspection system for non-nuclear powers for gaseous diffusion isotope separation facilities has not been formulated to date. It may be possible that a perimeter inspection scheme utilizing continuous sampling of feed product and tails, or some other system of inspection not requiring access to process equipment, could be developed for a gas centrifuge plant that would be suitable for application by IAEA or a similar international inspectorate.

I trust that this information will be helpful in providing a meaningful perspective of the current situation with respect to gas centrifuge technology in relation to the Nth power problem. If you would like additional information on any particular points please let me know.

Cordially,

[redacted]

Chairman

Honorable McGeorge Bundy
Special Assistant to the President
for National Security Affairs

Enclosure:
Summary of Report K-OA-1237, Cy 1A

cc: Dr. D. F. Hornig, Director
Office of Science and Technology
Cy 3A, w/encl. Cy 2A

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SUMMARY REPORT OF NTH POWER PROBABILITY OF PRODUCING ENRICHED URANIUM VIA THE GAS CENTRIFUGE PROCESS

The following summary highlights the most significant information contained in report K-OA-1237, Nth Power Evaluation, which was issued on March 4, 1964. This report is an extension and a refinement of an earlier report*, published in 1960, which attempted to correlate the probability of some country (an Nth Power) successfully producing enriched uranium for weapons purposes by means of a clandestine gas centrifuge plant, with the industrial capability of that country. For this purpose the countries of interest were divided into three groups designated by X, Y and Z. Group X countries are those which possess a relatively high degree of technological competence and which have a high level of industrial activity, e.g., West Germany, Sweden, Japan, the Netherlands, and Italy. Group Z countries are those which possess relatively little technological skill and which have little industrial activity, e.g., Egypt, Peru and Pakistan. Group Y countries are those which lie in between and which have limited internal industrial activity, e.g., Brazil, Israel, India and Yugoslavia.

The 1960 report was a very preliminary evaluation which was based on meagre experimental data. The 1964 report covers a wider range of production rates and incorporates the technological advances through 1963 from the AEC gas centrifuge development program.

The experimental work performed by the AEC over the three year period (1960-1963) on the development of the gas centrifuge process for producing enriched uranium supports the conclusion made in 1960, that a number of countries could successfully develop the process, and thereby could produce nuclear weapons using U-235.

It is estimated in the 1964 report that Group X countries could develop and have in operation a small gas centrifuge production plant, capable of producing sufficient weapons-grade enriched uranium (90% U-235) for at least a single weapon, in approximately eight years. This assumes that these countries have no technical knowledge of the U.S. developments; having such knowledge, the time would be shortened to about five years. This does not include the time that would be

* K-OA-662, "Production of Nuclear Weapons by Nations X, Y and Z by Means of the Gas Centrifuge Process"

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needed to develop the actual weapon, but this might be done concurrently with the construction and operation of the production plant.

For Group Y countries, the time to produce sufficient material for a weapon would be about 12 years if the country had no knowledge of U.S. developments, and about seven years if they have U.S. information. These countries would probably have to import some of the hardware and auxiliary equipment necessary to fabricate the centrifuge plant.

Group Z countries would probably have to purchase prefabricated centrifuges and almost all of the auxiliary equipment for the centrifuge plant from foreign vendors. In addition, they would need technical advisors from the outside to aid in the construction and operation of the centrifuge plant. Hence, the Group Z countries probably could not develop a centrifuge model on their own. However, if they did gain knowledge of the U.S. development, the estimated time to produce enough 90% enriched uranium for a weapon is approximately nine years.

A comparative estimate of construction and operating costs, operating manpower requirements, and time to produce material for the first weapon, is presented in Table A for both a small (50 Kg of 90% U-235 per year) and a larger size (500 Kg of 90% U-235 per year) U-235 production complex utilizing the gas centrifuge process. Two subcritical models, a 1963 model operating at a peripheral speed of [redacted] and an advanced model, with a projected speed of [redacted] are used to show the effect of improved design and increased speed on the costs and operating work force requirements. A technologically advanced (Group X) country is assumed as the Nth Power. 6.2 (a)

The physical concealment of centrifuge plants of these capacities should present no problems because of their relatively small size (less than an acre). The feed and metals processing facilities are small operations, which could be performed within the centrifuge separation plant. The power requirements for the centrifuge plant will be small ranging from [redacted] for the small plant and [redacted] for the large plant, depending upon which centrifuge model is assumed. Disposal of the effluents from a centrifuge plant would pose no problem. The waste streams from a year's operation could be contained in a few large UF_6 cylinders which could be stored conveniently anywhere within the plant. The off-gases from the feed and metals plant could probably be neutralized with caustic and the product deposited in seepage pits. 6.2 (a)

The report shows that by further development and improvement, the projected Nth country resource requirements for the gas centrifuge-enriched uranium route could be substantially reduced below those shown in Table A. This large reduction in resource requirements for advanced centrifuge plants reinforces the necessity of maintaining current restrictions on dissemination of information on centrifuge technology.

As this report is based on developments and information that existed in late 1963, it should be noted that substantial progress has been made in the AEC's experimental gas centrifuge program since then. The 1965 production model centrifuge, for example, is operating in an experimental gas centrifuge cascade of 35 units at [redacted] close to the peripheral speed shown in the attached Table for the advanced model. A detailed re-examination of the gas centrifuge with respect to its significance to the Nth Power problem will be made during the Fall of 1966, and an updated (based on the latest developments) Nth Power report will be issued shortly thereafter. 6.2(a)

Attachment:
Table A, "Gas Centrifuge Plant
Summary Group X Nation"

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TABLE A

GAS CENTRIFUGE PLANT SUMMARY
GROUP X NATION

Production Rate	50 Kg U/Yr	
	1963 Model centrifuge	Advanced Sub-critical Model
	[redacted]	[redacted]
Capital Cost, $	$30,800,000	$13,850,000
Operating Cost, $/Yr	4,000,000	2,100,000
Operating Work Force		
Total	309	153
Technical	21	18
Time to Produce* Material for 1st Weapon, Years	5	5

6.2 (a)

Production Rate	500 Kg U/Yr	
	1963 Model centrifuge	Advanced Sub-critical Model
	[redacted]	[redacted]
Capital Cost, $	$260,600,000	$101,200,000
Operating Cost, $/Yr	22,900,000	10,100,000
Operating Work Force		
Total	1,616	707
Technical	71	39
Time to Produce* Material for 1st Weapon, Years	5	5

6.2 (a)

* For each case it is assumed that the Nth country has knowledge (blueprints, etc.) of the model of centrifuge involved. Time referred to, therefore, is solely the construction time required to go from demonstrated technology to the finished plant plus the time then needed to obtain enough product material for the first weapon. No judgment has been made concerning the time that would be necessary to develop the actual weapon (which might be done concurrently with the construction and operation of the production plants).

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